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MACHINERY

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September, 1911, to August, 1912

Engineering and Shop Editions

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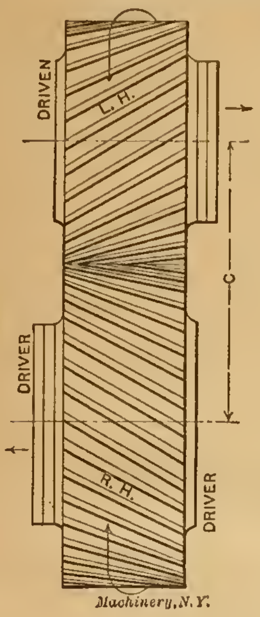
SPIRAL GEARS—IV

Contributed by James H. Carver

Shafts Parallel, Ratio Unequal, Center Distance Exact



Given or assumed:

1. Position of gear having right- or left hand spiral depending upon rotation and direction in which thrust is to be be received. (See thrust diagram.)
2. C = exact center distance = pitch diameter.
3. P_n = normal pitch (pitch of cutter).
4. N = number of teeth in large gear.
5. n = number of teeth in small gear.

To find:

1. $\cos \alpha = \dfrac{N+n}{2\,P_n\,C}$
2. D = pitch diameter large gear $= \dfrac{N}{P_n \cos \alpha}$
3. d = pitch diameter of small gear $= \dfrac{n}{P_n \cos \alpha}$
4. O = outside diameter of large gear $= D + \dfrac{2}{P_n}$
5. o = outside diameter of small gear $= d + \dfrac{2}{P_n}$
6. T = number of teeth marked on cutter (large gear) $= \dfrac{N}{\cos^3 \alpha}$
7. t = number of teeth marked on cutter (small gear) $= \dfrac{n}{\cos^3 \alpha}$
8. L = lead of spiral (large gear) $= \pi\, D \cot \alpha$
9. l = lead of spiral (small gear) $= \pi\, d \cot \alpha$

Example

Given or assumed:

1. Fig. 1 (thrust diagram). 2. $C = 18.75$ inches. 3. $P_n = 4$. 4. $N = 96$. 5. $n = 48$.

To find:

1. $\cos \alpha = \dfrac{N+n}{2\,P_n\,C} = \dfrac{96+48}{2 \times 4 \times 18.75} = 0.96. \quad \therefore \alpha = 16° 16'.$
2. $D = \dfrac{N}{P_n \cos \alpha} = \dfrac{96}{4 \times 0.96} = 25$ inches; 3. $d = \dfrac{n}{P_n \cos \alpha} = \dfrac{48}{4 \times 0.96} = 12.5$ inches;
4. $O = D + \dfrac{2}{P_n} = 25 + \dfrac{2}{4} = 26.5$ inches; 5. $o = d + \dfrac{2}{P_n} = 12.5 + \dfrac{2}{4} = 13$ inches;
6. $T = \dfrac{N}{\cos^3 \alpha} = \dfrac{96}{(0.96)^3} = 108$ teeth; 7. $t = \dfrac{n}{\cos^3 \alpha} = \dfrac{48}{(0.96)^3} = 54$ teeth;
8. $L = \pi\, D \cot \alpha = 3.1416 \times 25 \times 3.427 = 269.15$ inches.
9. $l = \pi\, d \cot \alpha = 3.1416 \times 12.6 \times 3.427 = 134.67$ inches.

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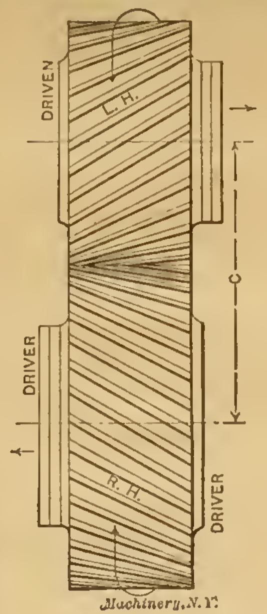
SPIRAL GEARS—III

Contributed by James H. Carver

Shafts Parallel, Ratio Unequal, Center Distance Approximate



Given or assumed:

1. Position of gear having right- or left-hand spiral depending upon rotation and direction in which thrust is to be received. (See thrust diagram.)
2. C_a = approximate center distance.
3. P_n = normal pitch.
4. N = number of teeth in large gear.
5. n = number of teeth in small gear.
6. α = angle of spiral.

To find:

1. D = pitch diameter of large gear $= \dfrac{N}{P_n \cos \alpha}$
2. d = pitch diameter of small gear $= \dfrac{n}{P_n \cos \alpha}$
3. O = outside diameter of large gear $= D + \dfrac{2}{P_n}$
4. o = outside diameter of small gear $= d + \dfrac{2}{P_n}$
5. T = number of teeth marked on cutter (large gear) $= \dfrac{N}{\cos^3 \alpha}$
6. t = number of teeth marked on cutter (small gear) $= \dfrac{n}{\cos^3 \alpha}$
7. L = lead of spiral on large gear $= \pi\, D \cot \alpha$.
8. l = lead of spiral on small gear $= \pi\, d \cot \alpha$.
9. C = center distance (if not right vary α) $= \frac{1}{2}\,(D + d)$.

Example

Given or assumed:

1. Fig. 1 (thrust diagram). 2. $C_a = 17$ inches. 3. $P_n = 2$. 4. $N = 48$. 5. $n = 20$.
6. $\alpha = 20$ degrees.

To find:

1. $D = \dfrac{N}{P_n \cos \alpha} = \dfrac{48}{2 \times 0.9397} = 25.541$ inches. 2. $d = \dfrac{n}{P_n \cos \alpha} = \dfrac{20}{2 \times 0.9397} = 10.642$ inches.
3. $O = D + \dfrac{2}{P_n} = 25.541 + \dfrac{2}{2} = 26.541$ inches. 4. $o = d + \dfrac{2}{P_n} = 10.642 + \dfrac{2}{2} = 11.642$ inches.
6. $T = \dfrac{N}{\cos^3 \alpha} = \dfrac{48}{(0.9397)^3} = 57.8$, say 58 teeth. 6. $t = \dfrac{n}{\cos^3 \alpha} = \dfrac{20}{(0.9397)^3} = 24.1$, say 24 teeth
7 $L = \pi\, D \cot \alpha = 3.1416 \times 25.641 \times 2.747 = 220.42$ inches.
8. $l = \pi\, d \cot \alpha = 3.1416 \times 10.642 \times 2.747 = 91.84$ inches.
9. $C = \frac{1}{2}\,(D + d) = \frac{1}{2}\,(26.541 + 10.642) = 18.091$ inches.

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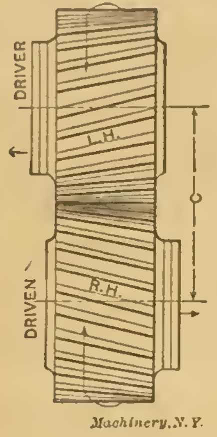
SPIRAL GEARS—II

Shafts Parallel, Ratio Equal, Center Distance Exact



Machinery,N.Y.

Given or assumed:

1. Position of gear having right- or left-hand spiral depending on rotation and direction in which thrust is to be received.
2. C = exact center distance = pitch diameter D.
3. P_n = normal pitch (pitch of cutter).
4. N = number of teeth in each gear.

To find:

1. $\cos\alpha = \dfrac{N}{P_n D}$
2. O = outside diameter $= D + \dfrac{2}{P_n}$
3. T = number of teeth on cutter $= \dfrac{N}{\cos^3\alpha}$
4. L = lead of spiral $= \pi D \cot\alpha$.

α is usually less than 20 degrees to avoid excessive end thrust.

Example

Given or assumed:

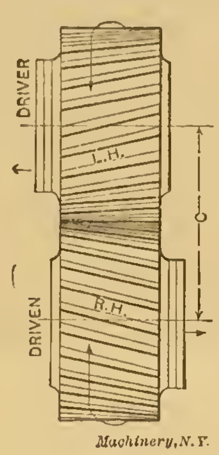
1. Fig. 4 (thrust diagram). Direction of spiral reversed, also direction of rotation.
2. $C = 3$ inches.
3. $P_n = 8$.
4. $N = 22$.

To find:

1. $\cos\alpha = \dfrac{N}{P_n D} = \dfrac{22}{8 \times 3} = 0.9166$ or $\alpha = 23° 34'$
2. $O = D + \dfrac{2}{P_n} = 3 + \dfrac{2}{8} = 3\frac{1}{4}$ inches.
3. $T = \dfrac{N}{\cos^3\alpha} = \dfrac{22}{(0.92)^3} = 28.2$, say 28 teeth.
4. $L = \pi D \cot\alpha = 3.1416 \times 3 \times 2.29 = 21.58$ inches.

SPIRAL GEARS—I

Shafts Parallel, Ratio Equal, Center Distance Approximate



Machinery,N.Y.

Given or assumed:

1. Hand of spiral on driver or driven gear depending on rotation and direction in which thrust is to be received.
2. C_a = approximate center distance.
3. P_n = normal pitch (pitch of cutter).
4. N = number of teeth.
5. α = angle of spiral (usually less than 20 degrees to avoid excessive end thrust).

1. D = pitch diameter $= \dfrac{N}{P_n \cos\alpha}$
2. O = outside diameter $= D + \dfrac{2}{P_n}$
3. T = number of teeth marked on cutter $= \dfrac{N}{\cos^3\alpha}$
4. L = lead of spiral $= \pi D \cot\alpha$.

Example

Given or assumed:

1. Fig. 4. (thrust diagram). Direction of spiral reversed, also direction of rotation.
2. $C_a = 3$ inches.
3. $P_n = 8$
4. $N = 24$
5. $\alpha = 15$ degrees.

To find

1. $D = \dfrac{N}{P_n \cos\alpha} = \dfrac{24}{8 \times 0.9659} = 3.106$ inches.
2. $O = 3.106 + \frac{2}{8}. = 3.356$ inches.
3. $T = \dfrac{N}{\cos^3\alpha} = \dfrac{24}{0.9} = 26.6$, say 27 teeth.
4. $L = \pi D \cot 15° = 3.1416 \times 3.106 \times 3.732 = 36.416$ inches.

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Supplement to MAC

Formulas for Article in thi

MACHINERY
September, 1911

THE PROCESS OF MANUFACTURING PERMANENT MAGNETS*

By F. B. HAYS†

PERMANENT magnets are used on magnetos, tools, slot machines, toys, voltmeters, ammeters, speedometers, telephones, wattmeters, ignition devices, recording instruments, compasses, controlling devices, physical instruments, and switches. The magnets used on these devices are of various shapes and sizes, the illustration, Fig. 1, representing the most common forms in use at the present time.

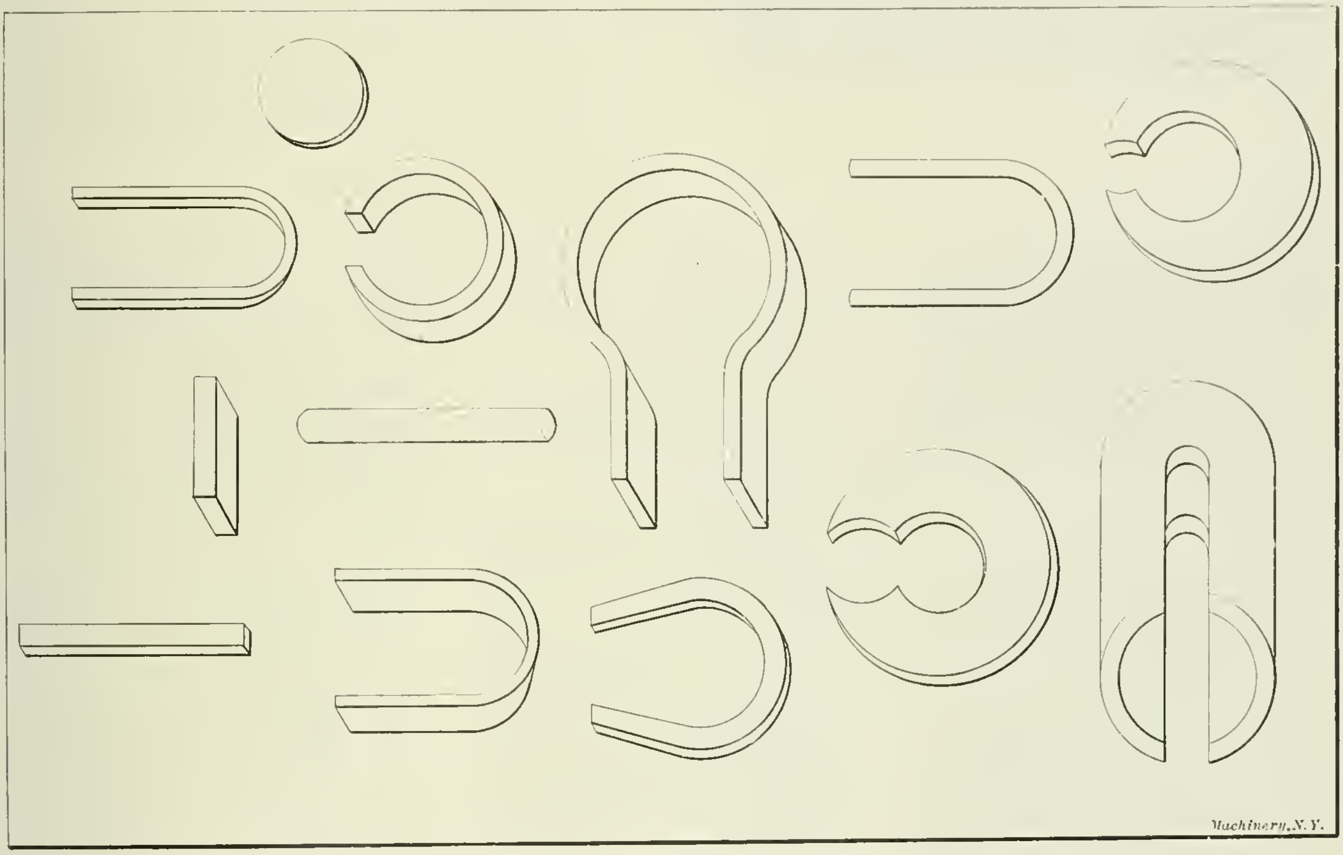
Machinery,N.Y.

Fig. 1. A Collection of Various Types and Shapes of Permanent Magnets

The extensive use of permanent magnets, together with scientific methods of manufacturing them, has come about only in recent years. Ten years ago the production of permanent magnets was a branch of manufacturing of very little consequence, while today it is one of the important phases of the steel-working industry. Every plant making permanent magnets has its own process of manufacture, but the underlying and fundamental principles for the production of successful magnets are the same in all. A summary of these methods is given in this article.

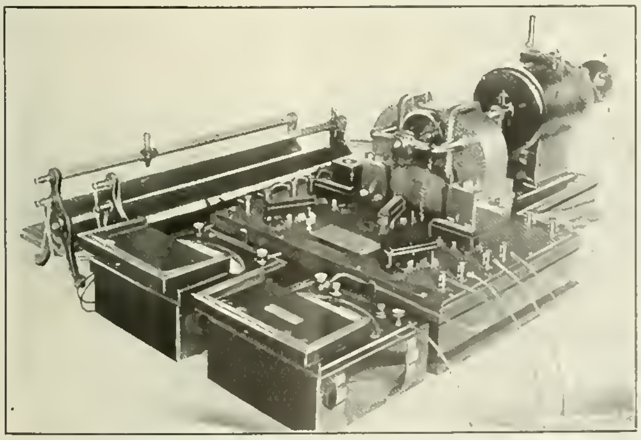

Fig. 2 Esterline Permeameter used for Testing Magnet Steel

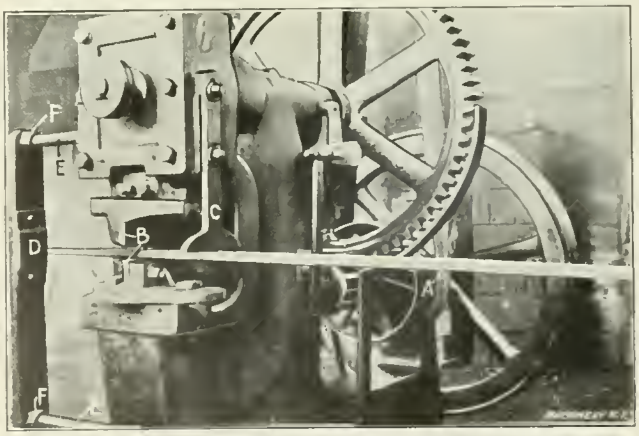

Fig. 3. Shearing Magnet Bars to the Required Lengths

Steel Used for Making the Magnets

Permanent magnets are made from alloy steels. The composition of these steels is governed to a large extent by the various purposes for which the magnets are to be used. For instance, telephone magnets are made from 50- to 60-point carbon steel containing a high manganese content. Where a stronger magnet is required, as for magnetos, a 50- to 60-point carbon steel with a 3 to 7 per cent tungsten content is used.

Magnet steel is hard and tough before hardening, and its physical properties closely resemble those of low carbon tool steel. In several plants the scrap from the magnet department is used for lathe and shaper tools in the machine shop. After hardening (chilling), the steel becomes as hard and nearly as brittle as glass. Magnet steel is rolled into bars and sheets of any desired size. Bar magnets such as are used on wattmeters and most magnetos are made from bars, while plate magnets such as those in telephone receivers and on some types of magnetos are made from sheets. The principal requisites of a good magnet steel are: uniformity of composition, freedom from blow-holes and seams, high magnetic qualities, retentivity, and freedom from cracks and blisters after treating.

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* For additional information on this and kindred subjects previously published in MACHINERY, see: "The Operation and Manufacture of Magnetos—1 and 2," October and November, 1910, engineering edition.

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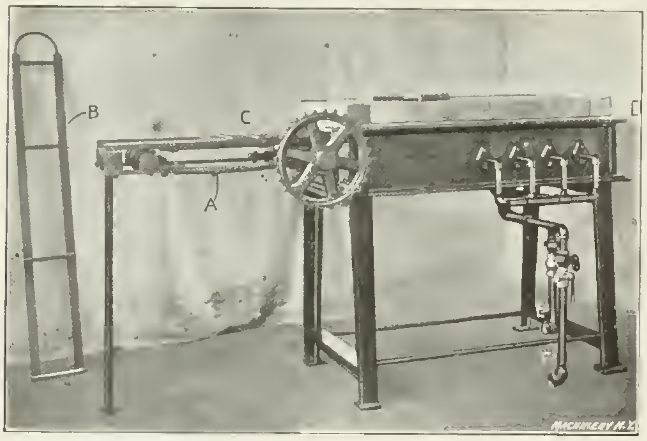


Fig. 4. Gas Furnace for Heating Bar Magnets for Bending

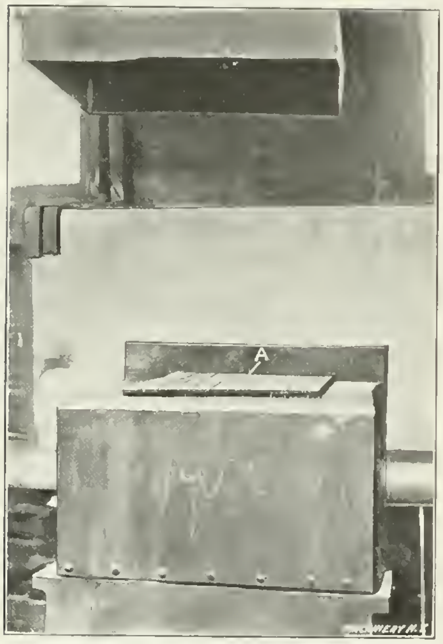


Fig. 5 Coke Furnace for Heating Bar Magnets for Bending—Bar Magnets shown at A

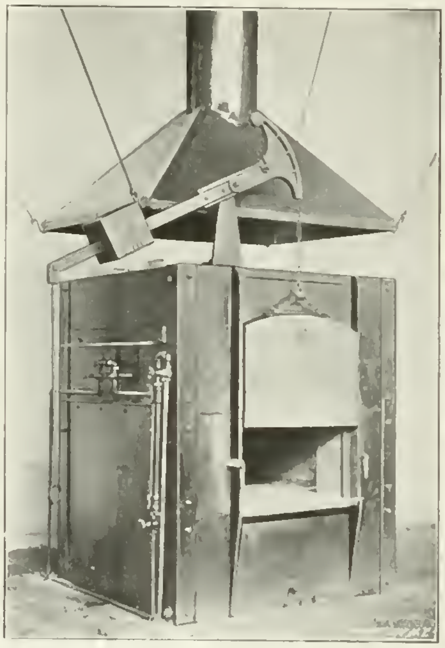


Fig 6. Rockwell Oil Furnaces for Heating Magnets before or after Bending

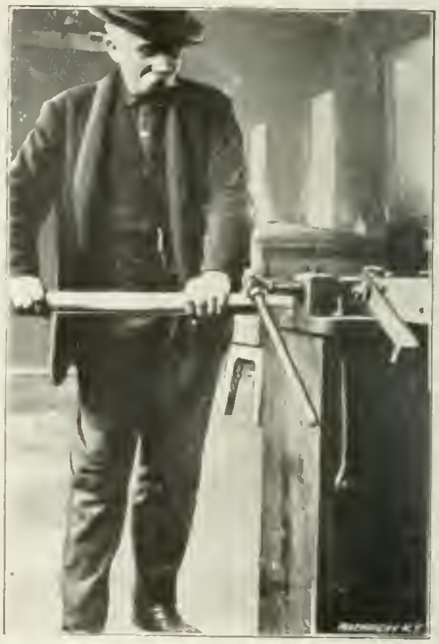


Fig. 7. Forming Odd-shaped Magnets by Hand

Synopsis of the Methods of Making Magnets

The process of making permanent bar magnets may be divided into five distinctive steps, as follows: (1) Testing the steel; (2) cutting the bars to proper lengths; (3) heating and forging; (4) heating and hardening; (5) grinding and magnetizing. For plate magnets, the process is shorter: (1) Testing the steel; (2) punching the plates from the sheet metal; (3) grinding and magnetizing.

Testing the Steel

Magnet steel is usually tested both at the steel mill and at the plant where it is used, to determine the proper "heats", and the magnetic qualities of the steel. Several methods are employed to determine this information, the most efficient of which is the following: Test bars and plates of magnet steel, as well as magnet forgings, which have been treated at different heats are tested for strength, permeability, and retentivity by means of a direct-reading permeameter. The results of these tests show the best temperatures for treating the steel, and also furnish complete data regarding its magnetic qualities. This method is used in the large steel mills and also in most modern magnet manufacturing shops. A direct-reading permeameter which is used for testing the magnet steel bars is shown in Fig. 2. This instrument is made by the Esterline Co., Lafayette, Ind.

Cutting Magnet Bars to Required Lengths

The bars of magnet steel are obtained of the proper width and thickness, and then are sheared to the short lengths required for the magnets. The shears used for this purpose must be of massive construction, low geared, and provided with a heavy flywheel to overcome the sudden resistance offered by the hard-steel bars. The shaft driving the moving head must be adequately large or it will be twisted off when the shear blade strikes a hard spot in the steel, which frequently happens.

Some form of stop must be provided to accurately gage the length to which the bars are cut off. This stop must be strong and rigid and provided with some means of adjustment in order that it may be varied to suit the required length of the bars to be cut. The stop is usually placed on the opposite side from that at which the bar is fed, so that the operator may quickly push the bar through the jaws of the shear until its movement is arrested by one end of the bar butting against the stop.

The illustration, Fig. 3, shows a shear used for cutting the bars to the length required for the magnet. *A* is the bar of magnet steel, *B* the shearing blades, *C* a guide bar, to prevent the bar from tilting when it is being sheared, and *D* a stop for regulating the length of the piece being sheared. The stop *D* is adjusted along the threaded studs *E*, and when in the desired position is locked by the lock-nuts *F*.

Forging

Practically all forms of bar magnets require one or more forging operations, to give them the proper shape. Forging operations on magnets are often termed "heating and

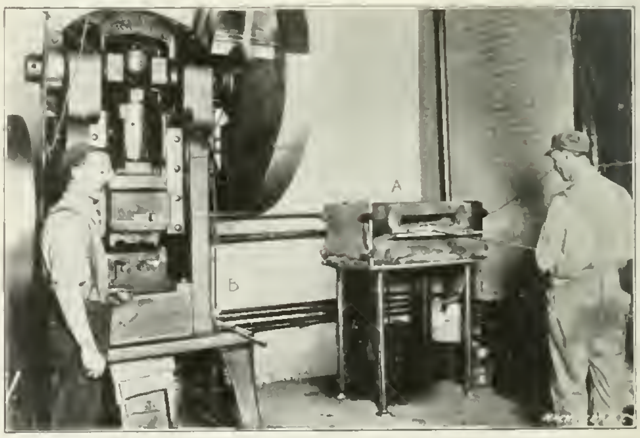


Fig 8. Heating and Bending Magnet Forgings in the Sangamo Electric Co.'s Plant

bending", or "heating and forming", as the short bars (cut to the proper length by the shear) are heated and then bent to the required shapes. The bars are heated to from 1472 to 1652 degrees F. (according to predetermined temperature tests) in coke, oil, or gas furnaces made especially for this work. The illustrations Figs. 4, 5 and 6 and Fig. 8 at *A* show the four types of furnaces used. The heating temperature is regulated by electric pyrometers, as shown in Fig. 10. Coke furnaces are rapidly being superseded by oil and gas furnaces, as the latter can be more accurately regulated and produce better results.

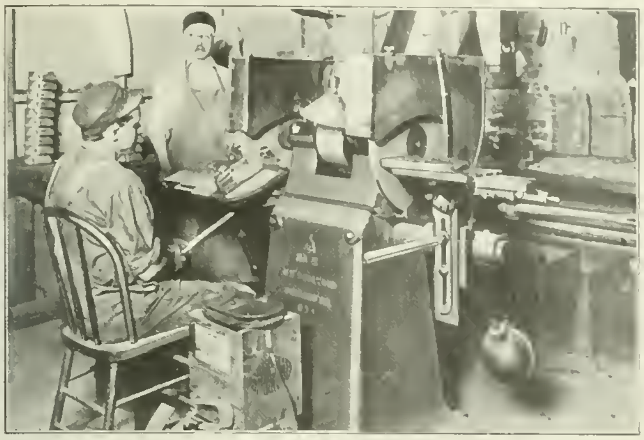


Fig. 9. Grinding Magnet Forgings

The most recent development in this line is a furnace made by the American Gas Furnace Co., shown in Fig. 4. This furnace is equipped with a power-driven endless chain *A* upon which is placed the carrier *B* loaded with the short magnet bars. The carrier moves slowly from left to right, the cold bars entering at *C*, being heated to the required temperature and discharged at *D*, at the rate of about six bars a minute. *E* is the gas inlet and *F* the air-blast inlet.

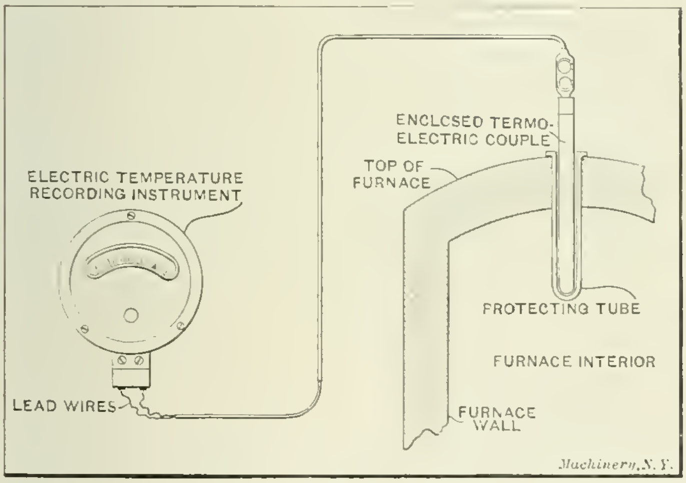


Fig. 10. Showing Application of an Electric Pyrometer to Magnet Heating Furnace

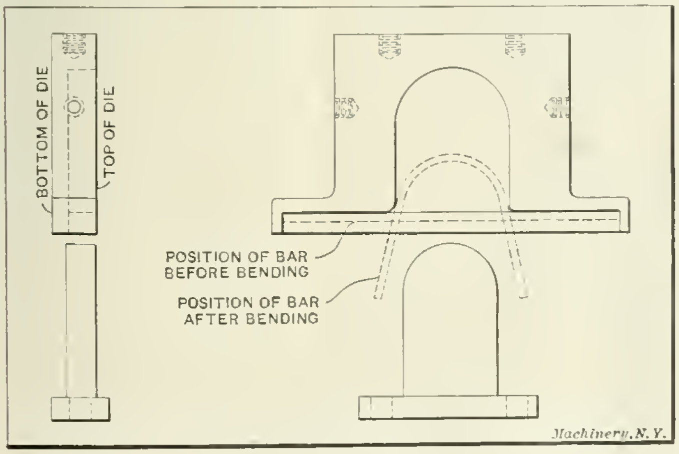


Fig. 11. Punch and Die used for Forming U-shaped Magnets in a Bulldozer

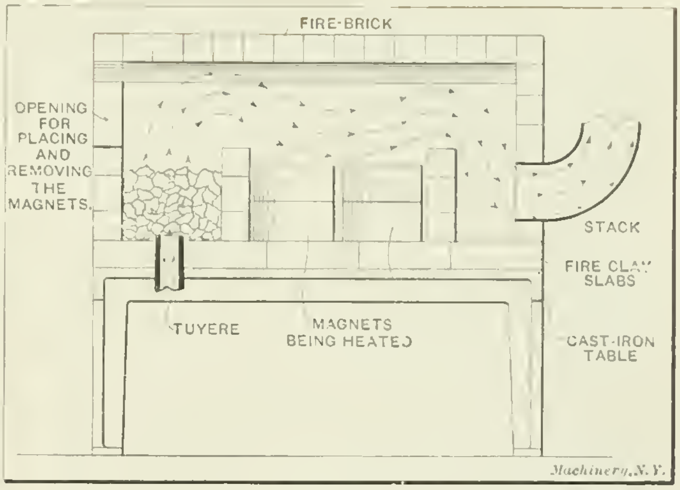
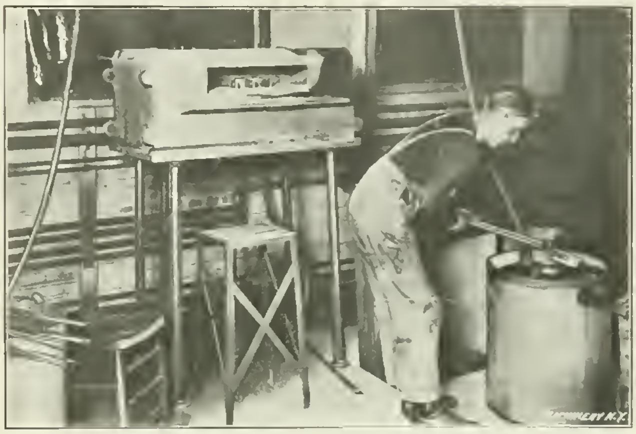


Fig. 12. Section of Coke Furnace for Heating Magnets previous to Hardening

After heating, the bars are placed one at a time in some form of power press, usually a very powerful and massive bulldozer or vertical press, as shown at *B*, Fig. 8. These machines are equipped with special dies (those for forming a U-shaped magnet in a bulldozer being shown in Fig. 11), which bend the bar to the correct shape. Simple magnets such as those of the horseshoe type require only one bending operation, whereas more complicated shapes require two or three bending operations. Extremely irregular shapes which are not used in great quantity are bent by hand as shown in Fig. 7. This machine consists of a cast-iron die around which a steel roller is revolved by means of a lever to which the roller is pinned. One end of the hot bar is fastened to the die by a clamping device, so that the bar is held between the roller and the die. The lever is pulled around the die by the operator, causing the roller to press the heated bar against the die, and thus bending the bar to the desired shape.


Machinery,N.Y.
Fig. 13. Hardening Magnet Forgings in the Sangamo Electric Co.'s Plant

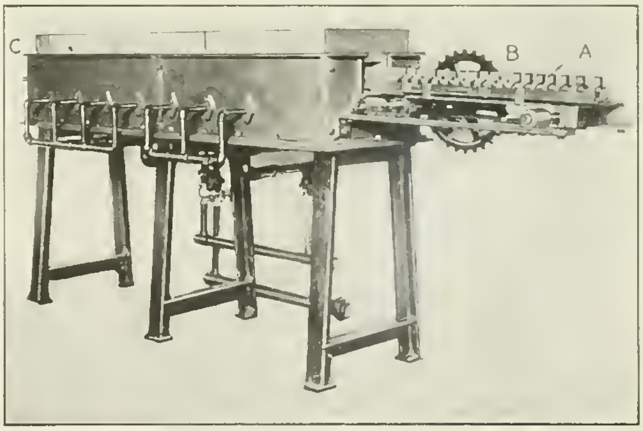


Fig. 14. A Gas Furnace for Hardening Magnets, equipped with a Conveyor

Hardening

The forged magnet bars are now allowed to cool slowly in order to prevent crystallization. They are then ground on disk grinders or emery wheels to the proper lengths, as shown in Fig. 9, and drilled or machined if so required by the specifications. After this they are placed in the hardening furnace, and brought to a temperature of from 1500 to 1600 degrees F. (as determined by previous tests). The temperature must be very accurately regulated, as a variation of only a few degrees is likely to injure the steel.

Coke, oil and gas furnaces are used as shown in Figs. 12, 13, and 14. Oil and gas furnaces give the best results, but are more costly and more expensive to operate than coke furnaces. The difficulties experienced with coke furnaces are due to the impurities in the coke, such as sulphur and silicon, being absorbed by the steel at the high temperature maintained. However, the fault is almost entirely overcome in a furnace constructed as shown in Fig. 12.

Fig. 14 shows a gas furnace similar to the one described for heating magnet bars for bending (Fig. 4). The magnet forgings *A* enter the furnace at *B* and are discharged at *C* at the rate of about four a minute. The magnet forgings shown in this illustration are for use in electric meters.

When the magnet forgings reach the required temperature they are removed from the hardening furnace and plunged into cold running water or brine, where they are allowed to remain until cold; they are then removed and piled up ready for grinding and magnetizing. When magnets of very accurate dimensions are required, such as those used on magnetos, the forgings are placed in special tongs with gage-blocks between them, as shown in Fig. 15, to prevent them from warping while cooling. A typical group of tongs for handling heated magnets is shown in Fig. 17. Magnet forgings of complicated shape are frequently annealed before hardening, in order to insure uniform heating.

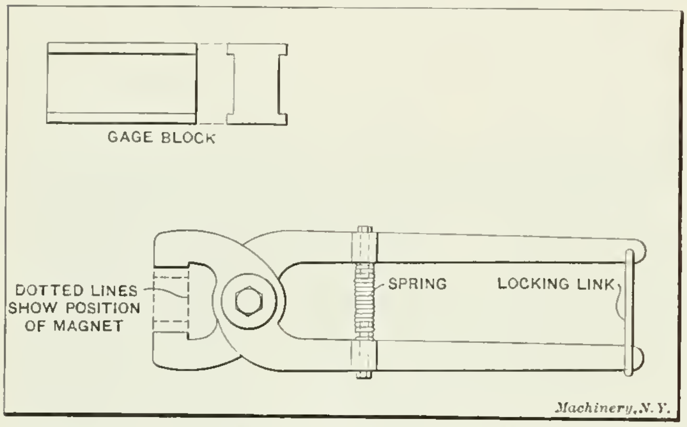


Fig. 15. Tongs and Gage Block for Holding Magnets while Hardening to prevent them from Springing out of Shape

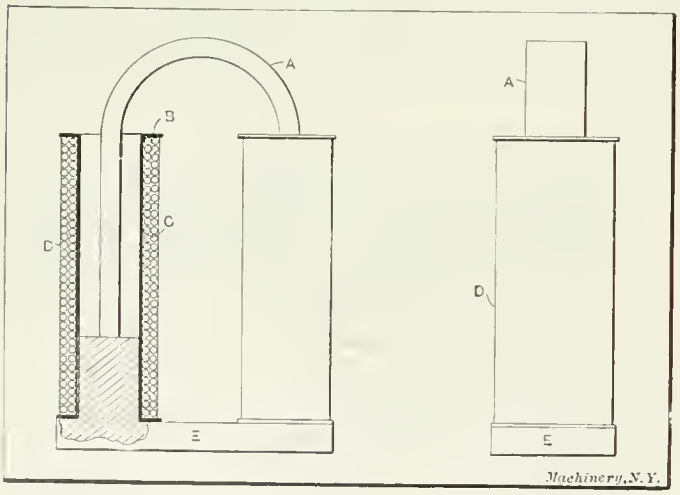


Fig. 16. Magnetizing a U-shaped Magnet

Grinding and Magnetizing

After being removed from the cooling bath, the forgings are ground to the specified dimensions and all scale and rough edges removed. They are then ready for magnetizing.

Magnetizing is accomplished by means of electro-magnets, solenoids, or a combination of the two. One of the most efficient devices for this purpose is shown in Fig. 16, in which *A* is the magnet being magnetized, *B* the shell of the solenoid, *C* the winding of the solenoid, *D* the insulating covering, and *E* the malleable iron electro-magnetic field piece. While the magnet is being magnetized, the current is rapidly interrupted and the magnet hammered with a rawhide mallet to cause the magnetic molecules to properly adjust themselves. From ten to twenty seconds is usually required for each magnet. This is the last operation required in making permanent magnets. After magnetizing they are ready for use and will retain their magnetism for years under ordinary conditions.

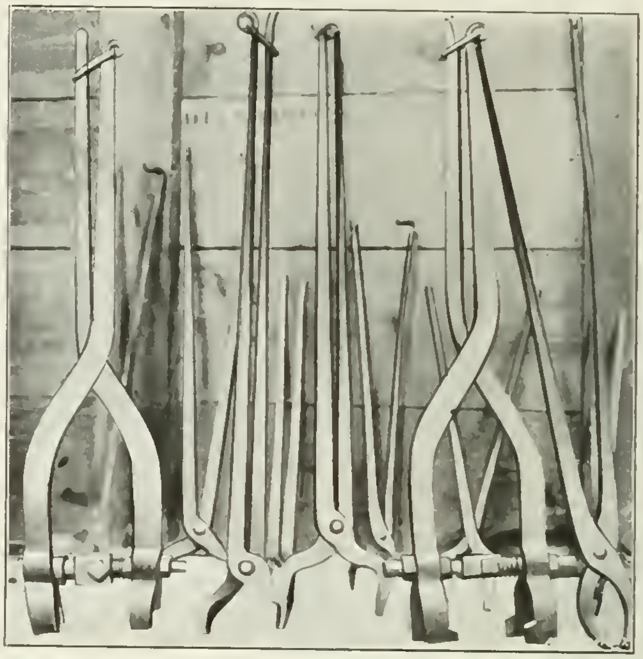


Fig. 17. A Group of Tongs for Handling Heated Magnets

Plate Magnets

Plate magnets are stamped out of sheet magnet steel 1/16 inch to 5/32 inch thick, by means of ordinary punch presses equipped with hardened steel punches and dies. The process is practically the same as that used for making any form of flat stamping. The stampings require no grinding, drilling or machining before hardening. The method of hardening is similar to that used for other forms of magnets, except that special care must be observed to prevent warping, and to keep the hardening heat from being blanketed by accumulation of scale on the surface. The means used for grinding and magnetizing are similar to those used for bar magnets.

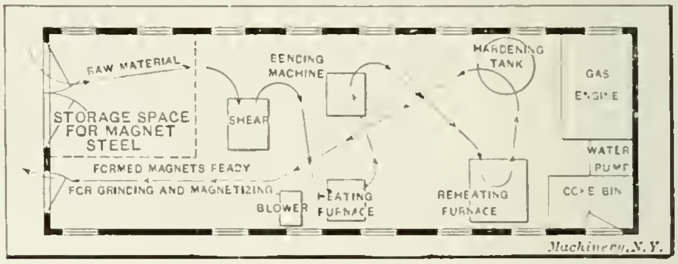


Fig. 18. Plan of Magnet Forming Department of Hercules Electric Co. Arrows indicate Movement of Stock

Conclusion

The manufacture of permanent magnets, although a comparatively new industry, has reached a place of considerable importance both from a monetary and scientific standpoint. Its rapid growth may be attributed to the extensive use of this type of magnet in electrical measuring instruments, magnetos, telephones, and recording instruments. The scientific production methods employed are due largely to the constant demand of magneto manufacturers for powerful magnets that will retain their magnetism for an indefinite period under all sorts of adverse conditions, and which will at the same time be absolutely accurate in size and shape. Taken as a whole, few branches of industry represent a more interesting study from a chemical, mechanical, and electrical standpoint than the manufacture of permanent magnets.

GAS ENGINE PISTON RINGS

By S. H. SWEET*

Designers of gas engines usually have certain forms of construction which they use in preference to others, but it is a good idea to know of the different forms in use, how they stand up, their good and bad points, the cost of manufacture, and how easily assembled and disassembled. Herewith are shown a number of wrist pins for gas engine pistons, taken from the writer's note-book, and some comments are made on the different designs. Of course the forms shown may be more or less familiar to many of the readers of MACHINERY, but some of them may be new or present ideas that will be of sufficient interest and value to find a place in their data- or note-book.

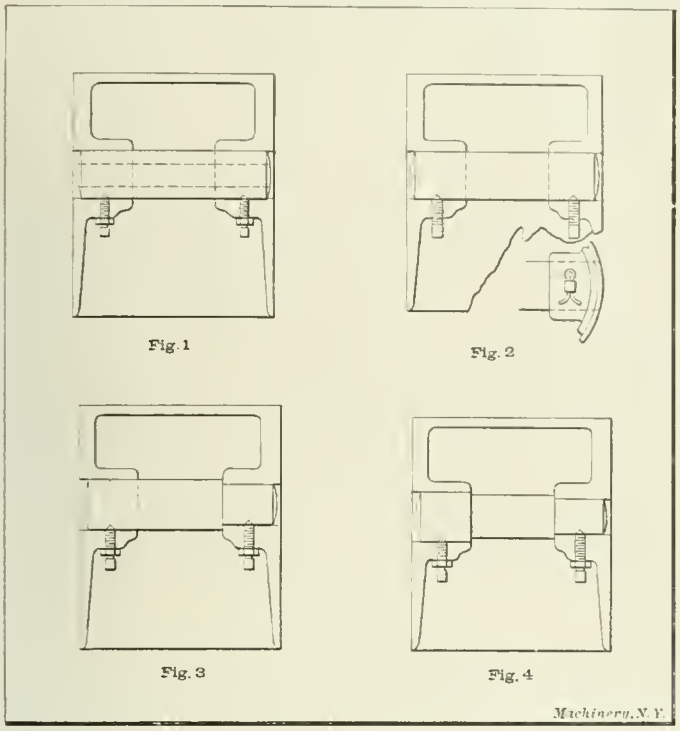


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Fig. 1. Straight Pin held by Nut-locked Set-screws. Fig. 2. Same Pin with Set-screws locked by Cotters. Fig. 3. Two-stepped Pin. Fig. 4. Three-stepped Pin

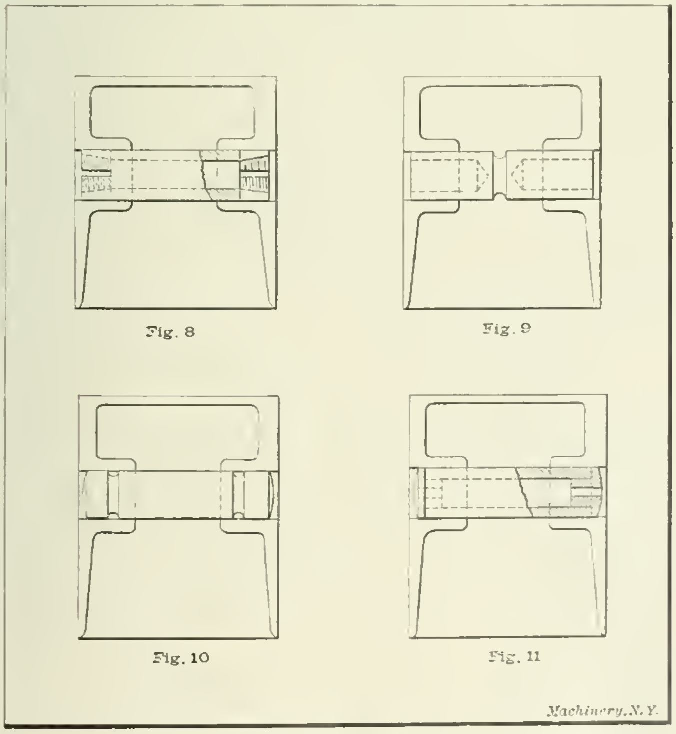

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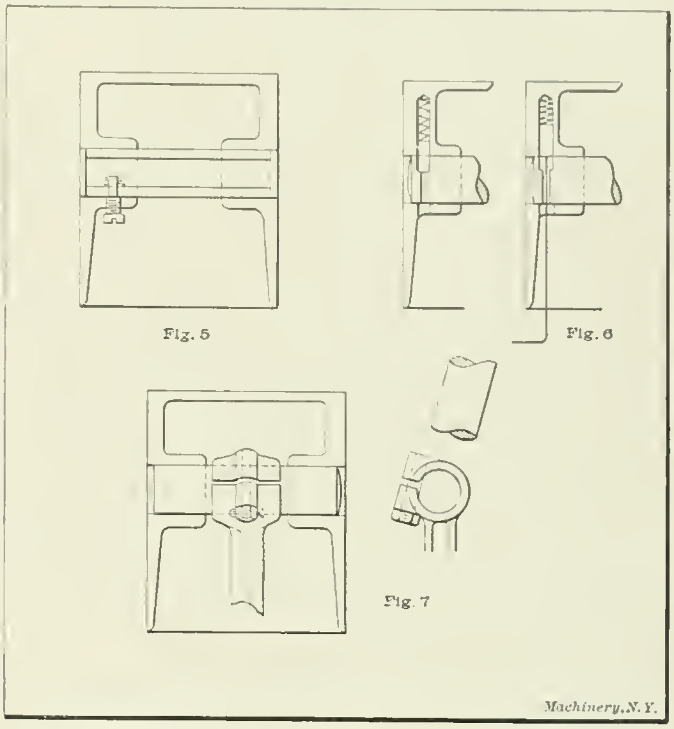
Fig. 8. Hollow Pin held by Expanding Plugs. Fig. 9. Pin with Circular Retaining Groove. Fig. 10. Circular Grooves in End of Pin. Fig. 11. Bronze-ended Pin

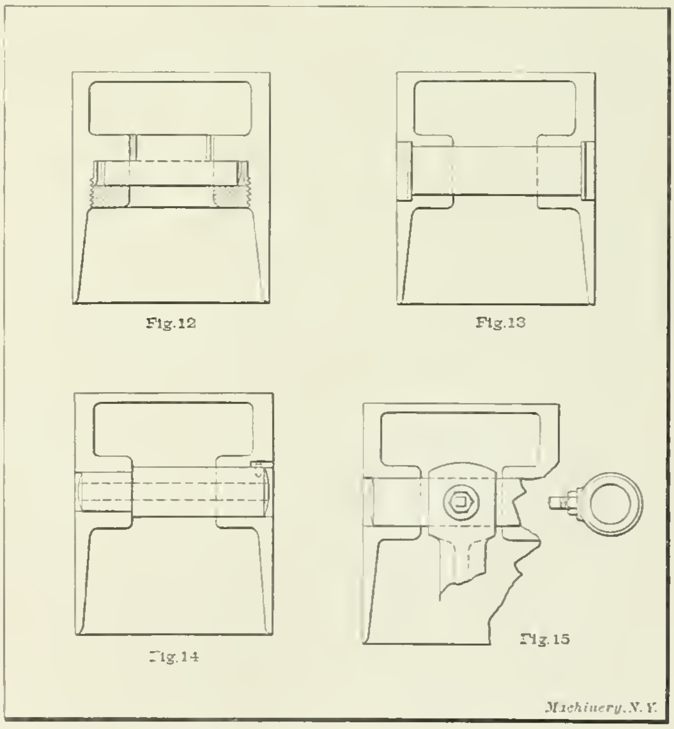
The wrist-pin shown in Fig. 1 is a straight pin which is held from end movement and from turning by set-screws with lock-nuts. The pins are spotted for the point of the set-screw, so that the latter will not form a burr which might cause trouble in removing the pin. The pins are made either solid or hollow as desired. When made hollow, a few holes drilled through the center connecting with an oil groove, form a good means of lubricating the wrist pin bearing at the piston end of the connecting-rod. The one shown in the illustration is probably the simplest and least expensive construction.



Machinery, N.Y.

Fig. 5. Hollow Pin held by Projecting Reduced End of Set-screw. Fig. 6. Spring-pin Method of holding Wrist-pin. Fig. 7. Pin held by Screw in End of Connecting-rod

Fig. 2 shows the same construction as Fig. 1, with the exception that the set-screws are locked by cotter-pins instead of lock-nuts; the cotter-pins strike the wall of the piston and prevent the screw from turning. In some cases one set-screw is used instead of two. With a straight pin it is necessary to drive it in its full length, unless two different sizes of reamers are used, making one end a driving fit, and the other a sliding or running fit. However, if the wear on the central



Machinery, N.Y.

Fig. 12. Nut Method of securing Pin. Fig. 13. Pin with End Bosses. Fig. 14. Two-step Pin with Drive-fit End and Key. Fig. 15. Pin Held by Set-screw in End of Piston-rod

portion of the wrist-pin bearing forms a burr, it makes the removal of the pin difficult.

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Fig. 3 shows a pin turned smaller on one end and held in the same way as that in Fig. 1. This pin can move in only one direction and only one set-screw is necessary. This construction costs more than the first, but the pin is more easily removed.

A three-step pin is shown in Fig. 4, and is held in the same manner as the one in Fig. 1. It is very easily assembled and removed, and it is only necessary to drive it the length of one of the piston bosses. While it is an expensive construction on account of the necessity for turning three sizes on a pin and requiring two sizes of reamers in the piston, this is compensated for by the fact that it can be turned down when worn without disturbing the ends which fit the piston.

In Fig. 5 is shown a hollow, straight pin kept from turning by a screw reduced on one end. The reduced part fits into a hole drilled in the wrist pin and the inner end is drilled to receive a cotter-pin to prevent it from backing out.

A pin held by a small plunger or spring pin is represented in Fig. 6, where the construction may be readily understood. When assemblying, the spring and plunger are put in place and the wrist pin pushed in until the plunger drops into the hole that is drilled in the wrist pin to receive it. This both locks the pin from end movement and turning. To remove the wrist-pin, a wire is inserted through a hole in the boss and the plunger pushed up clear of the wrist-pin; then by tapping the end of the latter it may be made to move sufficiently to prevent the plunger from dropping back. The wire is then removed and the wrist-pin driven out.

Fig. 7 shows the wrist-pin held by a screw in the end of the connecting-rod, the screw fitting into a groove milled in the side of the wrist-pin. This differs from the previously mentioned wrist-pins, for it is free to turn in the piston bosses and is held in the rod end, thereby giving more bearing surface.

The method of holding by splitting the pin and internally threading the ends is shown in Fig. 8. The pin is held by screwing in taper plugs which spread the ends, making a tight fit in the bosses. The objection to this plan is that the plugs are liable to work loose and score the cylinder walls.

In Fig. 9 a screw in the end of a connecting-rod fits in a groove turned in the center of the wrist-pin as shown. This construction is similar to that of Fig. 7. The wrist-pin is free to turn in the bosses and also in the rod end, giving a very good bearing surface, but at the same time the pin is materially weakened by the circular groove.

A wrist-pin similar to that just described is shown in Fig. 10, only it is stronger. Instead of a central groove there is one at each end of the pin, though one would be sufficient; the set-screws prevent end movement.

Fig. 11 shows a wrist-pin with soft bronze ends which has free rotary and endwise play in both the rod and piston bosses. The bronze ends prevent scoring the cylinder walls, if the end of the wrist-pin should rub against them.

A wrist-pin that is flattened at each end and is held in place by a threaded ring or nut is shown in Fig. 12. It will be noticed that neither the wrist-pin nor nut can turn unless the connecting-rod turns also. In assemblying, the nut is slipped over the rod, the pin is inserted in the bearing and the rod is used to tighten up the nut.

A wrist-pin that is made straight and is free to turn in the rod end and bosses is represented by Fig. 13. It is kept in place by a ring which also acts as a packing ring.

A wrist-pin used by a prominent designer is shown in Fig. 14. The stepped end is a driving fit in the piston boss, and a pin used in the opposite end prevents turning.

Fig. 15 shows a straight pin held by a set-screw in the rod end.

* * *

The firm of Krupp, in Essen, Germany, this year celebrates its hundredth anniversary. The firm was established in 1811, and for fifteen years only six persons were employed. Now the total number of employes is 70,000.

GRINDING HARDENED GEARS

By E. H. PRATT*

The subject of grinding hardened gears for automobile transmissions and similar purposes has been given much time and thought in the attempt to overcome the errors which creep in during the hardening process. In most cases these gears are made of special alloy steels which require very careful heat treatment, and if precautions are taken, there will be very little shrinkage and consequently less warping. In most cases a few degrees variation in the temperature of the ovens will cause warping—sometimes to a very marked degree. In the case under discussion, the gears are made from high-grade chrome-vanadium steel which requires twelve hours at 1,600 degrees F. to properly carbonize, and a reheating to 1,300 degrees F. for hardening. The latest improved electric pyrometer is used for testing the heat of the ovens. It was found that a variation of 50 degrees F. would change the shape of the gears; it is a very difficult matter to hold the heat of an oven for twelve hours within such a range.

From the difficulties thus experienced in tempering, it became necessary to devise some method of grinding the gears that would overcome the hardening errors, for the inspection department demanded gears within a 0.001-inch limit on the pitch line; that is, the pitch circle could not be eccentric by more than 0.001 inch. This is, of course, a very small margin, but having advertised a noiseless transmission it was necessary to hold to this limit in order to produce gears that would run close and smooth enough to be practically noiseless.

Several grinding chucks were used with but little success, and eventually it became necessary to devise a special chuck; the one to be described in this article is the outcome. In grinding gears, the gear is gripped concentric with the pitch circle, and when in that position, the hub is ground out so that the pitch circle will have no eccentricity. Of course the warping in the gear will have changed the pitch line from a true circle, which makes it necessary, in devising a chuck to grip the gear on the pitch circle, to equalize the variation caused by hardening, by placing a suitable bearing on each tooth of the gear.

Fig. 1 shows two typical automobile transmission gears, made of steel, hardened and ground in the hub, with the teeth lapped together. These gears are of a 6-8 diametral pitch and it was found that a 9/32-inch pin, when placed between two teeth, would bear on both sides at the pitch line. Taper pins *A*, such as shown in detail in the upper left-hand corner of Fig. 2, were formed, the lower side of the piece being made with a 9/32-inch diameter in order to fit in the teeth, as just mentioned. One such tapered piece was required for each tooth of the gear, being held in alignment in the proper place in the chuck by a hoop spring *B*, and circumferentially spaced by a disk *C* which provides clearance for these pieces. Outside of these pieces is an annular ring *D* with an inside taper corresponding to that of the taper pieces *A*. Outside of that, again, is another annular ring *E* also with a taper as indicated. These several rings are contained in a rigid cast-iron body *F*, which is made strong enough to withstand the severe strains due to the large number of taper surfaces used on the inner members. Inside this body *F* behind the tapered annular rings is a screw-adjusting plate *G*, threaded into the body

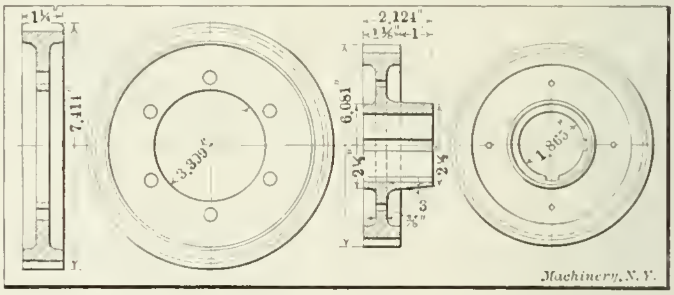

Fig. 1. Typical Hardened-steel Automobile Transmission Gears

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F with a 29-degree Acme thread. This body *F* is, in turn, attached to the chuck plate *H*, screwed onto the head of the grinder. A rod *I* passes through the hollow spindle of the grinder, and on the inner end has a head *J* with inwardly projecting pins engaging recesses in the face of the screw-adjusting plate *G*. On the outer end of rod *I* is a handwheel *K*; by turning this, the screw-adjusting plate may be moved backward or forward as desired. By moving the screw-adjusting plate forward, the taper strips *A* will be forced radially inward, gripping the gear on the pitch line and holding it accurately for the grinding operation. A spring *L* keeps the projecting pins on the rod *I* always in contact with the screw-adjusting plate.

To prevent emery from working into the threads of the screw adjusting plate, a felt washer *M*, is introduced as shown. Although it is impossible to prevent emery dust from working its way into the moving parts of the chuck, it was found that this felt washer was very effective.

The making of the screw-adjusting plate presents some interesting features. It is a steel forging, hardened and ground, and was first roughed out to within 1/16 inch of its finished size, then thoroughly annealed, and finally finished to size, threaded, drilled and hardened. Now a forging of this shape will always warp more or less in hardening, and this one proved no exception. As it was important to have the face absolutely true with regard to the thread on account of the bearing surfaces presented to the ends of taper pins, it became necessary to grind the piece, for it was badly warped. The thread was ground by setting up in an engine lathe in the usual manner and grinding the thread with an electric center-grinder. The chuck body was then threaded to fit this piece nicely.

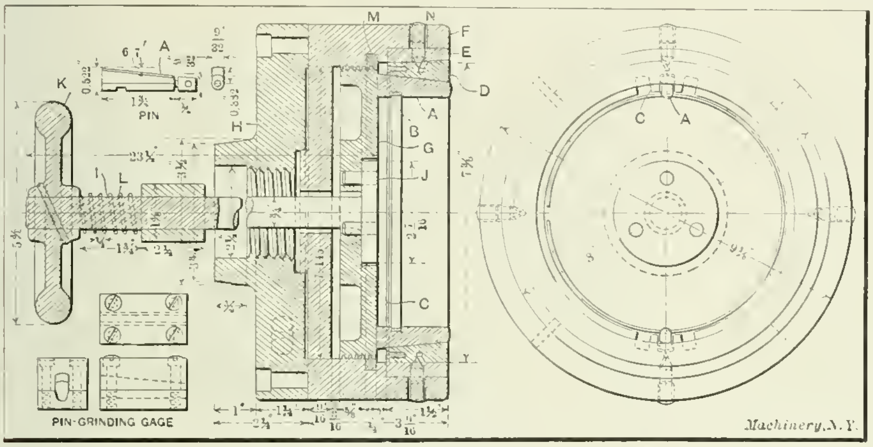

Fig. 2. Chuck used for Holding Gears correctly on Pitch Circles while Grinding the Hubs

The making of the taper pins *A*, shown in the detailed illustration in the upper left-hand corner of Fig. 2, is also interesting. The pins were centered on both ends and turned and milled to the proper size for grinding. Then about ½ inch from the smaller end, the pin was cut nearly in two, and the small end had a transverse hole formed in it by which the pin was revolved on centers while grinding the 9/32-inch diameter; the larger diameter of the taper was also ground on these centers. As all pins had to be made exactly the same size in regard to both sides, a small gage was made, which is illustrated in the lower left-hand corner of the engraving. As will be seen, this gage represents a gear tooth and a section of the gear chuck circle. The pins are ground on the taper until they project about 1/64 inch beyond the gage, when they are ground on the end to bring them flush.

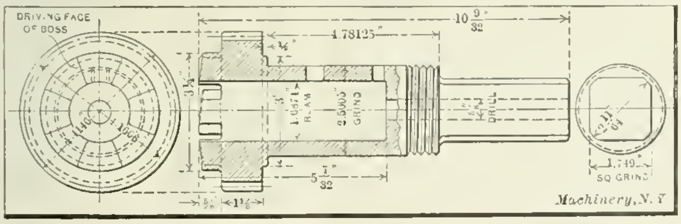

Fig. 3. Typical Transmission Drive Sleeve ground on Outside only

The annular chuck rings *D* and *E* are made of steel, hardened and ground inside, and are made of different sizes to suit the various gears; as shown, the chuck is arranged to hold the smaller gear illustrated in Fig. 1. When it becomes necessary to change these rings, the ring *D* is first removed by taking out the headless set-screw *N*; after this ring is removed, ring *E* will slip out.

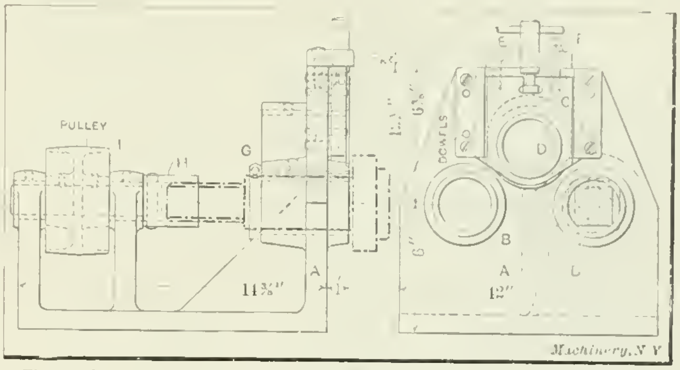

Fig. 4. Device for Lapping the Transmission Drive Sleeve shown in Fig. 3

The clamping device operated by the handwheel *K* would seem to give but little leverage, but it has enough to hold the gear firmly without springing it out of shape, and by the use of so many pins the bearing area is increased to such an extent that but slight pressure is required.

The chuck-plate *H* attached to the grinder spindle is ground in place in order to insure an accurate attachment of the chuck. The gears ground in this chuck are of various sizes and styles ranging from countershaft gears having 1⅞-inch holes, to main-shaft gears with 3½-inch holes; the main drive sleeve shown in Fig. 3 is ground on the outside only. These gears are not all ground on the same machine, two different chucks being used. For a smaller plant, however, one chuck should be ample to handle all the gears.

It was, of course, impossible to produce perfect gears from those sprung in hardening to the exent of from 0.003 to 0.008 inch, but after grinding, the variations were found to be evenly distributed, so that with the majority of them a short run on the lapping fixture was all that was necessary. Fig. 4 shows the fixture for lapping the drive sleeves, one of which is shown in Fig. 3. This jig is designed to lap three sleeves at a time. Bosses on the main casting *A* are bored out to receive bronze bushings *B* which fit the ground part of the drive sleeve, as indicated in the illustration. A vertically adjustable member *C*, operating in V-grooves, holds a third bushing *D* in which an intermediate gear can be placed and adjusted to give the required contact by means of the top adjusting screw *E*. Lock screw *F* may be set to give the same adjustment for each set of gears. The driven gear of the train is held in position by a collar *G*. The squared end of the drive sleeve is fitted to a corresponding coupling *H*, driven from the pulley *I*, which supplies power for the lapping process.

The fixture for lapping the other gears is similar to the one used for the drive sleeves, only as these gears have no ground external surface they are held on pins set in the face of the supporting casting, which is similar to the casting *A* just described. The upper one of the gears is adjustable in a manner similar to that in the last fixture, but the driven gear is on a pin which extends through the face of the main part of the fixture and has a pulley attached on the inner end by which the train of gears is driven. Adjustment is made as before through the upper vertical slide. After a few minutes lapping with emery and oil, the gears will be found to run smoothly and quietly, and will readily pass the closest inspection. With this chuck and fixture large numbers of gears pass through the shop and form what is probably the most quiet transmission construction that is known to the automobile trade.

DROP-FORGE DIE-SINKING—3

By CHESTER L. LUCAS* and J. W. JOHNSON†

In the first two articles of this series, the principles of making drop-forge dies were treated upon, covering all of the main operations of sinking the impressions in the dies. There are, however, many special operations that must be employed at times to correctly shape the impressions, and these are fully as essential to good die-sinking as are the rudiments of the trade. Space will not permit us to describe all the special operations in detail, but we can at least touch upon some of the most necessary of these operations, selecting at the same time the most interesting ones and those that are apt to be used in making the average line of drop-forging dies.

Cherrying

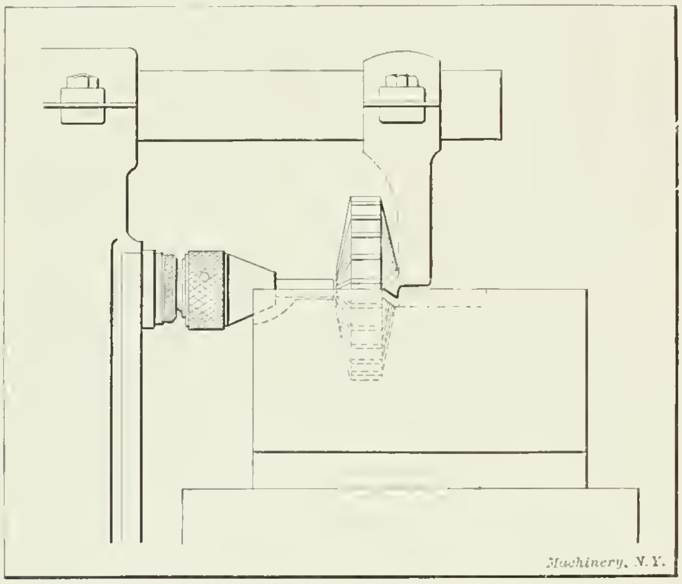

Fig. 32. Cherrying a Die on the Milling Machine

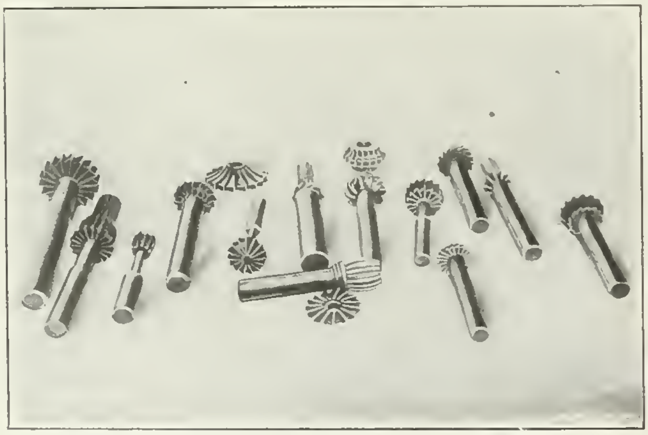

Fig. 33. Collection of Cherries used in Die-sinking

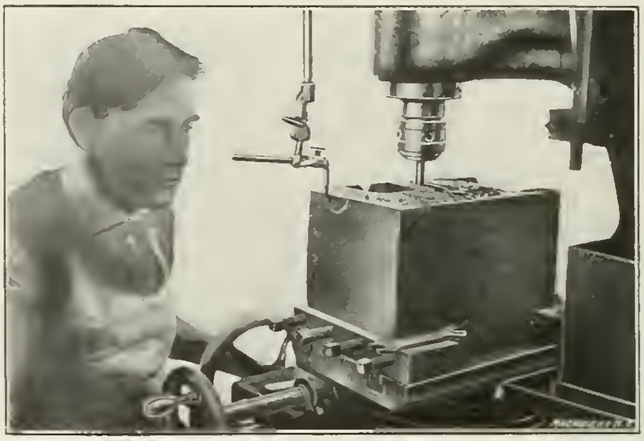

Fig. 34. Milling out a Deep Impression with the Aid of an Indicator

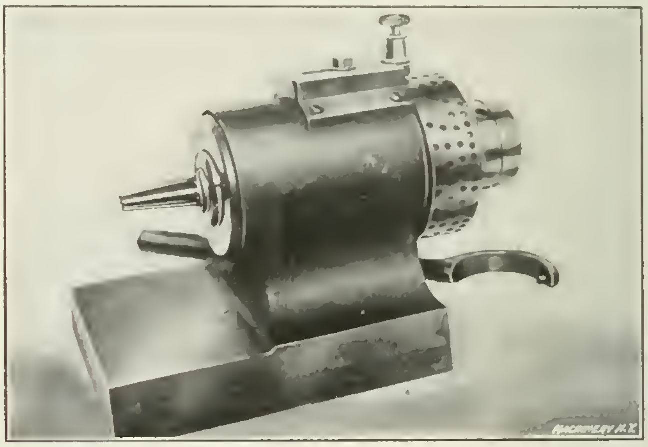

Fig. 35. Fixture for Fluting Cutters, used on the Die-sinking Machine

In making the impression in a drop-forging die for producing forgings for valve stems or other forms in which each die will have at least one-half of its impression of the cylindrical shape, it is obvious that some means must be provided to sink a cutter into the die block to exactly one-half of its depth. There are several different methods of reaching this end, one of which is to use a special milling fixture in which the cutter is supported on a very short arbor and rotated by means of a raw hide pinion that meshes between the teeth of the cutter, this pinion being driven by the spindle of the milling machine. Of course, the bulk of the steel in the impression is roughed out in the ordinary way before the special attachment and the finishing cutter are put into use.

Another method of sinking the cutter to one-half its depth is by the use of the method called "cherrying." Cherrying and cherries are terms somewhat unfamiliar to the general machinist and toolmaker. A cherry is a milling cutter, usually made integral with an arbor whose length varies with the requirements of the job to be done. The cherry is held in the spindle of the milling machine. The die to be cherried is roughed out on the die-sinking machine as nearly to size as possible and the sprue and gate cut. On dies that are to be cherried the sprue is made semi-circular in shape so as to accommodate the shank of the cherry; that is, the impression in each of the two halves is semi-circular. Next, the die is mounted on the milling machine and the table raised to bring the cherry into the impression that has been previously roughed out. After the cherry has been carefully centered, the table is raised to bring the cherry to the proper depth into the die, cutting very slowly on account of the large amount of cutting surface involved when the cherry is well into the die. When the impression is deep and is located at quite a distance from the front of the die block, the shank of the cherry must be long, and if the front end of the impression is shallow, the shank of the cherry will necessarily be small in diameter. In such cases, and in fact in all cases where possible, the cutting end of the cherry should be supported. This support consists of an arm, swung from the supporting arm of the milling machine. The cutting end of the cherry is deeply centered and the support consists of a very short center that is cut away to clear the rest of the die, substantially as shown in Fig. 32.

Fig. 33 shows a group of cherries used in different dies, as accumulated in doing general drop-forge die-sinking, these being of the average type. The operation of cherrying has been described in preference to some of the special milling fixtures because it is the most common method used in this connection. The special fixtures are not found in the majority of die-sinking departments, although the best-equipped shops employ them for special jobs that would be difficult to cherry.

Indicator Used in Making Deep Impressions

Fig. 34 shows a most interesting operation and the indicator used in connection therewith. This die is for making the sister hook illustrated in Fig. 40 and as may be seen, there is a very deep part of the impression used for forming the eye, that would be very difficult to mill out without the fixture shown in this illustration. The main rod of the fixture is screwed or clamped to the body of the die-sinking machine.

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This rod terminates in a ball and socket joint from which is supported a cross bar that holds the pointer of the indicator. The die in which the impression is to be milled is laid out as usual, and in addition, a line is scribed on the side of the die that indicates the shape of the bottom of the impression, as projected from the impression that is to be cut. This line may be seen on the side of the die block that is shown on the machine in the illustration, Fig. 34. After the die has been set up on the die-sinking machine, a roughing cutter is held in the chuck and the table of the machine raised until the cutter just touches the top surface of the die. Next, the indicator is adjusted so that the needle is on a line with the surface of the die and at the same part of the scribed outline on that side of the die that agrees with the position of the cutter within the outline of the die impression. With the cutter and indicator thus located, the impression may be roughed out, the die-sinker always keeping the needle of the indicator within the lines on the side of the die. After the die impression has been roughed out, a finishing cutter may be adjusted in the same manner as was the roughing cutter, and by carefully watching the indicator to see that the cutting is always within the scribed lines, the die may be finished much quicker than would be possible without an attachment of this kind.

Cutter Milling Fixture

The die-sinker uses so many special cutters in addition to the regular cutters, that it is essential that he be equipped to make cutters as expeditiously as possible, especially as it often happens that he must stop in the midst of the work of cutting the impression to replace a broken cutter or to make a new shaped cutter. The cutter milling fixture shown in Fig. 35 is a great help in fluting all kinds of die-sinking cutters. As the illustration shows, it is merely a special form of index head, fitted with spring chucks to take the standard sizes of cutter shanks. The fixture is used on the die-sinking machine, using an end mill for cutting the flutes. Both the fixture and its operation are so simple that a description is hardly necessary. The cutter blanks are turned up to the proper clearance angle and fluted while being held in the spring chuck of the fixture. The fixture is held in the vise of the die-sinking machine and the vise swung around enough to give the proper degree to the fluting cut, which on a seven degree cutter would be about five degrees. By means of the indexing arrangement at the back end of the fixture, the cutters may be given any number of flutes desired. It is only necessary to compare the time of setting up this fixture with the time of rigging up a horizontal miller for the job, to see where the advantage of this fluting method lies, especially when it is considered that this operation does not bring another machine into use.

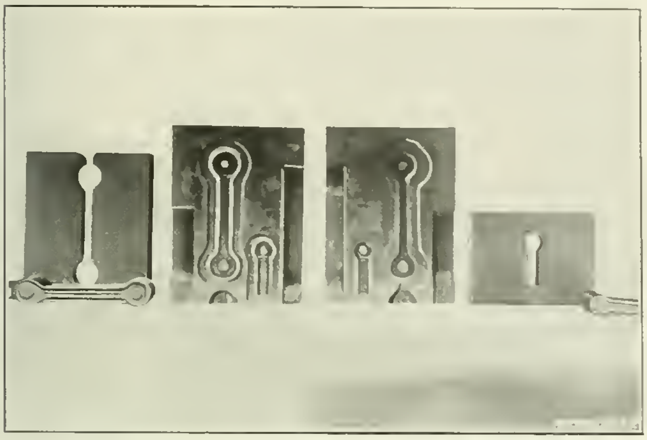
Fig. 36. Set of Dies for Drop-forging and Trimming Shackles and Pins

Making Dies for Bronze and Copper Forgings

In making the dies for the production of drop forgings from bronze and copper, there are several points of the work that differ from the making of dies for steel or iron forgings. Foremost among these differences is the finish that must be given the dies. Copper, and bronze as well, are much softer metals than iron or steel, consequently the metal is driven into every detail of the dies during the forging operation. On account of this fact, the dies must be perfectly free from scratches of any kind in order to obtain a copper or bronze forging with a smooth finish. This only means that extra care must be used in polishing out the dies both before and after hardening.

Forgings of copper and bronze are used for machine parts that would be liable to rust from the action of water and also in places that require a non-magnetic metal part. On account of their density they are tougher and harder than a casting of similar metal could possibly be. However, the hammering that is necessary to form such forgings is very hard on the dies, even though the metal being worked is soft. To prevent the dies from dishing or spreading, tool steel is nearly always used for the dies, unless the forgings to be produced are extra large and heavy. The shrink, draft and finish allowances on this class of drop-forge dies are practically the same as on dies for steel and iron. Bronze and copper forgings are trimmed the same as are forgings of iron and steel, but the dies must be kept sharp, in order to do good work; if allowed to become dull, the trimming will be ragged, leaving the forging with a rough surface on the edge.

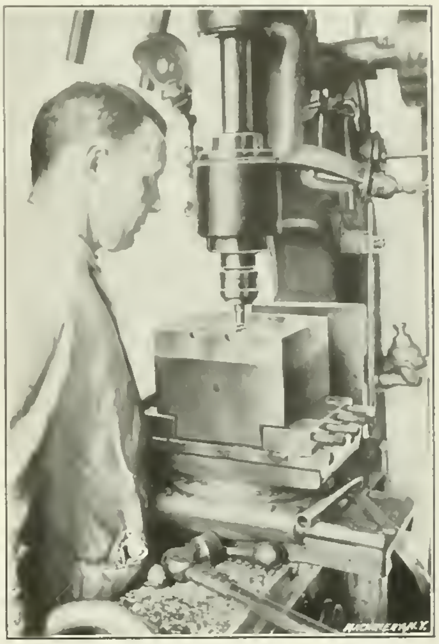

Fig. 37. Starting to Mill out a Drop-forge Die

Dies for Chain Shackles

In making the dies for drop-forging and trimming shackles for chains, we have a representative job of die-sinking, and in addition, there are several special points that are worth noting. Fig. 36 shows a set of dies for drop-forging and trimming a shackle and the pin used in connection therewith. The dies for the drop-forging are the pair in the center and the different parts of the die are well shown, the anvil, breakdown and the central impression. In addition, the impressions for the pin that is put through the shackle after it has been bent to shape, are included at the side of the central impression. The reason for this is that the shackle pin impressions are so small that there is plenty of room for them without crowding the main impressions. Another reason, fully as important, is the fact that with every lot of shackles, the same number of pins must be made, and by placing the pin impressions by the side of the shackle impressions the job is set up and ready for use whenever the shackle dies are set up.

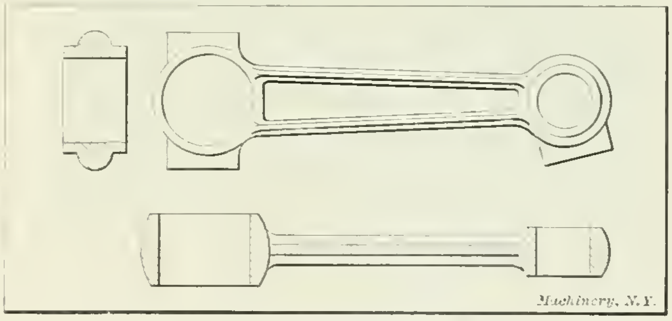

Fig. 38. Connecting-rod Forging, after Machining, to illustrate a Case where Parts of the Die Impression should be milled and typed before the Hub Impressions are milled

Fig. 37 shows the die sinker starting to mill out the impressions in one of a pair of shackle dies. The system of lighting the work, when artificial light is required, is indicated in the illustration where two adjustable incandescent lights are attached to the frame of the die-sinking machine. When these lights are swung down close to the cutter, every detail of the cutting may be seen, for by the use of two lights, on opposite sides of the work, there is no shadow thrown on the die by the cutter.

The trimming dies for this job are interesting in that they illustrate both styles of dies, hot trimmers and cold trimmers. The die for trimming the shackles shown at the left of Fig. 36 is a hot trimmer, made in one piece. At the front is the punch for this die, recessed out to fit the forging. The trimming die on the right is a cold trimmer for the pin that goes through the shackle.

Connecting-rod Forging

In Fig. 38 is illustrated a forging for a connecting-rod that is shown as a further example of forgings for which the die impressions are best milled and typed for the irregular spots before the central hubs are cut. This illustration shows the finished connecting-rod. The parts that would require typing, are, of course, the projecting lugs through which the bolts pass. The forging for this connecting-rod would be solid at the two ends and into these open places in the impression, the types would naturally slip, should the central opening of the impression be cut out before the projecting lugs were typed.

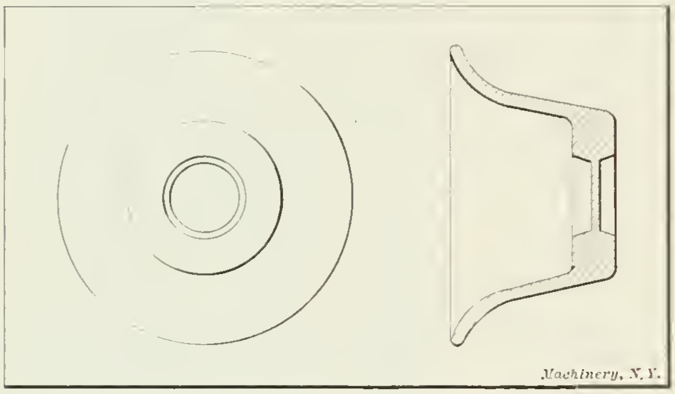
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Fig. 39. Thrust Collar, made in a Pair of Dies with but One Set of Impressions; no Breakdown or Anvil required

A Simple Set of Dies for Drop-forging a Thrust Collar

The thrust collar shown in Fig. 39 can be drop-forged in a pair of dies with but one impression. From the illustration, it would not seem possible to do this at first thought, but as a matter of fact, it is a practical piece of drop-forging. The secret of the success of this forging operation lies in the preparation of the stock from which the forging is to be made. The stock should be cut into blanks somewhat smaller in diameter than the greatest diameter of the forging, and of such a thickness as will just give stock enough to fill the die, after allowing for a sprue for handling the forging while being worked. The size of this blank can best be obtained by weight, the blank being two-thirds of the weight of the lead proof, after adding enough for the weight of the sprue and an allowance for the shrinkage of the steel in the fire from scaling, etc. The corners of this blank are first hammered in and a short sprue drawn out under the hammer, after which the stock may be placed in the impression of the forging die and struck until full.

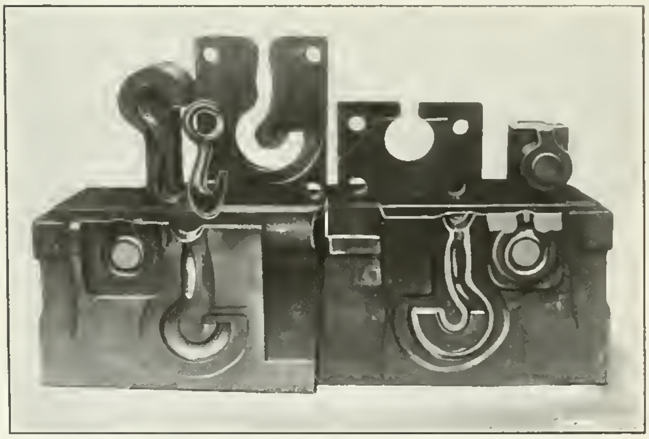

Fig. 40. Set of Dies for Drop-forging and Trimming Sister Hooks

No breakdown or anvil are required with this set of dies and the central impression is designed so that the lower die will contain the cavity while the upper half will have the projecting plug. This arrangement is for the purpose of taking advantage of the "shooting up" tendencies of the hot steel. For trimming the central web from the forging, a loose punch is used; that is, a punch that is not fastened in any way to the ram of the trimming press. The cutting end of this punch is made to the size that is wanted for the opening in the forging; back of the cutting edge, the stock is relieved to clear the forging when going through. When used, the punch is pushed through the forging, the punch dropping through the forging to the bolster, from whence it is taken and used again on the next forging. The trimming of this piece should be done hot, although if the central hole is small, that part of the trimming may be done cold. If the hole is trimmed hot, however, the dies will meet much quicker, saving quite a little time in the forging operation.

Dies for Drop-forging Sister Hooks

Another interesting set of dies, shown in Fig. 40, is for drop-forging sister hooks used in the United States Navy. The set consists of the two forging dies and the two pairs of trimming dies, one of which trims the hook end and the other takes care of the ring end of the sister hook. The center of the ring is trimmed by another die not shown. It is obvious that the entire forging could not be trimmed in one operation on account of the two different parting lines on the forging. It is also obvious that the shape of the forging makes it necessary to forge each end of the hook separately. To take care of this requirement, an additional set of impressions is cut in the dies to shape the ring at the end of the sister hook. This ring impression is gated the same as the main impression, but it is not used until after the front end of the hook has been completed and the forging with its unfinished ring end has been cut off from the bar. The forgings are made just as though the hook end were solid, being trimmed and cut from the bar leaving the hook end in the shape of a flat disk. Then the ring ends of these semi-completed forgings are reheated and struck in the second set of impressions at the front of the die. It will be noticed that these impressions are gated in such a manner that the hooks will not be crushed while being struck. The stock that is within the center of the ring is more than enough to form the outside in good shape, so no extra allowance need be made.

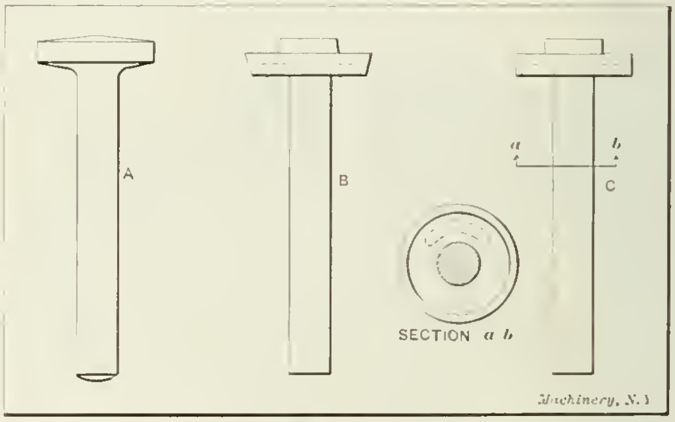

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Fig. 41. The Operations of Making a Cam-shaft

In the illustration, Fig. 40, the two trimming dies are shown placed on the top of the forging dies. These trimming dies are each made in two halves, being dowelled and screwed to bolsters while in use, a matter that will be more fully treated under the head of trimming dies. In this illustration will also be noticed the way in which trimming punches are cut away to properly support the forging during the trimming operation.

Dies for Upsetting Cam-shaft Forgings

The forging shown at *B*, Fig. 41, is for a cam shaft that is shown, after machining, at *C* in the same illustration. To produce this piece, a forging is made as shown at *A*, in the same illustration. This is done in a simple pair of dies, having half of the impression in each die. The forging is finished in the pair of dies shown in Fig. 42. A pair of dies of this design are known as "upsetting dies" and consist essentially of a recess to take care of the shank of the forging, confining it while a blow is struck to shape the head of the cam shaft in the impressions of the dies. Dies of this kind work after the manner of heading dies used in making rivets and screw blanks, except that they are not split for ejecting. The forging is forced from the die by means of a knock-out, as shown in the illustration. When the blow is struck, the knock-out pin is down, resting on the bottom of the die-shoe; after the striking is completed, the forger strikes the knock-out handle with a hand hammer, and the forging is ejected from the die. Ejection is made easier by the fact that the forging is losing heat all the time after the blows have been struck, consequently it is shrinking in diameter. Another precaution, taken to prevent the forging from sticking in the die, is the practice of giving the recess a draft of one-half degree.

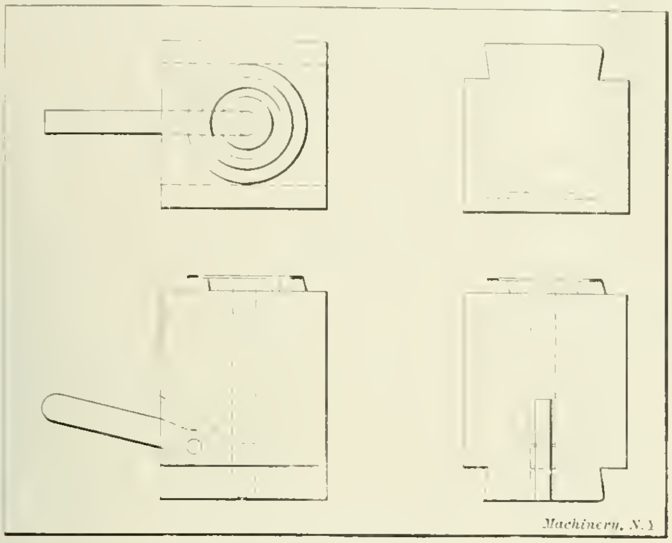

Fig. 42. Upsetting Die for the Second Operation of Forging the Cam-shaft

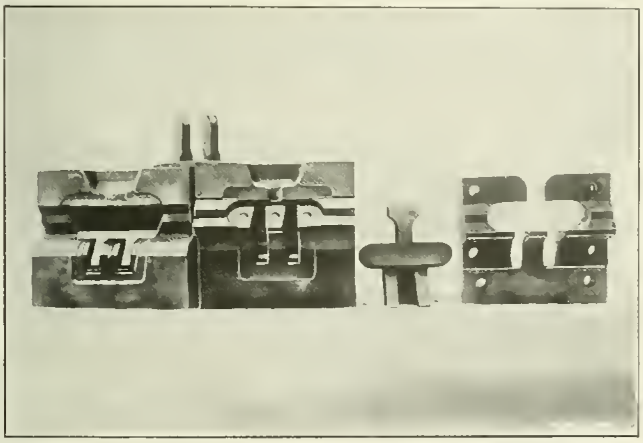

Fig. 43. Lock Dies for Forging and Trimming a Special Hinge

The impressions in the faces of the dies, in which the top of the forging is shaped, involve one feature that has not been touched upon before. Around the part of the lower die that contains the impression, the stock is turned down for about one-half inch, leaving the shoulder on a 15-degree bevel. To match this part, the upper die is recessed for the same distance and on the same bevel, thus forming a "lock" that insures the dies properly meeting within close limits of alignment. This particular lock, owing to its form, is called a circular lock. Circular locks are formed on such dies that must produce forgings that are close in dimension or of such a shape that there would be difficulty in setting the dies and holding them in proper alignment without such a help as the lock.

As to the impressions for shaping the top of this cam shaft forging, there is nothing out of the ordinary about them. All parts are sunk with a seven-degree draft, including the sunken section that is the shape of the cam. While being machined, these beveled sides are cut straight. The best method of cutting the arc impression for the cam is by the use of the circular attachment on the die-sinking machine.

A Lock Die for a Hinge

A difficult job of die-sinking is illustrated in the set of dies shown in Fig. 43. This set of dies is for drop-forging the heavy hinge shown on the top of the dies. At the right is the trimming die and punch. In these dies we have a good example of lock dies of another variety, and a more complicated one as well. The forming impression and breakdown for this piece were cut in another set of die blocks as the forging was too large to admit of the various impressions being placed on the same block. The finishing die shown is the most important and it will be noticed that the draft, flash, gate and sprue are just as much in evidence as they were in the straight type of die. In one of the dies may be noticed the cone-like projections for spotting the centers of holes that are afterwards to be drilled in the forging. The leaves of this hinge are inclined from the base at an angle of 70 degrees. If they were at right angles with the base, the forging of the piece would be simplified a great deal. The hot trimming die shown has its face cut to agree with the parting line of the forging dies, so that the fin will lie against the cutting edge of the die at all points. In cutting the deep parts of the impressions for the leaves of the hinge, the indicator previously described is a great help.

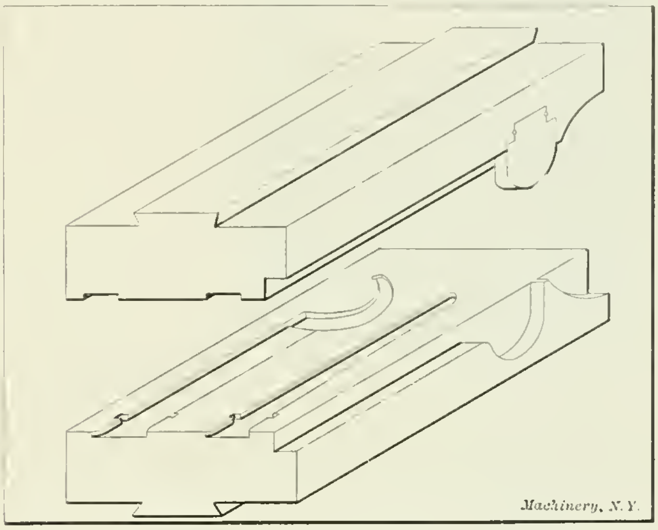

Fig. 44. Drop-forge Dies for Making a Long Forging by Halves, to Obviate the Necessity for Large Dies

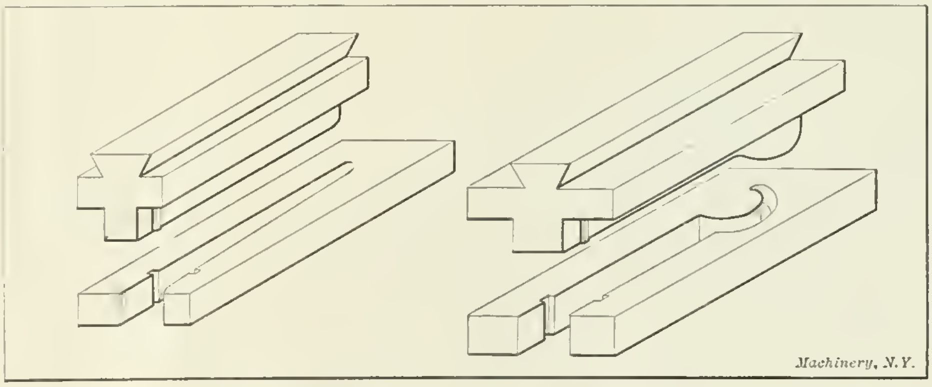

Fig. 45. Trimming Dies for Long Forgings made in Halves

Dies for Making Extra Long Drop Forgings

An extra long forging cannot well be made in a die with one full length impression for several good reasons. First, the dies would be so large and heavy that the item of stock alone would be almost prohibitive, and second, such dies could only be used in an extra large hammer. The drawing in Fig. 44 shows the method of forging such awkward shaped pieces, taking for example, a long heavy spanner wrench, three feet six inches in length. The impressions of each half of the wrench are cut side by side in the die blocks, keeping in from the edge of the die about one inch. At the halfway point where the two impressions leave off, square notches are cut nearly to the depth of the impressions; these notches are the key-note of the whole method of producing such forgings. They serve as locating points to start the forgings from and they will in this particular die, prevent the metal from sliding forward when struck in the tapering impression for the handle. As the steel fills these notches, it forms lugs on the forgings; these lugs fit into the notches in the second impression, thus locating the blank in the proper position. Some forgings would require breakdowns for each end of the piece when made in this manner, but this spanner wrench only requires a breakdown for the hook end. The horn, or bender, is dovetailed into the upper breakdown after the manner previously described.

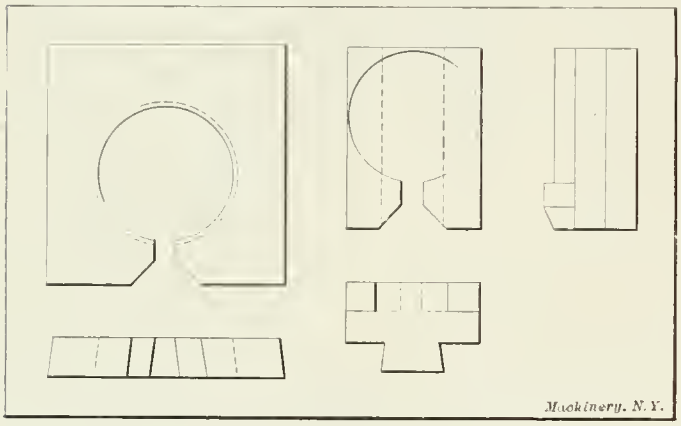

Fig. 46. Illustrating a Plain Hot-trimming Die and Punch

The method of forging the spanner wrench is as follows. Steel is used that is large enough to make the heavy end of the wrench. One forging is made complete, care being taken to note the length of the bar required to make the forging. After the proper length of the blank has been ascertained, the stock is cut to this size and the entire lot of forgings are made and trimmed on one end. The trimming dies for both ends are shown in Fig. 45. The stock for the handle end of the wrench is then drawn down and forged in the second set of impressions in the dies, using the lugs formed in the first operation as a guide to the proper location for the second operation. In turn, this small end is trimmed as was the forward end, and at last, when the forging is completed, it is moved backward in the trimming die just enough to clip off the lugs on the sides and then struck once more in the dies to round the edges where the lugs were clipped off.

It often happens that the forging is of such a shape that no lugs are required to locate the forging in the second impression. A boss, hub or other projection, either vertical or lateral, does just as well as the lugs just described. With care in the forging, it is possible to make drop forgings of this character within 1/32-inch limits of variation in length.

Trimming Dies

All drop forgings require trimming after the forging proper is done. The ideal forging comes from the dies with a small amount of fin evenly distributed all around the forging, at the parting line. In many ways the fin is to be desired, provided it is uniform. Its presence denotes that the dies are "full" in every respect and after being trimmed, the forging is sure to present a clean edge with all traces of the parting line removed. At the time of the trimming operation, a good part of the draft that has been given the forging may be trimmed off, in case it is detrimental to the finished product.

Trimming dies are of two general classes, called hot-trimming dies and cold-trimming dies, according to the condition the forgings are in when trimmed. These two classes differ materially in their design and in the steel from which they are made, although the die-making operations are similar.

Hot trimmers, as they are called in the shop, trim the fin from the forging while the forging is being made. Fig. 46 illustrates a plain hot-trimming die and punch. Generally, the forging is practically completed, then trimmed and struck again to correct any twists or distortions due to the trimming as well as to bring the edges up sharp and size the forging. In the case of a piece having a large displacement of stock, there is apt to be more fin than in a uniform piece; consequently if this fin is trimmed out of the way just before the forging is finished, it is obvious that the dies will have a better effect upon the forging while striking the finishing blows. Most forgings of the medium and larger classes are hot trimmed.

Cold trimmers must do a great deal harder work than the hot trimmers, and for this reason they are made from high carbon steel and hardened the same as any blanking die. Forgings that are to be cold trimmed are severed from the bar when finished, with the fin untrimmed, and run through the trimming die when cold. Thus it will be seen that to trim other than small forgings in this manner, would be too great a strain upon both punch and die.

Hot-trimming Dies

There is a special grade of steel that is used exclusively for making hot-trimming dies, commonly known as hot-trimming die-stock. The objection to using ordinary tool steel for hot-trimming dies is that the edges of the hardened die check very badly after the die has been in use for a short time. Checking is followed by breaking away of the steel around the edges, rendering the die unfit for use. This special grade of steel, used for hot trimmers, requires no hardening and after the die has been put into use, the edges toughen up and give better service than the best hardened tool steel could possibly do.

Hot-trimming dies, as well as cold-trimming dies, are made either solid or in sections, of which there may be two, three or even more. If the piece to be trimmed is a plain, regular shape, the die is best made in one piece, and at the other extreme, if the forging is a difficult one to trim, the die is built up of two or more pieces; this die construction is a matter to be decided by the die maker. Naturally a one-piece die is much easier to handle in setting up, etc., but a die of two or three sections has the advantage of being more easily sharpened and closed in whenever necessary. Fig. 47 shows the general idea of hot-trimming dies of one and two sections, and a cold trimmer in three sections. As shown, the different sections are properly located by means of dowels set between the sections. A die made in sections must have a special bolster on which the parts are mounted, while a one-

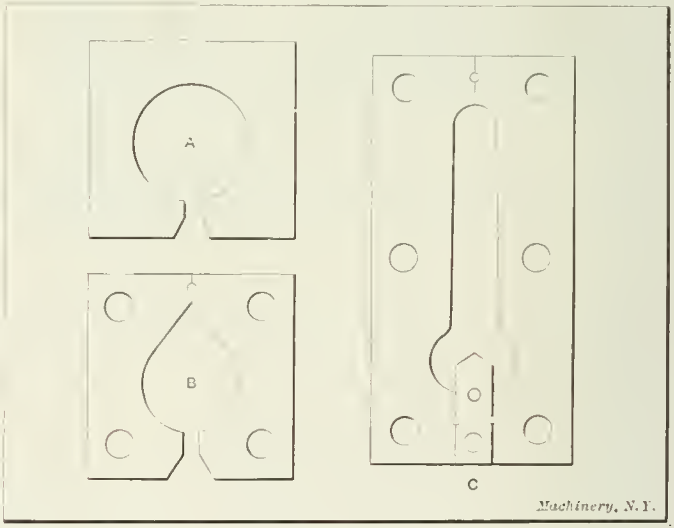

Fig. 47. Trimming Dies A, One-piece Hot Trimmer, B, Two-piece Hot Trimmer; and C, Three-piece Cold Trimmer

piece trimmer can be mounted on a bolster that is used for other trimming dies.

The main difference in the appearance of hot and cold trimmers lies in the fact that the hot trimmers are left open in the front, while cold trimmers have no openings of this kind. The opening in a hot-trimming die is for the purpose of clearing the sprue that connects the forging to the bar, otherwise the forging would be severed from the bar at the first trimming operation. As hot-trimmed forgings are trimmed two or three times in the forging operation, it is of course, necessary that the forging should remain intact with the bar until it is finished. The trimming die is made to trim the sprue section as well as the forging itself. After the forging is completed, it is cut off at the sprue by means of the special cut-off on the side of the trimming press. The opening at the front is cut clear through the thickness of the die stock, and there must be a corresponding opening through the bolster, so that the forgings may be carried through the die and bolster after trimming and taken out from beneath. The die shoe is made with an open space in the center beneath the die and bolster, therefore when the forging is trimmed, it drops through the die and bolster into this open space and is drawn out through the front of the shoe, still intact with the rest of the bar of steel. The positions of the die, bolster and shoe are graphically shown in Fig. 48.

Making a Hot-trimming Die

In making a hot-trimming die, the templet used in laying out the outline for the impression in the drop-forging dies comes into use again, for with it the trimming die may be laid out. The shrinkage allowances in this case are correct, being the same in the trimming dies as they were in the forging die. In connection with the templet, a half-lead should be taken from the forging dies, using the top die for the purpose. A half-lead is easily taken by standing the die on end and clamping a piece of steel or iron over its face, and pouring the molten lead in the ordinary manner. This half-lead must be replaced in the impression after pouring, and the edges peened out to fill the impression when it is cold, for the shrinkage spoils it for use as a templet without this peening. The reason for taking this lead from the top die is that the forging is usually laid in the trimming die with the same side up as it is in the forging die, so as to be convenient for the forger. Using the lead from the top die as a templet will give the trimming die the proper outline to agree with the forging die without reversing. Another reason for using the top half of the lead, is due to the fact that it is easier to fit the die to the top half-lead than the bottom half-lead. The die is tried by pushing the lead up through the back side of the die at intervals during the filing. It is obvious, therefore, that the impression side of the top lead will show up the places in the die that must be filed out, far more clearly than would the flat side of the bottom half-lead, in case it were used.

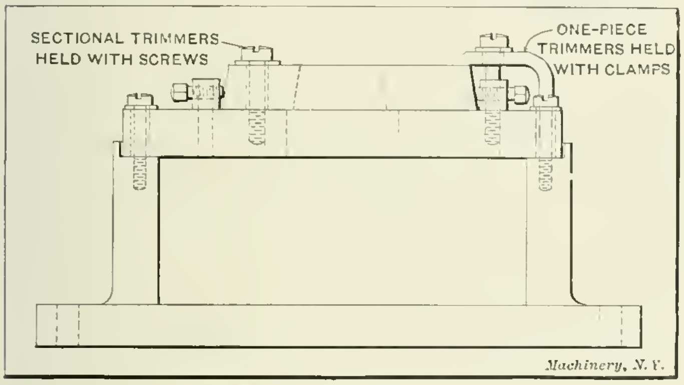

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Fig. 48. Showing Method of Mounting a Trimming Die on the Bolster and Shoe

After the die has been laid out and the outline lightly prick-punched, then a row of holes is laid out the edges of which just clear each other and the outline of the die opening. The size of these holes is dependent upon the size of the die to be made; but for other than small dies, one-half inch is a good size for the holes. After these holes are drilled, the central core may be knocked out and the die is ready for milling.

Fig. 49 illustrates the operation of milling out a trimming die. The die is set up in the vise of the die-sinking machine and a stiff, straight cutter is held in the chuck. With this cutter the die is milled up to the scribed outline, cutting away the rough stock left by the drilling operation. The cutting section of this cutter should be long enough to extend through the entire thickness of the die. After the opening is roughed out, the straight cutter should be replaced by a three-degree cutter that is made with the larger diameter at the bottom. With this cutter the stock may be taken out just to the line. Next, the die should be turned bottom side up in the vise, and a four-degree cutter of the regular die-sinking type placed in the cutter chuck. This cutter should be entered into the opening in the die to within 7/16-inch of the face of the die (which is now at the bottom), and a clearance milled all around the opening, about as shown at Fig. 50. As this illustration shows, this method of putting in the clearance leaves a sort of shelf about one-third the distance from the face of the die to the bottom. Trimming dies are, on an average, 1½-inch thick; therefore, with the above clearance, there will be less than ½ inch to file at those points and corners that require filing.

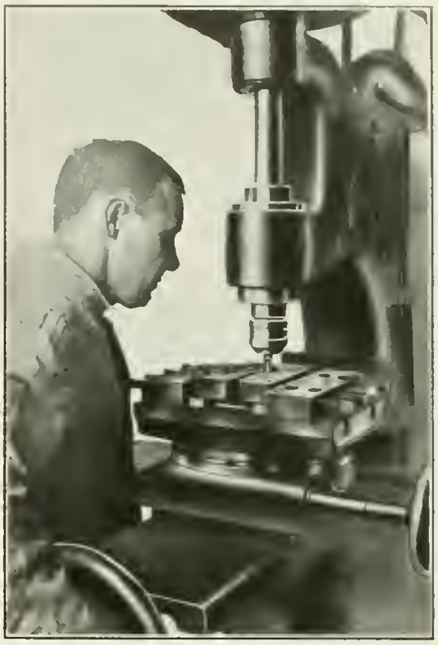

Fig. 49. Milling out a Trimming Die

Should the die be composed of more than one piece, the sections must be fitted and dowelled for alignment before drilling or milling, after which they may be clamped together in the vise of the die-sinking machine just as though they were one piece and treated that way during the milling operations. After the milling has been completed, some filing will be necessary to smooth up the cutting edge and to clean out any corners or angles that could not be milled. For a one-piece die, no holes are required to hold the die to the bolster, as that feature is taken care of by the clamps and side screws with which the bolster is supplied; this feature is illustrated in Fig. 48. This style of a bolster is used only with one-piece trimmers. If the trimmer is made up of more than one piece, the parts must be screwed and dowelled to the bolster.

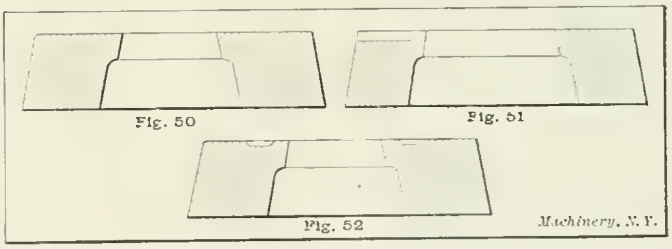
Fig. 50
Fig. 51
Fig. 52
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Fig. 50. Section of Trimming Die to show the Clearance given to the Cutting Edge. Fig. 51. Section of Cold Trimmer to show Method of Cutting away a Space at the Front to clear Rough Sprues. Fig. 52. Section of Trimming Die to show Channel Cut around the Die-opening to accommodate Forgings that must be trimmed Wrong-side up

Punches for Hot-trimming Dies

The general idea of a punch for a hot-trimming die is not to cut, but to support the forging while it is being pushed through the die. If the forging has a broad flat top face, the trimming punch need be little more than a flat punch that covers the top of the forging and acts as a "pusher" without regard to the size of the die itself. Such punches are commonly made of cast iron, and for wrench forgings and other flat work, especially of the larger class, they answer the purpose as well as a steel punch. A wood pattern is usually made, and the casting from it will require little machining before it is ready for use. If the forging is of a round section, the punch must be hollowed out to fit the top face of the piece. There is but one part of the forging where the punch should fit fairly well and that is the sprue section, for unless this part is fitted close, it will bend up and make extra work for the forger. On the other parts of the die it is an advantage to have the punch fit the die very loosely, so that the fin will not stick to the punch during the trimming. Punches for hot trimming are not usually hardened and they are held in the ram of the trimming press by means of a taper shank and key.

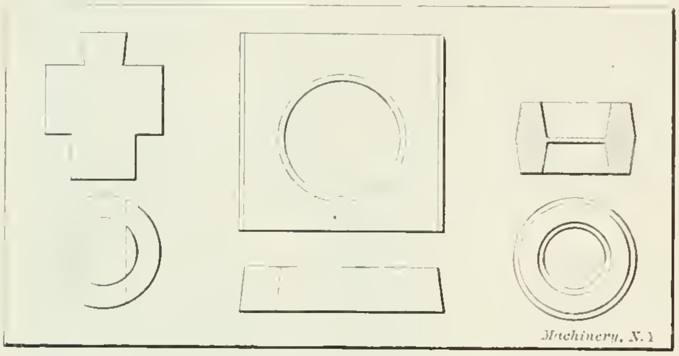


Fig. 53. Trimming Inside and Outside of a Ring Forging at the Same Time

Cold-trimming Dies

Cold-trimming dies are made from good tool steel, 100 to 125 point carbon, and after making are hardened and drawn to a dark straw color. The machine operations in the making are the same as with the hot trimmers except that the opening at the front is omitted because the forgings are not trimmed until they have left the forging press, cut from the bar at the sprue. Although trimming dies for cold work are not made with an opening in the front, there is usually a shallow space cut away just outside of the cutting edge at the front of the die to clear the ragged end of the sprue that is necessarily left after being severed in the cut-off of a pair of drop-forging dies. This clearance appears about as shown in the illustration, Fig. 51.

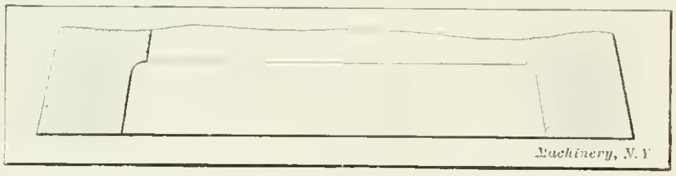


Fig. 54. The Way in which Long Trimming Dies are Sheared

In laying out the cold trimmer for a drop forging, the shrinkage problem comes up again. One of the best methods of obtaining the outline, is to measure with a shrink rule the templet that was used in laying out the drop-forging dies, and to make the outline of the trimming die to these dimensions as read from a standard rule. In making a cold-trimming die, it is a wise plan to first trim up one of the forgings by hand and then to keep away from the lines of the trimming die until it is sure that they are going to be correct for the actual forging. With this precaution it will be easier to fit the forging closer, for there is always a little uncertainty due to the difference in shrinkage arising from the use of the different steels from which the forgings are made.

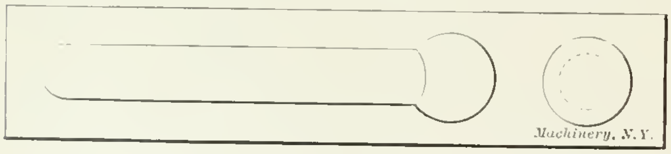


Fig. 55. A Difficult Forging to trim because of its Tendency to roll

The average thickness of trimming dies lies between one and two inches, probably being nearer the one-inch limit on small and medium work. In the case of lock dies, the thickness will depend upon the amount of irregularity caused by the parting line of the forging dies. The surfaces of some cold-trimming dies are cut away to within ¼-inch of the cutting edges of the dies. The reason for this is that on account of their shape, it is often advisable to trim some forgings in the opposite direction to that in which they were forged. This is not often necessary, but when it is, the trimmer must be cut away to clear the back flash that is left on the upper side of most fins. Such a trimming die is shown in Fig. 52. On account of the fact that in drop forging, the steel is more easily forced up than down, into the dies, nigh projections would be in the upper dies, but it would be rather awkward to trim such forgings, from this direction. For this reason the die is cut away as shown and the forging trimmed in the opposite way.

Punches for Cold-trimming Dies

The punches for cold trimmers are made from tool steel, and are hardened and drawn to a very dark straw color. These punches are not hardened to make them cut better, but to prevent them from upsetting at the edges. As with hot-trimming punches, the punch should fit the die loosely, but it should support the forging at every point while it is being pushed through the die.

There are two cases in which trimming punches must fit the dies as closely as the average blanking die for sheet metal work. One case is in trimming forgings on which the fin comes at the corner of the forging and the other case is similar, being on forgings that are formed all in one die, having the other die flat. Unless the dies fit fairly well, burrs will result at the trimmed edges of such forgings.

Trimming a Ring Forging

Fig. 53 shows a trimming die that trims the inside and outside of a ring forging at one operation. The die is a hot trimmer and made to fit the outside edge of the ring at the parting line. The punch is made with a projecting pilot punch that just fits the inside of the ring at the parting line, while the shoulder that pushes the fin off from the outside edge of the forging, is left far enough from the face of the pilot punch to allow the center web to be cut out before the shoulder strikes the top face of the ring. The forging is laid in the trimming die, the punch comes down and cuts out the central web before the shoulder of the punch reaches the top face of the ring. As soon as enough pressure is brought upon the top of the ring, the outside fin and the sprue are trimmed off. With this style of a punch and die, it is best to trim the outside very close, cutting off some of the draft so as to give more support to the punch while trimming the inside fin. The die will not require a stripper as might be supposed, for the inside punch will strip itself owing to the fact that it cannot draw the forging back through the trimming die. The inside punch should be no longer than necessary and should have a very slight taper toward the cutting edge.

General Notes on Trimming Dies

Trimming dies for forgings that are very irregular in shape, having been forged in lock dies, must have the surface of the trimming die, whether a hot or cold trimmer, shaped to agree with the face of the drop-forging die. The reason for this is very apparent, the object being to prevent the bending of the forging while being trimmed. A good example of this point is shown in the trimming and forging dies illustrated in Fig. 43.

Forgings that are to be cold trimmed should be pickled in a weak solution of sulphuric acid to remove the scale formed in the forging operation; by so doing, the dies will last much longer, saving the cutting edge from the hard scale that otherwise would have to be cut in trimming the forging.

A particularly difficult piece to trim is shown in the illustration, Fig. 55. The difficulty lies in the tendency of the forging to roll in the dies while being trimmed. If the forging is matched this tendency will be reduced, but even then if conditions are not of the best, the forging will not trim well. One way of helping to overcome this rolling tendency, is to roughen the surface of the punch where it comes in contact with the forging. This causes the punch to grip the surface of the forging, but it also tends to mar the forging.

If the outline of the forging to be trimmed is long, or of a large perimeter, it will be a good plan to shear the die. Fig. 54 shows the method of shearing a trimming die by grinding hollows in its surface at intervals. This, of course, lessens the force required for the trimming, or rather it divides the work of trimming, whereas in the case of a straight die, the trimming must be all concentrated into one stage of the blow.

By making the trimming die slightly smaller than the outline of the die impression, it is possible to trim off some of the draft that was given the forging in the dies. The appearance of this bevelled edge of the forging is often considered objectionable and by making the trimming die small, most of the draft may be shaved off.

TABLE OF DEDENDUM ANGLES FOR DIFFERENT ADDENDUM ANGLES

Minutes	Degrees											
	0		1		2		3		4		5	
	Deg.	Min.	Deg.	Min.	Deg.	Min.	Deg.	Min.	Deg.	Min.	Deg.	Min.
0	0	0	1	9	2	19	3	28	4	38	5	47
1	0	1	1	11	2	20	3	29	4	39	5	48
2	0	2	1	12	2	21	3	31	4	40	5	49
3	0	3	1	13	2	22	3	32	4	41	5	51
4	0	5	1	14	2	23	3	33	4	42	5	52
5	0	6	1	15	2	25	3	34	4	44	5	53
6	0	7	1	16	2	26	3	35	4	45	5	54
7	0	8	1	18	2	27	3	36	4	46	5	55
8	0	9	1	19	2	28	3	38	4	47	5	56
9	0	10	1	20	2	29	3	39	4	48	5	58
10	0	12	1	21	2	30	3	40	4	49	5	59
11	0	13	1	22	2	32	3	41	4	50	6	0
12	0	14	1	23	2	33	3	42	4	52	6	1
13	0	15	1	24	2	34	3	43	4	53	6	2
14	0	16	1	26	2	35	3	44	4	54	6	3
15	0	17	1	27	2	36	3	46	4	55	6	5
16	0	19	1	28	2	37	3	47	4	56	6	6
17	0	20	1	29	2	39	3	48	4	57	6	7
18	0	21	1	30	2	40	3	49	4	59	6	8
19	0	22	1	31	2	41	3	50	5	0	6	9
20	0	23	1	33	2	42	3	51	5	1	6	10
21	0	24	1	34	2	43	3	53	5	2	6	11
22	0	25	1	35	2	44	3	54	5	3	6	13
23	0	27	1	36	2	45	3	55	5	4	6	14
24	0	28	1	37	2	47	3	56	5	6	6	15
25	0	29	1	38	2	48	3	57	5	7	6	16
26	0	30	1	40	2	49	3	58	5	8	6	17
27	0	31	1	41	2	50	4	0	5	9	6	18
28	0	33	1	42	2	51	4	1	5	10	6	20
29	0	34	1	43	2	52	4	2	5	11	6	21
30	0	35	1	44	2	54	4	3	5	12	6	22
31	0	36	1	45	2	55	4	4	5	14	6	23
32	0	37	1	46	2	56	4	5	5	15	6	24
33	0	38	1	48	2	57	4	6	5	16	6	25
34	0	39	1	49	2	58	4	8	5	17	6	26
35	0	41	1	50	2	59	4	9	5	18	6	28
36	0	42	1	51	3	1	4	10	5	19	6	29
37	0	43	1	52	3	2	4	11	5	21	6	30
38	0	44	1	53	3	3	4	12	5	22	6	31
39	0	45	1	55	3	4	4	13	5	23	6	32
40	0	46	1	56	3	5	4	15	5	24	6	33
41	0	47	1	57	3	6	4	16	5	25	6	35
42	0	49	1	58	3	7	4	17	5	26	6	36
43	0	50	1	59	3	9	4	18	5	27	6	37
44	0	51	2	0	3	10	4	19	5	29	6	38
45	0	52	2	2	3	11	4	20	5	30	6	39
46	0	53	2	3	3	12	4	22	5	31	6	40
47	0	54	2	4	3	13	4	23	5	32	6	42
48	0	56	2	5	3	14	4	24	5	33	6	43
49	0	57	2	6	3	16	4	25	5	34	6	44
50	0	58	2	7	3	17	4	26	5	36	6	45
51	0	59	2	8	3	18	4	27	5	37	6	46
52	1	0	2	10	3	19	4	28	5	38	6	47
53	1	1	2	11	3	20	4	30	5	39	6	48
54	1	2	2	12	3	21	4	31	5	40	6	50
55	1	4	2	13	3	23	4	32	5	41	6	51
56	1	5	2	14	3	24	4	33	5	43	6	52
57	1	6	2	15	3	25	4	34	5	44	6	53
58	1	7	2	17	3	26	4	35	5	45	6	54
59	1	8	2	18	3	27	4	37	5	46	6	55

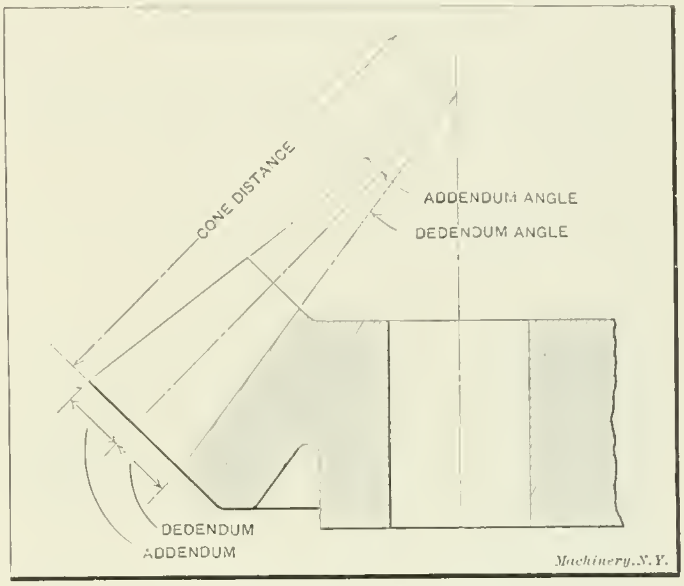
Credit is due Naval Constructor Geo. H. Rock of the Boston Navy Yard, and Asst. Naval Constructor J. E. Otterson in charge of the drop-forge die-sinking department for the assistance given and the courtesy shown the authors while securing photographs of the die-sinking operations illustrated in these articles.

TABLE OF DEDENDUM ANGLES FOR BEVEL GEARS

By E. WINSLOW BAXTER

When it is necessary to make calculations for bevel gears whose shafts are not at right angles, or where the depth of tooth is greater or smaller than the standard depth for the thickness of tooth used, it is not possible to make use of the tables for finding the addendum and dedendum angles, given in the various hand-books. The accompanying table is designed to save much of the labor of calculation in such cases. After the addendum angle is figured by the formula $\frac{\text{addendum}}{\text{cone distance}}$ = tangent of addendum angle, reference is made to the table to find the dedendum angle which is worked out from the following:

$$\text{Dedendum angle} = 1.157 \times \text{addendum angle}.$$



Notation used for Bevel Gear Formulas

Of course the table cannot be used where the ratio of dedendum to addendum is different from that of the standard Brown & Sharpe tooth parts.

Example: Find the dedendum angle for a given addendum angle of 3 degrees 43 minutes. At the intersection of the vertical column under 3 degrees and the horizontal line opposite 43 minutes, the answer, 4 degrees 18 minutes, is found.

* * *

The report of the Swedish Iron and Steel Institute for 1910 contains some interesting data relating to the results of the experiments undertaken in order to ascertain the practicability of the smelting of iron ore by electricity. The results obtained, says the report, show that the problem of smelting iron ore by electricity is solved even from the economical standpoint, on condition that electricity can be furnished at a cheap rate, the same as is now the case at Trollhättan, where the experimental smelting works are located. The experiments have thus far paid expenses. It has been said, however, by engineers connected with the iron industry that while the experiments have been successful, they have not indicated any advantage over smelting with ordinary coal. Nevertheless, the new process may prove profitable in the North of Sweden, where there is an immense supply of water power and great deposits of high-grade ore, but where there is no supply of coal.

* * *

The German patent law at the present time provides that the authorities may revoke a patent if the inventor neglects to work it adequately in the country within the first three years of the life of the patent. An amendment to the patent law is now proposed according to which the authorities are empowered to compel the licensing of the patent, instead of revoking it.

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* Address: 33 Flynt St., Norfolk Downs, Quincy, Mass.

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We solicit exclusive contributions from practical men on subjects pertaining to machine shop practice and machine design. All accepted matter is paid for at our regular space rates unless other terms are agreed on.

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PAID CIRCULATION FOR AUGUST, 1911, 25,789 COPIES

MACHINERY is published in four editions. The practical work of the shop is thoroughly covered in the Shop Edition, $1.00 a year, which comprises approximately 700 reading pages. The Engineering Edition—$2.00 a year, coated paper $2.50—contains all the matter in the Shop Edition, about 300 pages a year of additional matter and forty-eight 6 x 9 Data Sheets filled with condensed data on machine design, engineering practice and shop work. The Foreign Edition, $3.00 a year, comprises the same matter as the Engineering. The Railway Edition, $2.00 a year, is a special edition including a variety of matter for railway shop work—same size as Engineering and same number of Data Sheets.

SEVENTEENTH VOLUME OF MACHINERY

The seventeenth yearly volume of MACHINERY was completed with the August number, and the index of contents will be sent to any reader upon receipt of request. The index for the seventeenth volume is made up in the same form as that employed for the preceding volume, all the articles and page numbers for the engineering, shop and railway editions being comprised in one.

A retrospect of the volume just completed is a matter of satisfaction to those responsible for the contents. It calls attention to so great an array of articles touching on the varied features of machine design and construction that the mere naming of the principal ones would be too long for this page, interesting though it might be to casual readers. But of even greater interest to these and the regular subscribers will be the articles published in the coming year. Processes regarded in some quarters as trade secrets will be described in detail, and many improved methods of doing common work will be shown. The advantage of being a regular subscriber will be even greater than in the past.

* * *

WHY ARE OUR FOUNDRIES NEGLECTED?

We were recently asked by a European engineer of high reputation, who had traveled in the United States and made a careful study of our manufacturing methods, why our foundries are neglected while our machine shops are so efficiently operated. It was a difficult question to answer, particularly as we had not previously realized that our foundries were neglected. But so many instances of inefficiency in our foundry work were pointed out, and so many comparisons made to our disadvantage with foreign results, that we could not deny that the foundries in the United States in general are not worked as efficiently as the machine shops. The engineer mentioned is himself a foundryman and thoroughly conversant with the efficient working of a foundry. He admitted that most of our foundries are well equipped with modern appliances, but his criticism was that they are not managed efficiently.

Our machine shops are generally far more efficiently organized than our foundries; this may be because the management of the latter is often given over to foremen selected from the ranks of the molders on account of their skill as such, but lacking in other knowledge, and especially in the ability to develop new ideas and break away from the old methods in which they have been trained. In our machine shops the management is usually in the hands of men who are not only good mechanics, but full of new ideas and anxious to try them out, because success in that direction means profit and advancement. To raise our foundries to the same level of efficiency as our machine shops, it may be necessary to place them in charge of men having greater mechanical ability and better education, and with a more liberal tendency toward change than has been the case in the past. In Europe many firms employ engineers of high standing in charge of their foundries, and we might perhaps profit by their example.

* * *

SCIENTIFIC MANAGEMENT OF RAILWAY SHOPS

When Louis D. Brandeis made his famous declaration before the Interstate Commerce Commission last winter that the railroads were losing a million dollars a day through inefficient management, the statement was treated with derision by many railway officials, who resented the idea that an outsider was capable of pointing out opportunities for improvements to which they were blind. That there is an opportunity for improvement is now tacitly admitted by the action of several leading roads which have lately instituted searching investigations into the general management of train movements, maintenance-of-way and repairs of locomotives and cars.

Those who have visited railway repair shops and noted the conditions under which work is done in some of them must have been struck with the lack of proper tools and appliances to perform work expeditiously and economically. One such case recently came to our attention in a Southwestern railway repair shop, where a double-end punching and shearing machine with a capacity to punch a 3-inch hole through 2-inch material and to shear 4½-inch round soft steel bars, cold, was employed punching ¾-inch holes through boiler plate about ⅜ inch thick, and shearing 1-inch round bars.

On calling the attention of the mechanic in charge to the heavy over-head expense of operating so large a machine on such light materials, the visitor was informed that the condition was fully realized, but that it had been impossible for him to get through requisitions for lighter machines more suitable for the general run of work.

Between a large costly machine, slow in movement and therefore expensive to operate, and one too small and weak for part of the general run of work, there is little to choose on the score of economy. It is true that the large machine can handle everything that comes to it, but its operation results in waste of time and extra expense because of the overhead burden. The weak machine is more desirable for the work within its capacity, because of its more rapid movement and the smaller investment, but suffers in comparison when employed on materials too heavy for its normal capacity. Between these extremes there is a happy medium which it is the duty of the investigator to determine.

It is a poor policy in general to purchase machine tools or to build manufacturing plants to cope with remote conditions of expansion or development. It is more in keeping with the principles of scientific management to build the plant or purchase the tools for present average conditions of work, and let the future care for itself. In railway repair work certain abnormal conditions exist because of rapid expansion, but though the increase of power and size of locomotives has been rapid for the last ten years, it is safe to assume that the change in the next twenty years cannot be as great. The limitations of track, gage, bridges and tunnels will prevent any great increase in the width and height of locomotives. Therefore it seems that machine tools of all classes suitable for railway work can be designed to meet average conditions likely to continue for a generation to come—a period that measures the efficient life-time of machinery in general.

UNPROFITABLE PATENTS

We described in the July number a tool, lately patented, for extracting tight shaft keys from the hubs of pulleys and gears, which no doubt was useful in the shop where it was designed and made, but which did not warrant the expense necessary to secure a patent, because of its obviously limited use. The probabilities are that the inventor will never receive in royalties a sum sufficient to pay the postage on the correspondence incident to securing the patent.

This case would not merit attention were it not typical. The fact that a device is novel and useful is not a guarantee that it will be profitable. The inventor should consider the probable market, and the cost of selling as well as of manufacturing. The devices that bring the largest returns to the inventors are those that meet a general want. A simple household convenience, or any article of general utility, may become a staple and yield large profits. On the other hand, a very ingenious tool may have so limited a use as to be valueless to the inventor except in his own business. Between the articles having a wide sale and those required in such small quantities as not to warrant manufacturing, there is a broad middle ground, in which many inventions lie, and the relative nearness of the new invention to one limit or the other determines its commercial value.

* * *

SHEET-METAL WORKING ON A SCIENTIFIC BASIS

The engineer who developed the scleroscope, an effective and simple instrument for testing the hardness of metals, has had a peculiar experience in connection with its introduction. This instrument has been sold to many progressive concerns, and is in use for a wide variety of testing purposes, but the originator has been unable to obtain from a large number of users any definite knowledge of the uses to which the instrument is being put, or any data resulting from their experience with it. The condition mentioned has been especially true of the sheet-metal industry.

This selfish policy has materially retarded the development of the sheet-metal industry along scientific lines, and numerous cases have been found where costly die work could have been avoided if the hardness of the material in the first instance had been known. In designing bending punches and dies, experiments are necessary under present conditions each time a different form is to be produced, and also if the same form is required when the part is made from different material. The use of a testing instrument such as we have referred to does away with all but the first experiment, and the work connected with that would be greatly simplified by tabulating the results of experiments. This desirable object can be accomplished by ascertaining the hardness of the metal and obtaining a factor for a certain bend, when produced in a piece of material of a given hardness and thickness. It would be necessary, however, to make a series of tests on the different materials, such as copper, brass and steel, as a comparison of the hardness of these metals cannot be used as a basis.

The following case is a good example of the time and money wasted on experiments as they are now conducted in connection with such work. A certain spring was required for an electric apparatus to be made from German silver, and to an exact shape. The bending dies were designed, and as is the common practice, their shape was determined by trial. These dies were made and after considerable experimenting the supposedly correct shape to give the desired bend was obtained. The dies were then turned over to the press department, when it was found that there was not sufficient German silver in the store-room to complete the order. A new lot was obtained, but when the dies were completed it was found that they did not produce the desired bend. As a large supply of material had been ordered and furnished according to specifications, the only alternative was to anneal the dies and experiment—a second time—with the new material.

Another case in which a hardness testing device would save unnecessary work is in the making of dies for drawing sheet-metal. The mechanic must now depend entirely on the results of his personal experience, memory of which is more or less vague. He cannot tell exactly how much the metal will stretch, nor what hardness it will develop until the dies are completed. All he knows of the hardness of, say, brass, is that there are three grades, *viz.*, soft, half-hard and hard, and between these degrees exist factors unknown to him. This lack of definite knowledge makes experiments necessary with steel—a costly process when anything except ordinary drawing or press working of sheet metal is to be undertaken. Experimenting in the tool-room is often unsatisfactory, usually expensive. If it is impossible to determine the characteristics of the sheet material the work may be of little or no future value, because a slight variation in the hardness of the metal may make the tools unsuitable.

It is quite plain that the sheet-metal working industry as a whole has much to gain from cooperative work, and in order to reap the benefits of cooperation, it will first be necessary to publish the results of tests made in the course of tool-making, or to give the designer of the testing instrument the data resulting from its use.

* * *

SPIRAL GEAR DESIGN—1[*][†]

By JAMES H. CARVER[‡]

To the average machine designer, a problem in spiral gearing is not an every day occurrence. When such a problem is met with, say once in six months or in a year, he begins to hunt up some of the literature which he thinks may contain the required information, but which is not always available in convenient form. In the following are, therefore, given the data needed and the methods of solving the eight cases mostly used, with the hope that this information will be of use when occasion arises.

The eight cases mentioned are:

1.—Shafts parallel, ratio equal, and center distance approximate.

2.—Shafts parallel, ratio equal, and center distance exact.

3.—Shafts parallel, ratio unequal, and center distance approximate.

4.—Shafts parallel, ratio unequal, and center distance exact.

5.—Shafts at right angles, ratio equal, and center distance approximate.

6.—Shafts at right angles, ratio equal, and center distance exact.

7.—Shafts at right angles, ratio unequal, and center distance approximate.

8.—Shafts at right angles, ratio unequal, and center distance exact.

In the accompanying Data Sheet Supplement, the procedure to follow in calculating the required dimensions for each of the first four cases is outlined. In a following number of MACHINERY, the last four cases will be treated. All the required formulas are given, and also an example, showing the application of the formulas to a practical problem. All the information necessary for the shop operations is given, including the number of teeth marked on the spur gear cutter used, and the lead of the spiral, which data are often omitted on the drawing, but which always ought to be given. If omitted, the operator of the milling machine or gear-cutter must determine these data himself, or hunt up the shop scholar, who does it for him, and this is not a commendable method.

Procedure in Calculating Spiral Gears

One of the first steps necessary in spiral gear design is to determine the direction of the thrust, if the thrust is to be taken in any particular direction. The direction of this thrust being determined and the relative position of the driver and driven gear being known, the direction of spiral (right- or left-hand) may be found. The accompanying thrust diagram for gears having parallel shafts can be used advantageously as an aid in finding the direction of spiral. The direction of the thrust on spiral gears depends on the direction of spiral, the relative positions of driver and driven gear, and the direction of rotation. If the exact condition with regard to thrust is not found in the diagram, it may be obtained by changing any one of the above three conditions; that is, in Fig. 1 the thrust may be changed to the opposite direction, by interchanging driver or driven gear, by reversing the direction of rotation, or by changing the direction of spiral. Any one of these alterations will produce a thrust in the opposite direction. The conditions of design will determine the nature of center distances, whether they must be exact or approximate. The strength of tooth needed, or sometimes the cutters on hand, will determine the normal pitch of the gear. The formulas given for the different conditions of spiral gearing are all based on the normal diametral pitch which is the same as the diametral pitch of the cutter used. The number of teeth in each gear is, of course, determined by the required speed ratio of the shafts. The angle of spiral depends on the conditions of the design, and the relative position of the shafts. If the shafts are parallel, the gears may be of the herring-bone type, when an angle as great as 45 degrees may be used, as there is no end thrust. When used as shown in the thrust diagrams, the spiral angle should not exceed 20 degrees, thus avoiding excessive end thrust. In order to obtain smooth running gears, the spiral angle should also be such that one end of the tooth remains in contact until the opposite end of the following tooth has found a bearing, as indicated at V and W in Fig. 6.

---

[*] With Data Sheet Supplement.

[†] For articles previously published on this and kindred subjects, see MACHINERY, October, 1908, engineering edition, "Diagrams for Designing Spiral Gears"; April, 1908, "A Study in Spirals"; April, 1908, engineering edition, "Derivation of Formula for Determining Spur Gear Cutter Number for Spiral Gears"; June, 1907, "A Comparison of the Efficiency of Two Trains of Spiral Gears"; May, 1906, "A Method of Procedure in the Design of Helical Gears." See also MACHINERY'S Reference Series book No. 20, "Spiral Gearing," and MACHINERY'S Data Sheet book No. 6, "Bevel, Spiral and Worm Gearing."

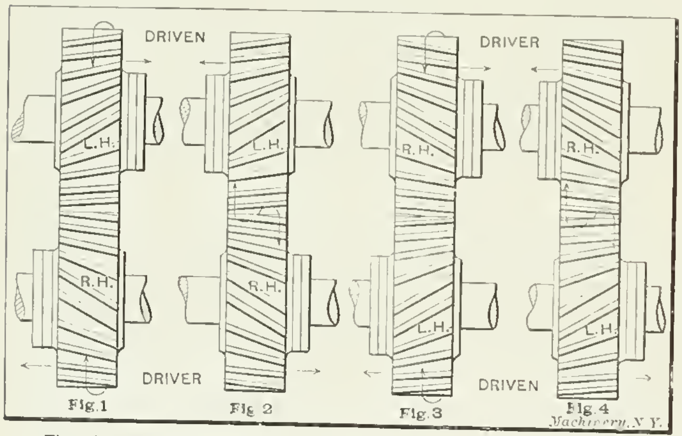
[‡] Address: 761 Eastern Ave., Schenectady, N. Y.

1. Shafts Parallel, Ratio Equal, and Center Distance Approximate

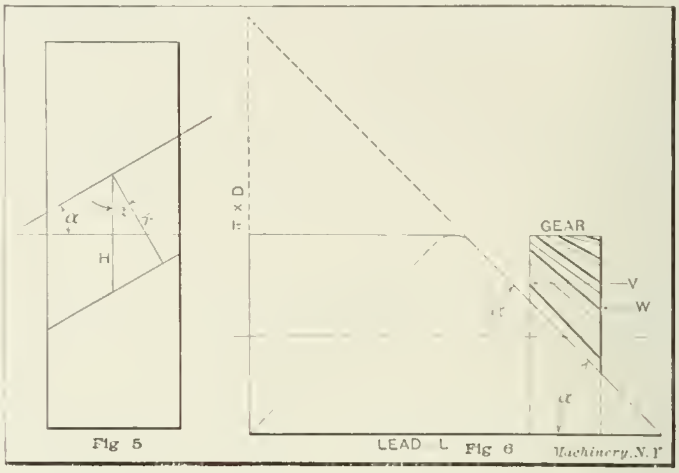
This case is met with in new designs, where an exact center distance is of no importance. The five factors, direction of spiral, approximate center distance, normal diametral pitch, number of teeth, and angle of spiral are first determined upon. Then, from the formulas given in the Data Sheet Supplement, the required data are found as shown in the example given. The following shows the derivation of the formulas; in Fig. 5, let a be the angle of spiral with the axis of the gear; let H be the distance from one tooth to the next, measured on the circumference of the pitch circle, and K the normal circular pitch of the gear. Then $H = \dfrac{K}{\cos a}$. The diametral pitch $= \dfrac{\pi}{\text{Circular Pitch}}$. Let $P_n =$ normal diametral pitch, or diametral pitch of cutter used. Then $P_n = \dfrac{\pi}{K}$, or transposing, $K = \dfrac{\pi}{P_n}$. If $N =$ number of teeth in gear, the circumference of the pitch circle $= N \times H$, and $\dfrac{N H}{\pi} =$ pitch diameter $= D$. Hence,

$$D = \frac{N}{\pi} \times \frac{K}{\cos a} = \frac{N}{\pi \cos a} \times \frac{\pi}{P_n} = \frac{N}{P_n \cos a} \qquad (1)$$

In all cases where the shafts are parallel, the value of a is the same for both gears. The outside diameter of the spiral gear is found exactly as in spur gears, by adding $\dfrac{2}{P_n}$ to the pitch diameter. The derivation of formula $T = \dfrac{N}{\cos^3 a}$ was treated fully by H. W. Henes in MACHINERY, April, 1908, engineering edition, in an article entitled "Derivation of Formula for Determining Spur Gear Cutter Number for Spiral Gears."[*] A standard spur gear cutter is, of course, used in cutting spiral gears, but T, the number of teeth marked on it, will probably not be the actual number of teeth in the spiral gear to be cut, T depending, as the formula shows, on the spiral angle. In place of using this formula, the number of cutter, ranging from No. 8, cutting 12 to 13 teeth, to No. 1, cutting 135 teeth to a rack, can be found directly by a diagram contributed by Elmer G. Eberhardt, and published in the September, 1907, number of MACHINERY.[†] As to the lead of spiral, let Fig. 6 represent a spiral gear, where the oblique line is the path of the tooth unfolded. Then $L = \pi D \cot a$, in which $L =$ lead of spiral, $\pi D =$ pitch circumference, and $a =$ spiral angle.



Figs. 1 to 4. Thrust Diagrams for Spiral Gears—Direction of Thrust depends upon Direction of Rotation, Relative Position of Driver and Driven Gear, and Direction of Spiral



Figs. 5 and 6. Diagrams for Derivation of Formulas

2 Shafts Parallel, Ratio Equal, and Center Distance Exact

The spiral angle a is found in terms of the number of teeth in each gear, normal diametral pitch, and pitch diameter, which latter is, of course, equal to the center distance.

From Formula (1) in Case (1) $D = \dfrac{N}{P_n \cos a}$, or $\cos a = \dfrac{N}{P_n \times D}$. The remaining formulas are found as in the first case.

3. Shafts Parallel, Ratio Unequal, and Center Distance Approximate

The formulas for this case are practically the same as for Case (1), and are derived in the same manner. The spiral angle is of the same value in both gears, as in all spiral gears with parallel shafts, but, of course, of a different direction (hand) in each gear.

4. Shafts Parallel, Ratio Unequal, and Center Distance Exact

In this case the sum of the two pitch diameters of the gears, or twice the center distance is $\dfrac{N}{P_n \cos a} + \dfrac{n}{P_n \cos a} = 2\,C$, from which, $\cos a = \dfrac{N + n}{2\,P_n\,C}$.

N and n are the numbers of teeth in the respective gears, and C the center distance. The remaining eight formulas are similar to those of the other cases.

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If you are looking for a perfect vacuum, examine the head of the man who "wasn't hired to do that."—*The Silent Partner.*

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[*] See MACHINERY'S Reference Series No. 20, "Spiral Gearing," second edition, pages 21 to 24.

[†] See MACHINERY'S Reference Series No. 20, "Spiral Gearing," second edition, page 30; see also MACHINERY'S Data Sheet Series No. 6, "Bevel, Spiral and Worm Gearing," page 24.

COMPOSITION AND HEAT TREATMENT OF CARBON AND ALLOY STEELS*

While the steels and methods of heat treating them given in the following article have been prepared more especially for automobile construction, they also can be used in a large number of cases for manufacturing other products. It is obvious that there are more kinds of material specified than are likely to be used by any one manufacturer, but the number given represents a choice sufficient to cover all requirements.

Carbon Steel—0.15 Per Cent

Composition. Carbon, 0.08 to 0.18 per cent (0.15 per cent desired); manganese, 0.40 to 0.60 per cent (0.50 per cent desired); silicon, not over 0.20 per cent; phosphorus, not over 0.04 per cent; sulphur, not over 0.04 per cent.

Characteristics and Uses. The source of this material is always the basic open hearth furnace. It is a material commonly used for seamless tubing, pressed steel frames, pressed steel brake-drums, sheet steel brake-bands and pressed steel parts of many varieties. It is soft and ductile, and will stand much deformation without cracking. This steel is weak, and in an annealed condition will have an elastic limit of about 30,000 pounds per square inch, with a very high reduction of area and elongation. When cold rolled, the elastic limit may be as high as 60,000 pounds per square inch, with but little reduction of area and elongation. This relatively high elastic limit can only be obtained in light or small sections. This material should not be used for such parts as are to be machined, as it will tear badly when turning, threading or broaching.

Heat Treatment. This steel is not much benefited in strength by heat treatment, but is increased somewhat in toughness. It is possible to heat treat this steel, and thus make it easier to machine than in the annealed state. Forgings may be made from it, but are not desirable and should be avoided. The heat treatment which will produce stiffness, is to heat to 1500 degrees F. and quench in oil or water, no drawing being necessary.

Carbon Steel—0.20 Per Cent

Composition. Carbon, 0.15 to 0.25 per cent (0.20 per cent desired); manganese, 0.50 to 0.80 per cent (0.65 per cent desired); silicon, not over 0.20 per cent; phosphorus, not over 0.04 per cent; sulphur, not over 0.04 per cent.

Characteristics and Uses. The natural source of supply for this material is the basic open hearth process. It is intended primarily for casehardening purposes, and can be easily forged and machined. It is not a very strong material. This steel is soft and ductile, having an elastic limit in the annealed condition of about 35,000 pounds per square inch. It may be drawn into tubes and cold rolled, and as a matter of fact, makes a better frame because of the slightly higher carbon content and resulting stiffness. The increased carbon content has no detrimental effect so far as working it is concerned, and it is only under the most difficult forming operations that it will crack.

Heat Treatment. This steel is little affected by heat treatment, as far as strength is concerned, but heat treating after forging, does cause a desirable refinement of the grain, and the toughness is materially increased. A simple quenching operation from about 1500 degrees F. in oil is generally used. The casehardening treatment is the most important for this steel, the character of the treatment depending upon the importance of the parts to be treated—their shape and size.

Heat treatment after forging or machining:

1. Carbonize at a temperature between 1600 and 1750 degrees F. (1650 to 1700 degrees F. desired). 2. Cool slowly in the carbonizing mixture. 3. Reheat, 1500 to 1550 degrees F. 4. Quench. 5. Reheat, 1400 to 1450 degrees F. 6. Quench. 7. Draw in oil at a temperature varying from 300 to 450 degrees F.—the temperature depending on the degree of hardness desired.

Carbon Steel—0.30 Per Cent

Composition. Carbon, 0.25 to 0.35 per cent (0.30 per cent desired); manganese, 0.50 to 0.80 per cent (0.65 per cent desired); silicon, not over 0.20 per cent; phosphorus, not over 0.04 per cent; sulphur, not over 0.04 per cent.

Characteristics and Uses. The natural source of supply of this material is the basic open hearth process, and it is primarily used as a structural steel. It forges well, machines well and responds to heat treatment in the matter of strength as well as toughness. That is to say, intelligent heat treatment will produce a marked increase in the elastic limit. It may be used for all forgings, such as axles, driving-shafts and other structural parts. In the annealed condition the elastic limit is about 45,000 pounds per square inch, with ample elongation and reduction of area.

Heat Treatment. As strength and toughness are of prime importance in this steel, the heat treatment must be modified in accordance with the experience of the individual user. The steel should be heat treated in all cases where reliability is important. Machining may precede the heat treatment of this steel. If the highest strength is required strong quenching solutions must be employed, for example, brine. If quenched in brine, the elastic limit will be correspondingly high, and the steel correspondingly hard and difficult to machine. On the other hand, if a moderately high elastic limit is all that is desired, an oil quench will suffice, and machining may follow without difficulty.

Carbon Steel—0.45 Per Cent

Composition. Carbon, 0.40 to 0.50 per cent (0.45 per cent desired); manganese, 0.50 to 0.80 per cent (0.65 per cent desired); silicon, not over 0.20 per cent; phosphorus, not over 0.04 per cent; sulphur, not over 0.04 per cent.

Characteristics and Uses. The natural sources of supply of this steel are basic or acid open hearth, and crucible or electric furnace, the most common being the basic open hearth. This steel possesses greater strength for structural purposes than 0.30 carbon steel. Its uses, however, are more limited and are confined in a general way to such parts as demand a high degree of strength and a relatively low degree of toughness. With proper heat treatment the fatigue resisting qualities are very high. The principal uses for this steel are: crankshafts, driving-shafts, propeller-shafts and transmission gears. It is not hard enough, however, without casehardening, and is not tough enough with case-hardening to make safe transmission gears, and should not be used for casehardened parts, except in an emergency. In the annealed condition this steel should have an elastic limit of about 50,000 pounds per square inch, and after heat treating, the elastic limit may be nearly doubled.

Heat treatment. After forging or machining: 1. Heat to 1550 degrees F. 2. Quench. 3. Anneal by heating to 1450 degrees F. 4. Cool slowly in furnace, in lime or soft coal. 5. Reheat, 1400 to 1500 degrees F. 6. Quench. 7. Heat, 800 to 1000 degrees F. and cool slowly.

Carbon Steel—0.80 Per Cent

Composition. Carbon, 0.75 to 0.90 per cent (0.80 per cent desired); manganese, 0.25 to 0.50 per cent (0.35 per cent desired); silicon, 0.10 to 0.30 per cent; phosphorus, not over 0.035 per cent; sulphur, not over 0.035 per cent.

Characteristics and Uses. This steel is used principally for springs, and generally speaking for springs of light section. Its sources of supply may be the open hearth, crucible or elastic furnace.

Heat Treatment. It must be understood that the higher the drawing temperature, the lower will be the elastic limit of the material. On the other hand, if the material be drawn to too low a temperature it will be brittle. The hardening and drawing of springs, that is the heat treatment of them, is as a rule, in the hands of the spring maker, but for small coil springs the following treatment is recommended: 1. Coil. 2. Heat, 1400 to 1500 degrees F. 3. Quench in oil. 4. Reheat, 400 to 500 or 600 degrees F. in accordance with the degree desired, and cool slowly.

Carbon Steel—0.95 Per Cent

Composition. Carbon, 0.90 to 1.05 per cent (0.95 per cent desired); manganese, 0.25 to 0.50 per cent (0.35 per cent desired); silicon, 0.10 to 0.30 per cent; phosphorus, not over 0.035 per cent; sulphur, not over 0.035 per cent.

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* Abstract of the second report made by the Iron and Steel Division of the Society of Automobile Engineers' Standards Committee at the Summer meeting in Dayton, Ohio, June 15-17, 1911.

Characteristics and Uses. This steel is obtained from the same sources as 0.80 carbon steel and is used principally for springs.

Heat Treatment. Substantially the same remarks apply to this steel as to 0.80 carbon steel. The heat treatment may be reduced slightly because of the increased carbon content, and possibly the drawing temperature will be different.

Nickel Steel—0.20 Carbon, 3 1-2 Per Cent Nickel

Composition. Carbon, 0.15 to 0.25 per cent (0.20 per cent desired); manganese, 0.50 to 0.80 per cent (0.65 per cent desired); silicon, not over 0.20 per cent; phosphorus, not over 0.04 per cent; sulphur, not over 0.04 per cent; nickel, 3.25 to 3.75 per cent (3.50 per cent desired).

Characteristics and Uses. This steel is primarily intended for casehardening. The carbon content is relatively low, which means that the interior metal of a casehardened piece will be tough. The elastic limit in the annealed condition is 45,000 pounds per square inch, with good reduction and elongation. It will respond well to heat treatment, and the elastic limit will be increased to about 60,000 or 70,000 pounds per square inch, with a better reduction of area than in the annealed state. The principal uses of this steel are for casehardened gears, both for the belt driven and transmission system, and for such other casehardened parts as demand a very tough, strong interior with a hardened exterior.

Heat Treatment. The casehardening sequence may be varied considerably, but as a rule those parts which require the use of nickel steel generally require the best type of casehardening.

After forging or machining: 1. Carbonize at a temperature between 1600 and 1750 degrees F. (1650 to 1700 degrees F. desired). 2. Cool slowly in the carbonizing material. 3. Reheat, 1450 to 1525 degrees F. 4. Quench. 5. Reheat, 1400 to 1450 degrees F. 6. Quench. 7. Reheat to a temperature from 250 to 500 degrees F. (in accordance with the necessities of the case) and cool slowly.

The second quench (operation 6) must be conducted at the lowest possible temperature at which the material will harden. It will be found that this is sometimes as low as 1300 degrees F. It will be found possible in some cases to omit the final drawing (operation 7) entirely, but for parts of the highest importance this operation should be followed as a safe-guard. Parts of intricate shape comprising sudden changes of thickness, sharp corners and the like should always be drawn, in order to relieve internal strains.

Nickel Steel—0.30 Carbon, 3 1-2 Per Cent Nickel

Composition. Carbon, 0.25 to 0.35 per cent (0.30 per cent desired); manganese, 0.50 to 0.80 per cent (0.65 per cent desired); silicon, not over 0.20 per cent; phosphorus, not over 0.04 per cent; sulphur, not over 0.04 per cent; nickel, 3.25 to 3.75 per cent (3.50 per cent desired).

Characteristics and Uses. This steel is primarily intended for heat treating, and is used for structural parts where much strength and toughness are desired; such parts as axles, spindles, crank-shafts, driving-shafts and transmission-shafts. The elastic limit in the annealed condition is about 55,000 pounds per square inch. By heat treatment this may be increased to 160,000 pounds per square inch, the ductility at this point being satisfactory, and a reduction of area of at least 45 per cent being obtainable. The wide variation in the elastic limit is obtained by the use of different quenching mediums—brine and oil—and a difference in the drawing temperatures.

Heat Treatment. After forging and machining: 1. Heat, 1450 to 1500 degrees F. 2. Quench. 3. Heat, 600 to 1200 degrees F. and cool slowly.

A higher refinement of this treatment is: After forging and machining: 1. Heat, 1450 to 1500 degrees F. 2. Quench. 3. Reheat, 1350 to 1400 degrees F. 4. Quench. 5. Heat, 600 to 1200 degrees F. and cool slowly.

By the proper regulation of the quench and drawing tempertures, a wide range of physical characteristics may be obtained. The thickness of the mass treated, the volume and temperature of the quenching medium and other details peculiar to most hardening plants, must be recognized in order to get intelligent and desirable results. This material may be casehardened, but it contains a rather high carbon content for this purpose. The lower ranges of carbon—0.25 per cent—are satisfactory, but the upper ranges—in the neighborhood of 0.35 per cent approach the danger point, and steel of this carbon content must be correspondingly carefully hardened.

Chrome-nickel Steel—0.15 Carbon

Composition. Carbon, 0.10 to 0.20 per cent (0.15 per cent desired); manganese, 0.40 to 0.60 per cent (0.50 per cent desired); silicon, 0.10 to 0.30 per cent; phosphorus, not over 0.04 per cent; sulphur, not over 0.04 per cent; nickel, 1.50 to 2.00 per cent (1.75 per cent desired); chromium, 0.50 to 1.00 per cent (0.75 per cent desired).

Characteristics and Uses. This steel is primarily intended for alloy steel frames, and for heat treatment when so used. It may be used for other purposes, such as structural parts or for casehardened parts by simply modifying the heat treatments, but as this composition is not intended for such use, no further discussion will be given.

Heat Treatment, for frames after forming. 1. Heat, 1400 to 1450 degrees F. 2. Quench. 3. Heat, 1000 to 1200 degrees F. and cool slowly. The exact temperatures for operations 2 and 3 must be determined experimentally, being somewhat dependent upon the thickness of the stock, temperature of the quenching medium and the design of the part. Generally speaking, thin sections, such as frames, respond readily to quenching operations and must be handled with corresponding care.

Chrome-nickel Steel—0.20 Carbon

Composition. Carbon, 0.15 to 0.25 per cent (0.20 per cent desired); manganese, 0.30 to 0.50 per cent (0.40 per cent desired); silicon, 0.10 to 0.30 per cent; phosphorus, not over 0.04 per cent; sulphur, not over 0.04 per cent; nickel, 3.25 to 3.75 per cent (3.50 per cent desired); chromium, 1.25 to 1.75 per cent (1.50 per cent desired).

Characteristics and Uses. This steel is intended primarily for casehardened parts. The treatment may be so varied as to render it possible to use this steel for many structural parts. Its strength in an annealed condition is not of much importance, as this alloy, as well as others, offers no material advantage over carbon steels unless it is heat treated.

Heat Treatment. The heat treatment should be modified according to the results obtained by practical experiment. An elastic limit of 120,000 pounds per square inch is possible, with a large measure of reduction of area and elongation.

After forging and machining: 1. Carbonize at a temperature between 1600 and 1750 degrees F. (1650 to 1700 degrees F. desired). 2. Cool slowly in the carbonizing mixture. 3. Reheat, 1400 to 1500 degrees F. 4. Quench. 5. Reheat, 1300 to 1400 degrees F. 6. Quench. 7. Heat, 250 to 500 degrees F. and cool slowly.

The heating for the second quench (operation 5) should be carried out at the lowest possible temperature at which sufficient hardness may be obtained.

Chrome-nickel Steel—0.30 Carbon

Composition. Carbon, 0.25 to 0.35 per cent (0.30 per cent desired); manganese, 0.30 to 0.50 per cent (0.40 per cent desired); silicon, 0.10 to 0.30 per cent; phosphorus, not over 0.04 per cent; sulphur, not over, 0.04 per cent; nickel, 3.25 to 3.75 per cent (3.50 per cent desired); chromium, 1.25 to 1.75 per cent (1.50 per cent desired).

Characteristics and Uses. This grade of chrome-nickel steel is intended largely for structural parts of the most important character; parts requiring this high grade of steel must be heat treated, otherwise there is no gain commensurate with the increased cost of the steel. It is suitable for crankshafts, axles, spindles, driving-shafts, transmission-shafts and, in fact, the most important structural parts of an automobile. The elastic limit in the annealed condition is of no importance, as this steel should not be used in the annealed state. The elastic limit after heat treating may be as high as 175,000 pounds per square inch, with a generous reduction of area and elongation.

Heat Treatment. After forging and machining: 1. Heat, 1450 to 1500 degrees F. 2. Quench. 3. Reheat to a temperature between 500 and 1250 degrees F. and cool slowly.

A higher refinement of this treatment is, after forging: 1. Heat, 1450 to 1500 degrees F. 2. Quench. 3. Reheat to 1400 degrees F. 4. Quench. 5. Reheat to a temperature between 500 and 1250 degrees F. and cool slowly.

The temperatures when treating and annealing should be controlled by a pyrometer.

The lower the temperature at which the proper response to treatment is obtained, the better will be the results. At the same time, if a sufficient temperature is not used, there will be an incomplete or unsatisfactory response. This steel is not intended for casehardening, but may be so treated in an emergency. If casehardening is attempted the highest degree of care must be exercised.

Chrome-nickel Steel 0.45 Carbon

Composition. Carbon, 0.40 to 0.50 per cent (0.45 per cent desired); manganese, 0.40 to 0.60 per cent (0.50 per cent desired); silicon, 0.10 to 0.30 per cent; phosphorus, not over 0.04 per cent; sulphur, not over 0.04 per cent; nickel, 1.50 to 2.00 per cent (1.75 per cent desired); chromium, 0.80 to 1.20 per cent (1.00 per cent desired).

Characteristics and Uses. This steel is used mostly for gears where extreme strength is necessary. The carbon content is sufficiently high to cause the material, in the presence of chromium and nickel, to become sufficiently hard to make a good gear when quenched, without casehardening. The characteristics of this steel in an annealed condition are unimportant, as it should not be used in that condition. The heat treatment produces as an elastic limit as high as 200,000 pounds per square inch, with good reduction of area and elongation. This steel is difficult to forge, and during the forging operation it should be kept at a thoroughly plastic heat, and not hammered after the temperature drops to ordinary forging temperatures, as cracking is liable to result; the steel also becomes hard and forges with great difficulty. On the other hand, too high a temperature is not advisable, as the steel becomes red-short and breaks. Generally speaking, the higher the carbon content of chrome-nickel steel, the more this characteristic is found to be true.

Heat Treatment. To heat treat this steel for gears after forging: 1. Heat to 1500 degrees F. plus or minus 25 degrees F. 2. Quench. 3. Reheat, 1400 to 1450 degrees F. (Hold at this temperature one-half hour, to ensure thorough heating.) 4. Cool slowly. 5. Reheat, 1450 to 1500 degrees F. 6. Quench. 7. Reheat, 250 to 550 degrees F. and cool slowly.

This steel cannot be machined unless thoroughly annealed. The final drawing operation must be conducted to a heat which will produce the proper degree of hardness. The Brinell hardness test for a gear is between 430 and 470, the corresponding Shore hardness number being from 75 to 85. This steel should not be casehardened.

Chrome-vanadium Steel—0.20 Carbon

Composition. Carbon, 0.15 to 0.25 per cent (0.20 per cent desired); manganese, 0.40 to 0.70 per cent (0.50 per cent desired); silicon, 0.10 to 0.30 per cent; phosphorus, not over 0.04 per cent; sulphur, not over 0.04 per cent; chromium, 0.80 to 1.10 per cent (0.90 per cent desired); vanadium, not less than 0.10 per cent (0.18 per cent desired).

Characteristics and Uses. This steel is primarily for casehardening, and is used for the best casehardened parts, such as shafts, gears, etc. The physical characteristics of this steel, annealed, are unimportant.

Heat Treatment. This material will respond somewhat to heat treatment, and be considerably benefited thereby. Its proper use is for casehardening, however, and the following treatment is recommended:

After forging and machining: 1. Carbonize at a temperature between 1600 and 1750 degrees F. (1650 to 1700 degrees F. desired). 2. Cool slowly in the carbonizing mixture. 3. Reheat, 1600 to 1700 degrees F. 4. Quench. 5. Reheat, 1300 to 1400 degrees F. 6. Quench. 7. Reheat, 250 to 500 degrees F. and cool slowly.

The high initial quenching temperature of this steel is noteworthy—that is, something a little over 1600 degrees F. This differs from the other steels referred to, and also from the characteristics of chrome-vanadium steel. The heating for the second quench (operation 5) should be conducted at the lowest possible temperature that will harden the exterior carbonized surface. Practical experiments will develop the best temperature for local conditions in any hardening-room.

Chrome-vanadium Steel—0.30 Carbon

Composition. Carbon, 0.25 to 0.35 per cent (0.30 per cent desired); manganese, 0.40 to 0.70 per cent (0.50 per cent desired); silicon, 0.10 to 0.30 per cent; phosphorus, not over 0.04 per cent; sulphur, not over 0.04 per cent; chromium, 0.80 to 1.10 per cent (0.90 per cent desired); vanadium, not less than 0.10 (0.18 per cent desired).

Characteristics and Uses. This steel is used for structural purposes, and for crank-shafts, driving-shafts, axles, etc. The physical characteristics in the annealed condition are unimportant, as the steel should not be used in that condition—not that it is unsafe, but because there will be no gain commensurate with the increased cost of the material.

Heat Treatment. After forging and machining: 1. Heat, 1600 to 1700 degrees F. 2. Quench. 3. Reheat to a temperature between 500 and 1300 degrees F. and cool slowly.

The elastic limit after heat treatment may be from 60,000 to 150,000 pounds per square inch, with good toughness as represented by the reduction of area and elongation. This steel may be casehardened, but if so treated it must be handled with care on account of the relatively high carbon content.

Chrome-vanadium Steel—0.45 Carbon

Composition. Carbon, 0.40 to 0.50 per cent (0.45 per cent desired); manganese, 0.60 to 0.90 per cent (0.75 per cent desired); silicon, 0.10 to 0.30 per cent; phosphorus, not over 0.035 per cent; sulphur, not over 0.035 per cent; chromium, 1.00 to 1.30 per cent (1.20 per cent desired); vanadium, not less than 0.10 per cent (0.18 per cent desired).

Characteristics and Uses. This steel contains sufficient carbon in combination with vanadium to harden when quenched at a proper temperature. The elastic limit after suitable treatment may be carried as high as 200,000 pounds per square inch, with a reduction of area great enough to indicate good toughness. This steel may be used for structural parts where exceedingly great strength is required.

Heat Treatment. The information given relative to the heat treatment of 0.30 carbon, chrome-vanadium steel also applies to this steel. The drawing temperature must be considerably modified to produce proper stiffness. For gears this steel must be annealed after forging. The heat treatment is as follows: 1. Heat to 1600 degrees F. 2. Quench. 3. Reheat to 1450 degrees. 4. Cool slowly. 5. Reheat, 1600 to 1650 degrees F. 6. Quench. 7. Reheat, 350 to 550 degrees F., and cool slowly.

This last drawing operation (7) must be modified to obtain any desired hardness.

Silico-manganese Steel

Composition. Carbon, 0.45 to 0.55 per cent (0.50 per cent desired); manganese, 0.60 to 0.80 per cent (0.70 per cent desired); silicon, 1.90 to 2.20 per cent (2.00 per cent desired); phosphorus, not over 0.04 per cent; sulphur, not over 0.04 per cent.

Characteristics and Uses. This steel is intended for structural parts, springs, gears, etc. It should not be used without heat treatment. The physical characteristics in the heat-treated condition are similar to those of the other alloyed steels specified, the elastic limit being under control, and ranging from 60,000 to 175,000 pounds per square inch, with good reduction and elongation of area.

Heat Treatment. For structural parts the heat treatment should be as follows:

After forging and machining: 1. Heat, 1650 to 1750 degrees F. 2. Quench. 3. Reheat to a temperature between 600 and 1400 degrees F. and cool slowly.

Suitable temperatures for a given thickness of piece, and the character of the quenching medium must be determined experimentally. When used for springs, this material may be treated as previously explained, with proper modifications as to the drawing temperature, with the probability that 800 degrees F. as a drawing temperature will give about the proper characteristics.

Common Screw Stock

Composition. Carbon, 0.08 to 0.25 per cent; manganese, 0.30 to 0.80 per cent; phosphorus, not over 0.16 per cent; sulphur, 0.05 to 0.15 per cent.

Characteristics and Uses. This steel may be made by any process. There are two types of screw stock commonly found in the market, and the composition given covers these. The controlling element in one type is phosphorus, which is commonly found between 0.10 and 0.20 per cent. The controlling element in the other type is sulphur, which is commonly found between 0.07 and 0.15 per cent. The ordinary screw stock machines easily and is a cheap steel, lacking strength and toughness. It is an unsafe steel and must not be used for vital parts of an automobile.

Heat Treatment. Screws made from these materials, from hot-rolled bars, should be heat treated and not used in a rolled or annealed condition. Screws made from cold-rolled bars are much stronger than if in a hot-rolled, annealed condition. But the best results from both types of steel may be obtained if heat treated. Heat treatment after machining produces the strongest screw. If machined after heat treatment, the grain of the material is, in effect, nicked by the thread and thereby weakened. The heat treatment for screws is as follows:

After machining: 1. Heat to 1500 degrees. 2. Quench. 3. Reheat from 600 to 1300 degrees F. and cool slowly.

Low Alloy Steel

Composition. Carbon, as desired; manganese, 0.50 to 0.80 per cent; silicon, not over 0.20 per cent; phosphorus, not over 0.04 per cent; sulphur, not over 0.04 per cent; nickel, 0.90 to 1.20 per cent; chromium, 0.15 to 0.40 per cent.

Characteristics and Uses. This steel is made of ores containing chromium and nickel. Steels made from such ores may be referred to as natural alloy steels. At the same time other steels closely duplicating them in analysis are made by the addition of chromium- and nickel-containing materials to an otherwise simple steel. As found in the market these steels contain about 1.00 per cent of nickel and from 0.15 to 0.40 per cent of chromium. Of such composition, there is a material gain in strength and toughness, as the result of heat treatment. These steels are obtainable in any desired carbon from 0.10 to 1.00 per cent. At a slight increase in cost, say, from $3.00 to $5.00 per ton in the billet form, these steels may be obtained containing from 0.30 to 0.60 per cent chromium, which composition results in a very decided gain in physical characteristics.

Heat Treatment. The natural alloy steels respond to the casehardened treatment better than the plain carbon steels and the nickel steels of similar carbon content. For example, a 0.20 carbon, natural alloy steel makes an excellent gear when properly carbonized and heat treated in accordance with the heat treatment given for 0.20 carbon, 3½ per cent nickel steel. For structural purposes 0.30 carbon or even 0.40 carbon steel may be used when properly treated.

Quenching Mediums

Brine, water, oil and many special compounds are used as quenching mediums; brine produces the sharpest results, but is severe, and has a greater tendency to warp the parts. It produces a higher elastic limit than either water or oil. Water is intermediate between brine and oil, and frequently may be used to advantage for hardening parts of suitable section and thickness. Its tendency to warp the parts is not as great as that of brine, nor can so high an elastic limit be obtained with it. Fish oil, cotton seed and lard oil are best for quenching purposes. These are the mildest of the quenching mediums, and should be used when it is found possible to obtain the desired results by their use. All reference to quenching in the foregoing treatment means oil unless otherwise stated. If found by experiment that oil will not produce the desired results, then water should be tried, or even brine. Nearly all casehardened parts may be successfully hardened in oil, as it exhibits less tendency to warp the parts than any other of the quenching mediums mentioned.

Summary and General Remarks

In the foregoing article the tensile strength per square inch indicates the strength of the steel in a rod having one square inch area of cross-section. This standard has been adopted so that no matter what the size of the test-specimen may be, the results are calculated on a square inch basis. The elastic limit as generally referred to in engineering practice is not the true elastic limit, except in those instances where close-reading extensometers are used. The elastic limit usually referred to is that obtained by either the drop of the beam of the testing machine or by means of dividers which indicate when the test-specimen begins to stretch, as visibly noted.

It is to be understood in connection with the foregoing that the elastic limit is that point at which, if the load on the steel specimen be released, the specimen will return to its original length before it was placed under the tension test, and beyond which, if the load be released, the specimen will not return to its original length. The elastic limit therefore is really necessary to use in figuring all strains and stresses for structural purposes. The reduction of area, is the measured amount (in per cent) that a test-specimen reduces in size at the point of fracture. This factor is valuable because it shows the condition of the steel in the specimen. For instance, a coarse-grained overheated steel or an under-worked steel shows a low percentage of reduction of area and is, therefore, to be avoided. On the other hand, a steel well hammered or rolled or heat-treated shows a high percentage of reduction of area as the result of a very fine grain.

Elongation represents the ductility and softness of material. A considerable degree of elongation is required in order that there may be nothing abnormal about the material being tested.

Endurance is conveniently studied by means of a so-called "alternate stress" or "endurance" machine, and is to be understood so when mentioned in the foregoing. It is a fact that tensile tests giving elastic limit, maximum strength, reduction of area and elongation, indicate the probable endurance of the steel. At the same time the endurance of the steel is not always proportional to the increase of elastic limit or the increase of elongation and reduction of area. Consequently, the endurance machine is the best method of studying the real effect of heat treatment on materials.

Natural conditions in a steel mean little. They are supposed to represent the condition of the steel after ordinary hot rolling or forging operations. Steel in such a condition may be said to be either good or bad, depending largely upon the accidental sequence of operations and the method of carrying them out. This condition might well be called an accidental rather than a natural condition. It is not a good term to use and should be avoided. Steel in a natural condition after annealing is uniform and safe, even if not as strong or as tough as it would be after a suitable heat treatment. Annealing consists of heating to a temperature above the critical point, and cooling slowly; drawing consists of heating to some point below the critical point and cooling slowly; heat treating consists of a sequence of quenching and slow cooling operations, and quenching and suddenly cooling the steel in any liquid or in air.

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HIGH-SPEED STEEL WELDED ARMOR PLATE

About three years ago W. S. Simpson discovered that plates of high-speed carbon steel, with a thin plate of copper between them, could be welded with a flux consisting of a stiff mixture of carbon (lamp black), brown sugar and water when heated to a temperature of 2000 degrees F. The copper melts and enters into solution with the steel and forms a perfect weld which will not part nor split. The copper appears to increase the tenacity of the steel so that the weld is even stronger than the solid steel. The process is being developed in England for the manufacture of composite armor plates consisting of a tough steel back plate faced with hardened high-speed steel. A plate consisting of 4-inch carbon toughened steel, and 2-inch hardened high-speed steel successfully resisted attack with 6-inch projectiles. A comparison of the process with the Harvey and Krupp processes of face hardening armor plate shows its advantages. The carbonization of a face-hardened plate rarely penetrates more than ⅞ inch, and while Krupp armor is about 50 per cent superior to the best Harveyized plate, the Simpson process plate has 75 per cent greater resistance.

POWER FORGING AND STEAM HYDRAULIC FORGING PRESSES*

The paper abstracted in the following deals principally with the most modern methods of producing forgings, but contains also a brief review of the various methods for power forging employed. It is a fact, well-known to all, that the power of the hand hammer is not derived from its weight alone, but from weight combined with velocity, and the same is true of the sledge and of all kinds of drop hammers, whether lifted by friction, water power, or steam. The power of a drop hammer depends solely upon the mass of the hammer and its lift, whereas certain kinds of hammers operated by steam or compressed air obtain additional power by increasing the acceleration beyond that caused by gravity alone.

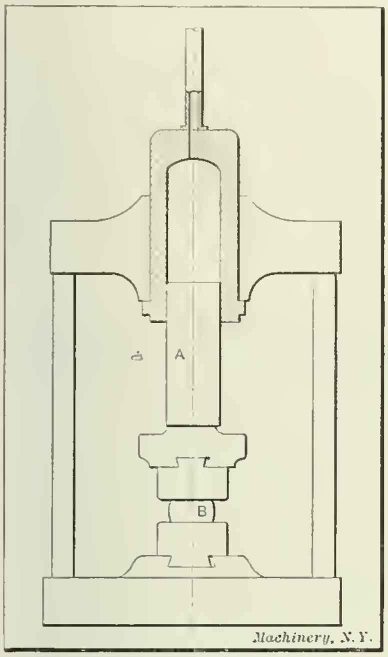

Fig. 1. One of the Simplest Types of Forging Presses

While the steam hammer is comparatively old, the modern type of forging press illustrated diagrammatically in Fig. 1 is a comparatively recent development. A plunger *A* is forced by hydraulic pressure against the forging *B*, thus exerting a steady pressure instead of a blow. In the course of events this type of forging press began to supplant large steam hammers everywhere, whereas the small hammer, operated by steam or compressed air, has held its own for small work. In the author's opinion, the logical reason for this fact is the following: Small pieces cool quickly and, as a rule, require a finer surface finish than is demanded in large forgings. Since the hammer strikes a blow, the force of the impact increases as the forging cools, so that work is done on the surface of the forging, even when it is quite cool. The press, on the other hand, would be powerless to do any work on the cold piece, unless the anvil surface was reduced very much. Thus the hammer will probably always be used for small work and for making tools, because tool steel must not be heated as much as machinery steel or wrought iron.

The very features which make the hammer desirable for small work make it undesirable for large work. The hammer acts upon the surface of the material, driving the surface over the core without compressing the latter, as shown in Fig. 2. The press, on the other hand, exerts a continuous pressure, which forces the semi-fluid material of the forging to flow under compression, as shown in Fig. 3, which process tends to increase the density of the material. It is thus evident that from the standpoint of improving the quality of the material in forgings, the press is superior to the hammer, and it would be considered even more useful if, under equal conditions, it used less steam than a hammer would consume.

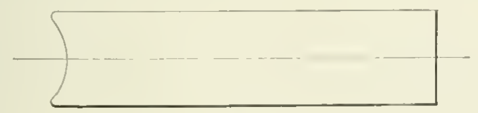

Fig. 2

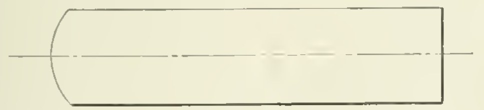

Fig. 3

Fig. 2. Effect of Forging by Hammering. Fig. 3 Effect of Forging by Pressure

To investigate the comparative steam consumption, a concrete case will be assumed. Let the dimensions of a hammer with live steam above the piston be as follows: (These dimensions were converted from the metric dimensions, which accounts for the odd sizes.)

Weight of falling parts, $P = 5$ long-tons,
Diameter of steam cylinder = 27½ inches,
Stroke of piston = 79 inches,
Initial steam pressure = 107 pounds per square inch,
Mean effective pressure = 71 pounds per square inch,
Face area of anvil = 186 square inches

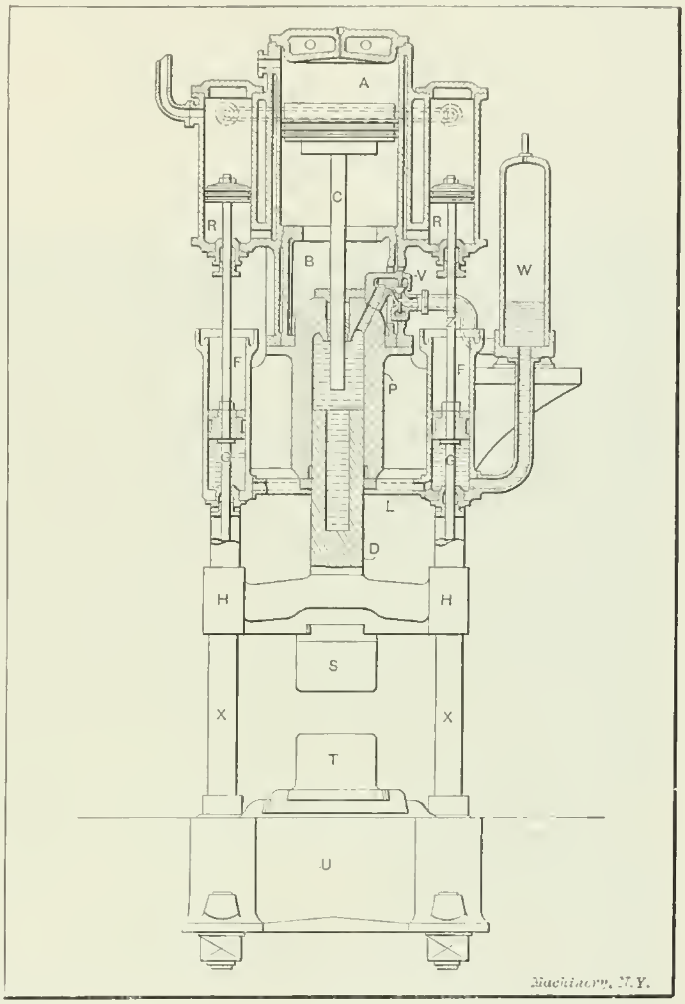

Fig. 4 Steam-hydraulic Forging Press

Then we find:

1. Mean effective accelerating force (P_2) due to steam pressure =

$$\frac{\pi}{4} \times 27.5^2 \times 71 = 42{,}000 \text{ pounds.}$$

2. Acceleration provided by P and P_2 =

$$\frac{(42{,}000 + 11.200)\ 32.2}{11{,}200} = 155 \text{ feet per second, approximately.}$$

3. Velocity (V) of moving parts at end of stroke =

$$\sqrt{2 \times \text{acceleration} \times \text{stroke}} = 45 \text{ feet per second.}$$

4. Kenetic energy stored up in moving parts =

$$\frac{53{,}200 \times 79}{12} = 350{,}000 \text{ foot-pounds.}$$

For hammers of this size and correct temperature of forging, it may be assumed that the moving masses are brought to rest within a space of 1⅝ inch. Basing the retardation of the moving parts upon this distance, the average retarding force is found to be 2,580,000 pounds or, approximately, 1200 long-tons. This figure may be termed "the force of the blow," and will be used in the following for comparison with the conditions in a press. This force was based upon a retardation space of 1⅝ inch. It should not be assumed that all of this space is utilized for compressing the forging. The elasticity of the foundations absorb a considerable amount of the work of the blow. A correct mathematical treatise of these losses meets with great difficulties. From the experience of the authors, it appears that almost one-third of the work is lost in vibrations, so that only about one inch of useful compression of the forging results.

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* Abstract of paper by Barthold Gerdau, of Düsseldorf, Germany, and George Mesta, of Pittsburg, Pa., read before the American Society of Mechanical Engineers, at the May, 1911, meeting in Pittsburg, Pa.

Since it is intended to investigate the relative economy of different methods of forging, the steam consumption per working stroke of the hammer in question will now be computed. Steam is needed for the lifting and for the down-stroke. The steam for the up-stroke may be figured approximately from the equation that pressure multiplied by change of volume equals work done. Thus, cubic feet of steam required for up-stroke =

$$\frac{11{,}200 \times \frac{79}{12}}{144 \times 107} = 4.8 \text{ cubic feet} = 1.3 \text{ pounds.}$$

For the down-stroke a cylinder full of steam at 71 pounds per square inch pressure may be taken, which will be sufficiently close for this purpose. Thus, the volume of steam per down-stroke =

$$\frac{\frac{\pi}{4} \times 27.5^2 \times 79}{144 \times 12} = 27 \text{ cubic feet} = 5.4 \text{ pounds.}$$

The steam consumption of one cycle then equals 6.7 pounds.

This steam consumption is based upon correct operation of the hammer, which, however, is seldom realized if the operator neglects to close the throttle at the instant the hammer touches the forging, because in that case the pressure in the cylinder may rise to boiler pressure. If the hammer is used to strike light blows, full strokes may be made, using the hammer principally as gravity drop, or short strokes may be made with live steam on top. In either case the steam consumption per unit of work done is enormously increased. The great number of combinations possible forbids giving figures.

Turning to the steam consumption of the press, we find that conditions are not so simple. It will be remembered from Fig. 1 that the press is operated by water under pressure. The steam consumption then depends first upon the method of producing the water pressure and second upon the losses of water pressure between its production and its application to the press plunger. Before the intended computation can be made, it is evidently necessary to review the various types of presses on the market. Two general types of presses exist: (1) The so-called purely hydraulic presses whose pressure water is furnished by separate pumping engines. (2) The so-called steam-hydraulic presses in which water under pressure is generated in a steam intensifier.

The general type mentioned under (1) is best illustrated by Fig. 1; the pipe at the top of the cylinder is connected either directly or by means of a hydraulic accumulator to a high-pressure pump which may be either direct-acting or of the crank-flywheel type.

The type mentioned under (2) is shown diagrammatically in Fig. 4. The press consists of a heavy base *U* and four uprights *X*, supporting the hydraulic and steam cylinders above. *S* and *T* are the dies, the upper one being carried by the crosshead *H*. This crosshead is moved into position for forging by the use of the steam cylinders *R*. Pressure for forging is obtained by admission of steam into the top of cylinder *A*, which moves the piston downward and forces rod *C* into the hydraulic cylinder *P*. This action again causes the plunger *D* to move downward, carrying with it the crosshead and the upper die. The effect is that of a steam-actuated intensifier. Hydraulic cylinder *P*, balancing cylinders *F*, and about one-third of air chamber *W*, are filled with water. Air pressure of about 100 pounds per square inch is pumped into air chamber *W*, which is sufficient to move piston rod *C* with its piston to the top of the cylinder. The areas of plunger *D* and cylinders *F* are equal, so that the downward force on plunger *D*, due to the air pressure on the water, is counterbalanced by cylinders *F*. By opening check valve *V* in the connection between air chamber *W* and hydraulic cylinder *P*, thus allowing water to flow from the hydraulic cylinder to the air chamber, and admitting steam to cylinders *R*, the crosshead can be raised to any position and similarly it can be lowered.

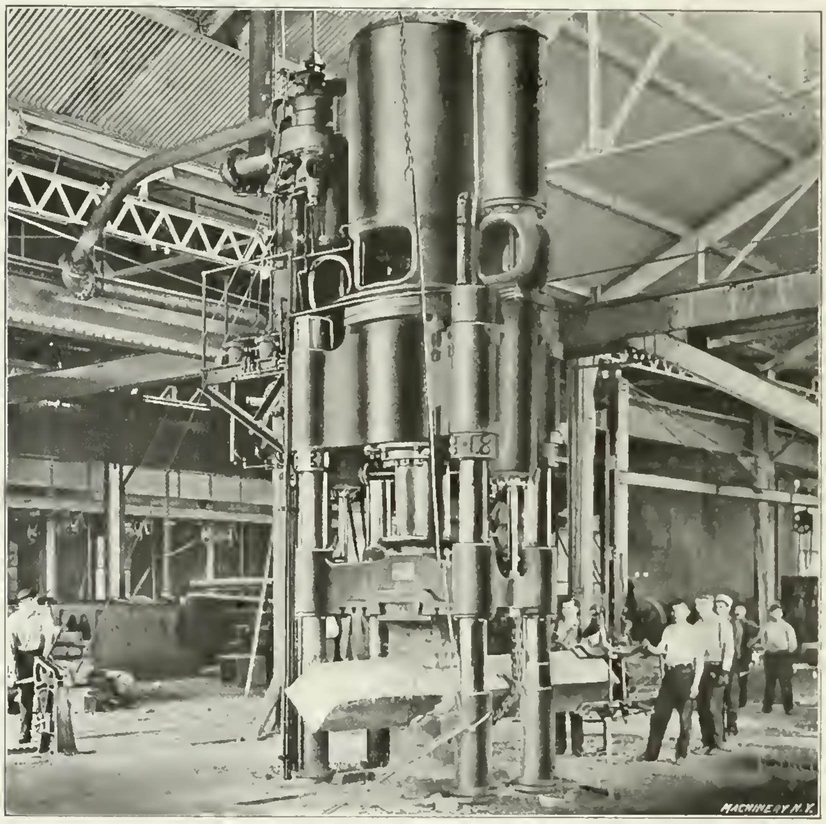


Fig. 5. Eight-hundred Ton Four-column Steam-hydraulic Forging Press

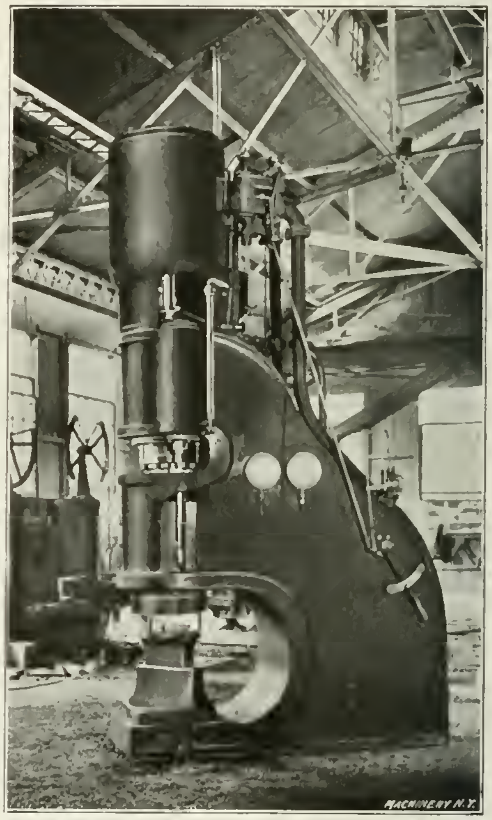


Fig. 6. Two-hundred Ton Forging Press

Referring to type (1) it is found that the pumps commonly work against a pressure of 4300 pounds per square inch, which is maintained by an accumulator. Unfortunately, the process of forging does not always require all of this pressure, but on the average only about 50 to 60 per cent of this amount, the remaining 40 to 50 per cent being lost in the controlling valve. It might appear that it would be more economical to let the pump work directly against the press without an accumulator and even without intermediate controlling valves, but this scheme is too ideal to be practical. It has been found necessary to provide controlling valves, by-pass valves, throttling governors and other means for regulating the speed and power of the press. Nevertheless, this type of press has one advantage, namely, that it can make a continuous full-pressure stroke of the maximum length for which the press was built. For this reason this type is most advantageous for drawing operations —for instance, the drawing of tubes, etc.

Taking up type (2) as illustrated by Fig. 4, it has already been mentioned that the pressure is generated by a direct-acting intensifier which is similar in its action to a direct-acting pump. While at first thought it might appear that the direct-acting intensifier, which necessarily has to maintain an almost constant steam pressure throughout the stroke, would be inferior to a high-class compound crank and flywheel pump, experience has taught that the opposite is the case, the reason being that the work is intermittent and requires a continually varying amount of power.

After these explanations we are ready to take up the computation of the steam consumption of a press for the same work which formed the basis for a similar calculation for the steam hammer. From what has been said it is evident that the type of pump, the conditions under which it works, the proper balancing of the accumulator pressure with regard to the work and other factors, affect the steam consumption. Therefore the following figures should be considered only as an attempt to solve the problem.

The effective work of the hammer was about 240,000 foot-pounds per working stroke. Basing the press on the same work and taking the efficiency of the transmission pipe as 90 per cent, the pressure drop in pump ports as 10 per cent, and the efficiency of the pump as 75 per cent, the work actually to be done in the pump cylinder is 395,000 foot-pounds. Let the pump be driven by a steam engine whose steam consumption is 32 pounds per horsepower per hour on account of the intermittent working; then the steam required for the equivalent work is

$$\frac{395{,}000 \times 32}{33{,}000 \times 60} = 6.3 \text{ pounds.}$$

This shows that the purely hydraulic press is slightly more economical than the steam hammer.

Matters are a great deal simpler for the direct-acting steam-hydraulic press. Basing the calculation upon the fact that pressure times change of volume equals work, and assuming a steam pressure of 150 pounds per square inch gage, we find the necessary volume of steam to be

$$\frac{240{,}000}{150 \times 144} = 11 \text{ cubic feet, or } 3.7 \text{ pounds of steam.}$$

For the sake of simplicity, friction of pistons has been neglected in all cases. This last result is reliable, whereas in the case of the purely hydraulic press and in the steam hammer, additional losses may occur which cannot very well be considered on account of their uncertainty. The excellent economy of the direct-acting steam-hydraulic press presupposes that no dead volume of clearance space has to be filled before the motion of the steam piston against its full resistance begins. The importance of this last sentence is so great that the authors take the liberty of repeating it in different words. The expression used actually includes three separate facts: The steam piston of the intensifier must be in its starting position with practically no clearance; the movable anvil must practically rest on the piece to be forged; there must be no voids in the plunger and intensifier cylinder.

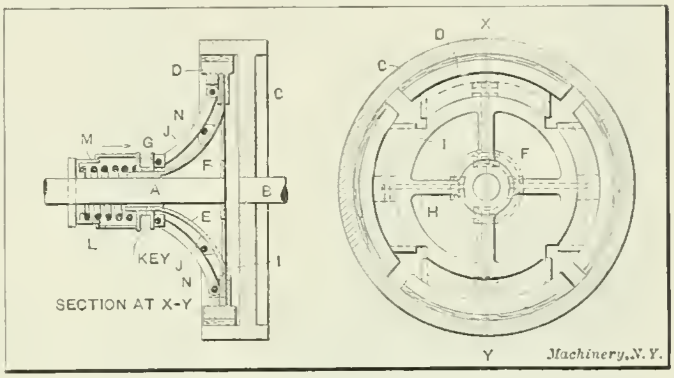
These three principles are embodied in the design shown in Fig. 4, which, in the authors' opinion, represents the most practical form which this type of press can assume. In this system the formation of voids in the water space is impossible, because the intensifier plunger floats upon the water at all times; in other words, the direction of motion of the intensifier piston and plunger is the same, which thus provides a continual force closure. If such force closure were absent, and in some types of steam-hydraulic presses it actually is, there would be no guarantee of a filled water space, and an increase of the steam consumption would be the inevitable result. Moreover it will be seen from Fig. 4 that the pressure is generated directly in the same cylinder in which it is used, thus avoiding the losses which must occur where the intensifier is separated from the press itself and the pressure water has to be forced through pipes and connections.

In Fig. 5 is shown an 800-ton four-column steam-hydraulic forging press of the type described, built by the Mesta Machine Co., of Pittsburg, Pa., and installed in the company's works at West Homestead, Pa. In Fig. 6 is shown a 200-ton single-column press built by the same company.

* * *

NEW-TYPE FRICTION CLUTCH

A friction clutch embodying some new features is the subject of patent No. 994,379, which has been granted to George E. Faile, New York City. This clutch consists essentially of an outer cylindrical rim, against the inner surface of which are applied four leather-faced shoes, these shoes being operated by links connected to a sliding collar located on the shaft *A*. The accompanying illustration shows sectional views of this clutch, *A* being the driven shaft and *B* the driver; *C* is the pulley or flywheel, against the inner rim of which four leather-faced shoes *D* bear. The inner face of the flywheel *C* is shown straight, but may be slightly cone-shaped if desired. Keyed to the shaft *A* is a hollow substantial conical member *E* presenting an outer annular flange lying in a plane at right angles to the axis of rotation of the shaft. On the left end of this conical member is mounted a cylindrical collar *G* which, as shown, is keyed to the shaft. The hub *F* has four arms *H* projecting from it, which add to the rigidity of member *E*. The flange *I* is provided with four V-shaped notches having an included angle of about 90 degrees. The four shoes *D* are mounted upon this flange, being grooved to fit over the flange. The annular part of each shoe has a lug formed integral with it, in which links or arms *J* fit.



A Friction Clutch with Modified Toggle Action

The sliding collar *G* is grooved, and can be operated by a yoke, not shown. This collar is acted upon by a spiral spring *L*, supported in a collar *M* which bears against a pin driven through the shaft. The collar *G* is provided with four lugs in which the links *J* are held by pins. It will be noted that as the collar *G* is moved to bring the shoes into operation, the links *J* travel over rollers *N* and, as the shoes reach their operative position, they are thus firmly braced. The rollers resist any tendency of the links to bend, and at the same time prevent any strain being brought against the flange of the conical member. The flanges on the shoes are so connected to the links that the latter resist any tendency of the shoes to be thrown outward by centrifugal force when the clutch is not engaged. The shoes are so formed as to engage with the sides of the notches in the flange *I* or, in other words, fit over the flange, so that they are prevented from any circumferential movement in respect to the flange.

* * *

According to experiments recorded by *The Brass World*, the proportion of boracic acid that can be used in a nickel-plating solution without having it separate, is as follows: Nickel-plating solution, 1 gallon; boracic acid, 6 ounces. These results indicate that much more boracic acid can be used in a nickel-plating solution than is usually supposed.

OXY-ACETYLENE WELDING AND THE EDISON STORAGE BATTERY CAN

By J. F. SPRINGER*

The Edison storage battery is contained in a steel can hermetically sealed at its seams; it is made from steel plating 0.015 and 0.025 inch thick which has been previously nickel-plated. The can is square or rectangular in cross-section, the corners being slightly rounded. The vertical wall is made from a single sheet bent at the four corners. The weld is of neither the lap nor butt form, but instead the edges of the plate are bent outwards at right angles to the wall of the can thereby forming a slight ridge, consisting of two thicknesses of metal which are welded together. The seams where top and bottom join the wall are formed in the same way; thus, the bottom is a stamping in which the edge is turned up at right angles to the main surface, and fitted into the vertical wall with the depression to the outside. The top is similarly arranged. The turned-up edge has no joint at the corners and is about 3/16 or 1/4 inch deep. The object of this article is to describe the welding operations.

The Side Seam

To weld this can, the operator has one straight-away seam and two duplicate rectangles or squares with rounded corners. At the works of the Edison Storage Battery Co., Orange, N. J., both styles of seams are acetylene-welded by automatic machinery. The apparatus used with the straight-away seam is, as one would naturally suppose, the simpler of the two, but in both, however, the torch is absolutely fixed and the work is carried past. There is a vertical post, at the upper end of which a movable arm is arranged, and to this arm the torch is secured, being horizontally located while welding. Between times, it may be thrown back out of the way, along with the torch. In the case of the straight-away machine, the post is placed to the rear and at the left end of the carrying device as indicated in Figs. 1 and 2. A small individual motor supplies the power, this motor being arranged in front and to the right of the operator, its horizontal spindle projecting toward the rear. Another horizontal spindle carrying a worm is driven by the motor spindle, connection being made in the following manner: Each spindle has a circular plate with two projecting pins, which overlap a large part or nearly the whole of their length as indicated in the illustrations. A leather strap run around the pins secures the whole together, the leather thong introducing a somewhat elastic connection. The rapidly turning worm rotates a worm gear, but as even the speed of the latter is far too great for a welding movement, it, in turn, rotates a screw, thereby giving the carriage a slow rectilineal motion, which, ordinarily, is perhaps a foot a minute. The carriage can be released from the screw for the return or for any other movement. The work is held by two clamps which are shown in the two illustrations, Figs. 1 and 2. One of these is hinged to move in a vertical plane; the other, in a horizontal plane. The ridge of the seam lies between them when they are in position. The work is put on the holder, with the seam uppermost, horizontal and to the rear; it lies perhaps half an inch from the adjoining wall of the can. The vertically moving clamp is secured in position on the front side of the ridge. Also, the horizontally moving clamp is locked; this clamp has a dihedral face. The horizontal portion fits into the narrow space along the rear of the ridge; the vertical face presses against the rear face of the work.

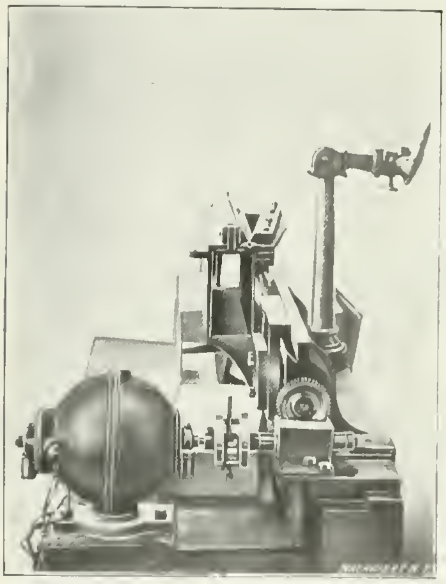


Fig. 1. Machine for Welding Longitudinal Seam, ready to receive Work

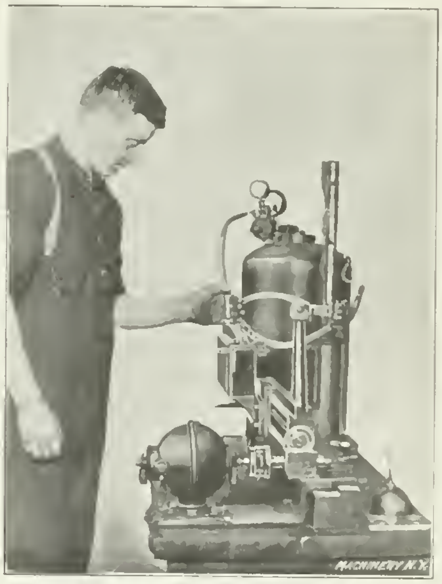


Fig. 2. Closing the Holding Device preparatory to Welding the Longitudinal Seam

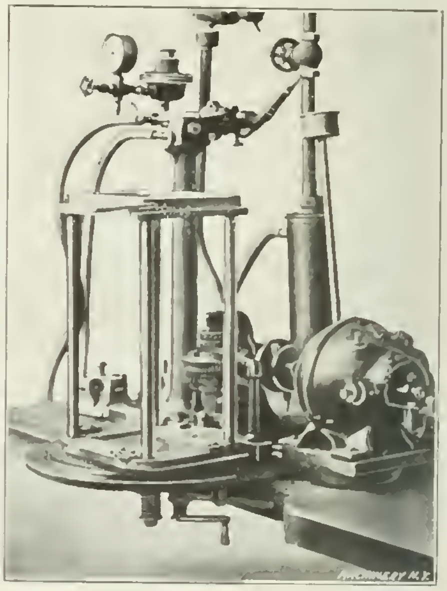


Fig. 3. Machine for Welding on the Tops and Bottoms of the Storage Battery Cans

The surface of the holder immediately below the seam is grooved out perhaps an eighth of an inch deep. The surfaces of the clamps are beveled off so as to form a valley with the seam between the bevels. The bevels are very steep—about 60 degrees—and hug the ridge pretty closely. The torch is inclined at an angle of about 45 degrees. When the torch is lit, and the small inner flame—the working flame—is formed, the tip of this flame and the seam are in contact or quite close together. The hollow beneath the seam acts as a heat insulator to confine the effects of the flame to the work. The 60-degree groove combined with the position and character of the flames operates to split the outer—the enveloping—flame, with the result that it fills the groove front and back of the inner flame. That is to say, the unwelded seam ahead is covered for several inches; and also the welded seam to the rear. The atmosphere is thus very effectively excluded from the vicinity of high temperature on the work. This arrangement gives an effective means of preventing oxidation of the work. At the Edison works, the seam can be welded with no discoloration except at the beginning and end. It would appear that even these discolorations could be avoided by bringing the torch into action with the outer flame fully split and doing this well in advance of beginning the weld; and by continuing the flame conditions beyond the work. The edge where the weld is located is, except at the ends, just about the color of the nickel-plated sheet. However, what is seen is probably steel—for the most part at least.

Considerations for Avoiding Oxidation

The matter of avoidance of oxidation is so important that it will be profitable to consider the matter more fully. The oxidation of steel may take place at a low temperature, the familiar form of this type of oxidation being rust. Apparently, two things are necessary—moisture and free oxygen. As water usually contains free oxygen in the form of atmospheric air and the atmosphere ordinarily contains water vapor, these conditions are often realized. The consequent oxidation is, however, not that which the welder has to fear; it is quite easy to get rid of the water. However, oxides of iron—higher oxides—form at high temperatures, and apparently, the presence of moisture is not necessary to produce these, for, given the temperature and the oxygen, the oxide will be formed. The acetylene welder certainly gets high temperatures; the oxygen may come from two sources. The very flame with which he works is formed by the combustion of acetylene (C_2H_2) by oxygen, the oxygen coming from the gas jet which feeds the flame. What takes place immediately the mixture of acetylene and oxygen leaves the nozzle appears to be substantially this: The acetylene is dissociated into its constituent gases—carbon and hydrogen; the carbon burns to carbon monoxide, using up in this way exactly as much oxygen as acetylene. The hydrogen and the carbon monoxide are both eager for oxygen, but the temperature of the little inner flame is probably everywhere too high to permit the formation of water vapor or of carbon dioxide. If this is a correct statement of the facts, then any excess of oxygen coming from the nozzle will find its way into the region exterior to the small flame.

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* Address: 608 W. 140th St., New York City.

Now the oxy-acetylene torches do supply an excess of oxygen; it is necessary, in fact, to supply an excess—a result obtained from experience. The Davis-Bournonville torch requires an amount of oxygen which is perhaps as small as or smaller than that required by any other torch now on the American market. This torch requires the exact amount of 1.28 volumes of oxygen to 1 volume of acetylene—both gases at ordinary pressure. This excess of 28 per cent is required probably because of some residual imperfection in mixture. Now what becomes of the excess? Does it operate in the direction of oxidizing the work? Experience would seem to say, No—at least for a torch with only a 28 per cent excess. And we can understand how this may be. While the temperature of the tip of the little flame is exceedingly high—claimed to be 6000 degrees Fahrenheit—that of the work is much less. With sufficient reduction of temperature, there are two other bidders for the oxygen—the hydrogen and the carbon monoxide. It would seem probable, then, that, with the moderate excess of 28 per cent, these gases are competent to deal with it to the exclusion of any absorption of oxygen by the work. It would appear reasonable that gases such as carbon monoxide and hydrogen would more easily effect combination with oxygen than a metallic substance. We can, however, not expect them capable of dealing with any considerable percentage to the exclusion of the metal. This question of the exact behavior of excess oxygen might profitably be taken up by some one of our technical schools and brought to a final determination. In practical work, it is doubtful whether much trouble from this cause will be experienced by the careful operator. Oxidation will probably result, if the excess is allowed to exceed to any extent the 28 per cent. The Davis-Bournonville torch is so constructed that the oxygen is very accurately proportioned to the acetylene when the small flame has its proper form; this can be determined by an operator with ease after a very little experience. This flame affords, in fact, a very sensitive guide.

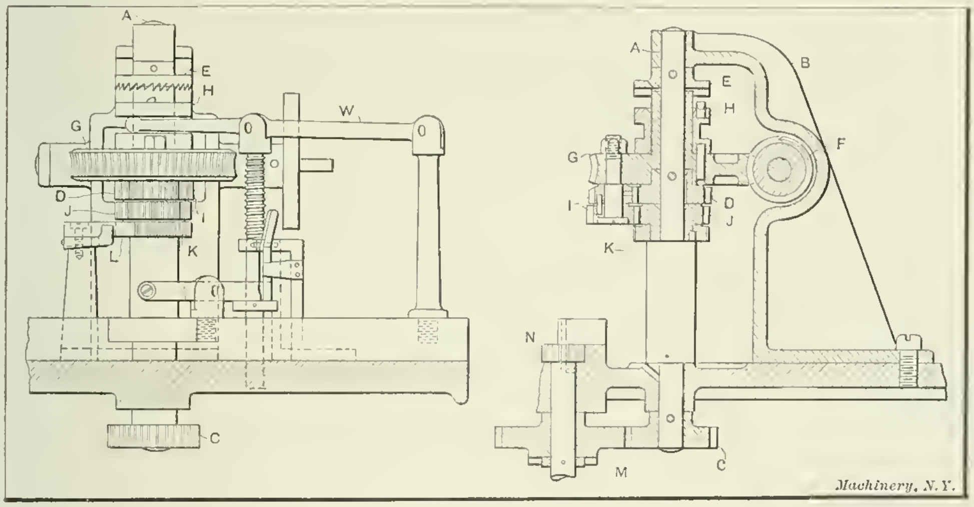

Fig. 4 Feed Arrangement for automatically moving the Can End under the Oxy-acetylene Welding Torch

There is another source from which oxygen may find the heated metal—the surrounding atmosphere. The oxygen here is very much diluted, but the supply is inexhaustible—limited, in fact, only by whatever difficulties of access may be present. The problem, then, is to provide adequate safeguards. When the torch is lit but not in use, the working point of the small flame is everywhere surrounded by protective gases, thus being effectively shut off from the atmosphere. A solution is thus presented, if it is possible to maintain an envelope of protective gases. When we bring the tip of the small flame into contact, or approximate contact, with the work, we are apt to break up the envelope at some point and admit the atmosphere. However, we can, no doubt, frequently so dispose the torch with reference to the work that complete protection is insured. This is exactly what seems to be the case with the arrangements in connection with the straight-away machine at the Edison works. One can readily understand, however, that, if the human hand be depended upon, the risk of breaking up the exact relation would often be incurred. Except at the beginning and end of the seam, the controlling factors are absolutely fixed. These factors may be assumed to be: (1) the character and strength of the small flame; (2) its distance from the work; (3) its angle of inclination; (4) the form and size of the seam and adjacent metal; and (5) the form and size of the working groove. When these factors have once been correctly provided for by the machine, they are then easily maintained. If hand control alone is attempted, difficulty with Nos. (2) and (3) may be expected.

The portion of the outer flame which is beneath the small flame would seem to be effective in preventing oxidation. That is to say, the danger of oxidation from the atmosphere is not confined to that part of the work upon which the small flame is operating. When it has been passed, the new weld may still have a very high temperature, high enough, in fact, to bring about atmospheric oxidation. Now the outer flame which surrounds the inner one and extends beyond it for perhaps ten times its length (when the torch is burning free) is also hot, although not nearly so hot as the inner one. It is in this outer flame that we assume that the excess oxygen from the air is united with the hydrogen and carbon monoxide to form water vapor and carbon dioxide. It is consequently the scene of much combustion and therefore heat. In fact, the amount of this heat is considerably more than that evolved by the inner flame. The temperature is comparatively low because of distribution over a much larger space. The streamer from this outer flame which lies in the working groove and covers the new weld operates to shield the highly heated metal until its temperature sinks below the oxidation point.

In this straight-away machine, there is an angle of 45 degrees on one side of the torch and an angle of 135 degrees on the other side. The new weld is on the side of the smaller angle. There is a streamer from the outer flame which covers this new weld, as already explained, for a distance. The other streamer is on the other side of the smaller angle where the unwelded seam lies. It is a little difficult to see whether it operates in any very decided manner to prevent oxidation. It is quite clear, however, that it acts as a preheating agent. This is important from the point of view of speed and economy. The desired temperature for the welding operation is partly secured by the time that the inner flame begins to play upon a given point. The time required to secure the temperature is consequently reduced. The expense for labor and gases is thus reduced as well. Further, the output of the machine is increased.

In the work on the straight seam of the storage battery cans, it is possible, as will now be seen, to pre-heat and preserve from oxidation by suitably directing and managing the outer flame. Where this is possible, it is the method which should ordinarily be adopted; it costs nothing extra. However, there may be work of such character that other means will have to be employed, either in substitution or as a supplementary procedure. There is no especial necessity, it would appear, why the auxiliary flame should consist of hydrogen and carbon monoxide; it would seem possible to use ordinary illuminating gas, natural gas, producer gas or some other convenient gaseous fuel. Separate jets disposed precisely as desired and supplying flames of the size and intensity necessary are thus possible. In other words, it is not necessary to be confined to the use of the outer flame of the oxy-acetylene torch. Thus, if the work is of such shape that it is impossible to so manage the outer flame as to provide a complete protection against oxidation, another heating jet can be used and directed in any way that may be necessary.

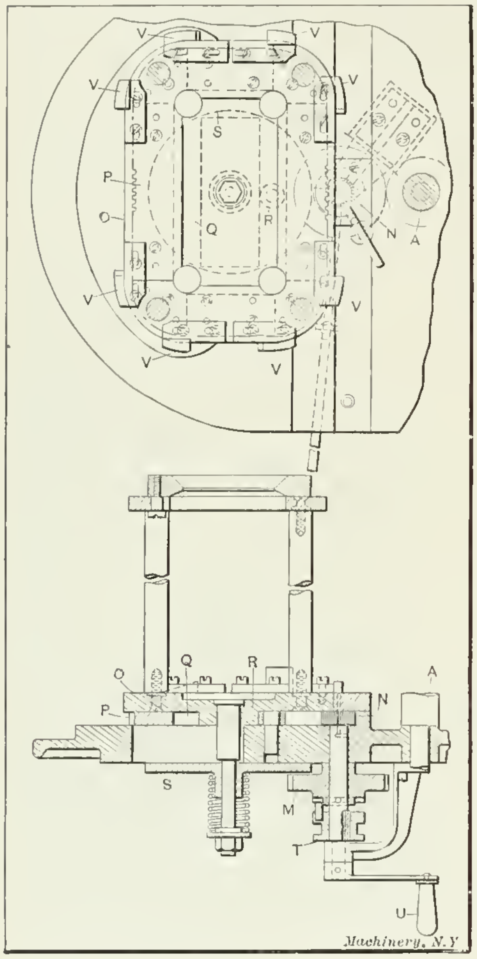

Fig. 5. Main Part of Machine for Holding Cans while the Ends are being welded

At the Edison works, a seam of perhaps 15 inches can be welded in about 1¾ minute. The material is quite thin, as previously stated; for such thicknesses, the machine method is the method to use, undoubtedly. To perform the work by hand requires too great steadiness, and an even, steady movement is exactly what a machine is adapted to give. In machine welding, it is quite usual to use no welding stick, the material for the weld coming from the work.

Welding Tops and Bottoms

The welding on of tops and bottoms constitutes a more difficult mechanical operation, the especial difficulty arising from the sharp curvature of the corners. The can is removably secured to a frame or jig and is controlled by a rack attached to it, the whole arrangement being shown in the halftone Fig. 3 and the details in the line engravings Figs. 4 and 5. The controlling rack has a pitch line of the same form as the outline of the plan of the can, and is driven by a suitable pinion. Because of the sharp curvature of the corners of the can, and the necessity of using a reasonably large pinion and depth of tooth, the pitch line of the rack lies considerably outside the can outline. Now the speed of the can will be the same as that of the rack on the straight-away portion; but, at the corners, the linear speed will be less. In order, therefore, to secure a uniform speed of movement of the seam beneath the torch throughout the whole operation, the speed of the rack at the corners is considerably increased. Other conditions being the same, if the linear speed were much reduced at the corners, these portions would be unduly heated by the slow movement.

The Edison Storage Battery Co. has overcome this difficulty by a mechanical device, which is very interesting although perhaps not original with them in its essential points. In its description, it may be as well to begin with the driving mechanism, which is shown in detail by the two views in Fig. 4. There is a spindle *A* mounted vertically in a frame *B*. The central portion of this spindle, it will be noticed, has a larger diameter than the remainder. Two gear wheels, *C* and *D*, are secured to the spindle, as is also a single-faced clutch *E*. There is a worm-gear arrangement, *FG*, through which power is transmitted. The hub of the worm-gear *G* is extended upwards to form a sleeve, the whole being loosely mounted on the spindle. The collar *H* may be moved vertically on the sleeve, but both are arranged to rotate together by the pin connection. On its upper face, this sliding coller is provided with one or more teeth to engage the clutch when the former is lifted a short distance. It will now be seen that with the clutch thus engaged, the spindle, and consequently the gear *C*, will be driven at the same angular speed as the worm gear *G*. This is the direct drive, and yields the quick movement desired when rounding the corners of the seam. Upon a pin through the worm-gear *G* is mounted a pair of small pinions *I*, near the periphery of *G*. These two little pinions are secured together, so that they rotate in unison, the stud providing a dead journal for them. A gear *J* is loosely mounted on the spindle. Upon a downward projecting hub of this gear, a toothed wheel *K* is keyed, the two rotating on the spindle as a single unit. The pinions *I* are always in mesh with the gears *D* and *J*. Swinging from a post, a ratchet finger *L* engages the toothed wheel *K*, permitting rotation in but one direction. Consideration will show that when the clutch *E* and the collar *H* are engaged no disturbing influence is exerted by the pinions *I* and the wheels *D*, *J* and *K*. In the first place, the parts *A*, *D*, *E*, *G* and *H*, all have the same angular speed, so that as far as the small pinions are concerned, it is only necessary that they remain immovable relatively to the gear *G*, on which they are mounted. This requirement will impose upon the pair *JK* simply a rotation in unison with the spindle; the ratchet arrangement permits this in the one direction. But, suppose now that the collar *H* and the clutch *E* are disengaged. Because of friction, the spindle will tend to remain still; that is to say, the gear *D* will provide a surface upon which the upper one of the small pinions will roll. The other small pinion will likewise turn because secured to its companion. From the difference in diameter of the gears in this four-gear train, the wheel *J* will be turned more rapidly than the wheel *D*. The effort will be in a reverse direction, but as *J* cannot be moved in the reverse direction because of the ratchet, the result will be that *D* will be driven in a forward direction. This will turn the spindle itself forward, because *A* and *D* are secured together. This forward movement, effected through reaction, is much slower than that resulting from the direct drive. It is employed in connection with the straight-away portions of the seam. The motion, whether slow or fast, is communicated through the gear *C* to the gear *M*, and thence to the pinion *N*. This last drives the rack which is attached to the cage holding the work.

Fig. 5 gives two views of the main part of the machine in plan and elevation. The fragment of spindle *A* seen on the extreme right in the elevation is the spindle *A* of Fig. 4. The gear at its lower end is not shown, but the gear *M* of Fig. 4 is to be seen, here marked *M* also. The final driving pinion *N* is just above. There is a table *O*, to the under side of which a rack *P* is secured. Within this rack contour, shown by the plan, are two rectangles in dotted lines, forming the channel *Q*, in which the roller *R* operates, being located in this channel opposite the driving pinion. The table is kept in a true horizontal position by the assistance of the sliding plate *S*, which is held not too rigidly in position by a pin or bolt and spring. There are four upright posts secured to the upper side of the table. The can to be welded is placed within these and held rigidly in position by a clamp arranged at the top, which clamps the can diagonally, the manner being best illustrated in the halftone, Fig. 3. A suitable form is used within. The movable portion of the clamp consists of two arms at right angles, both forming a single piece. By moving this angle along the diagonal passing through its vertex, closure and release are made. Pins and slots maintain the movement along the diagonal. The lever with a cam slot at one end enables the operator to produce the movement and to give force to the closure. The form on the inside consists essentially of four parts—all four forming a kind of pyramid cut by diagonal vertical planes. This device is put within the top or bottom to be welded, and readily expanded by a simple movement. This, with the exterior clamp, gives a very effective means for holding the metal edges of the work in exact position. Reference to the plan of Fig. 5 shows the driving pinion in mesh with the rack. Apparently, there is no need to drive at more than one point, the arrangements there affording sufficient control. Referring to the elevation in the same illustration, it will be seen that in fact the rack is run through a kind of pass between the pinion and the roller, both being fixed in position. If, at any time, it becomes necessary to operate, say for a short distance, by hand, it is possible to do so, for by raising the sliding collar *T*, engagement is secured with a clutch face arranged on the under side of the loose gear *M*. The handle *U* may then be used to obtain the movement desired.

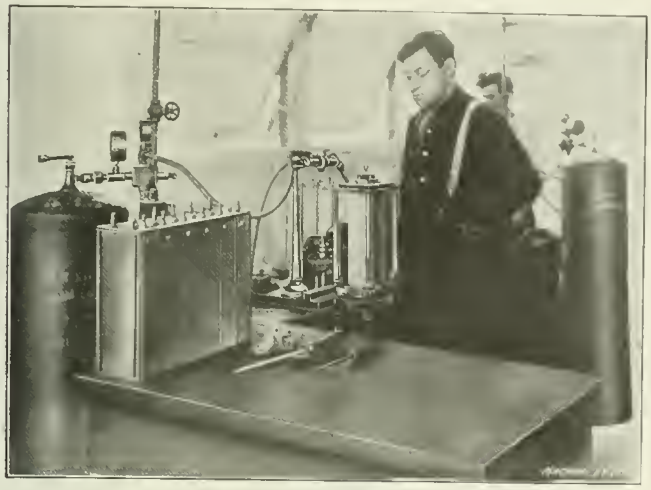

Fig. 6. Machine for Welding Can Ends in Operation. Finished Cans to the Left

Fig. 5 also shows at the corners, the adjustable pieces *V* which serve to bring about the speed changes by moving the yoke *W* (Fig. 4) which is pivoted as a lever to the post on the right. By this means, the sliding collar *H* and the clutch *E* are thrown in and out of engagement.

The machine in operation, welding the ends of the cans, is shown in Fig. 6.

* * *

The city of Milwaukee appears to be the first city in the United States to apply the methods of scientific management in the running of the city's affairs. A Bureau of Economy and Efficiency has been established, which in its first semi-annual report, just published, shows that as a result of the investigations made by the bureau nearly $100,000 can be saved the city by the application of economical and efficient methods. Among other things the bureau has started a study of purchasing methods, including standards, specifications, inspection and testing of purchases, and has made a study of the best purchasing methods employed by large private corporations, for such suggestions as may be found useful. Municipal engineers everywhere will undoubtedly be interested in this work, and in the reports that will be forthcoming, because the standards according to which the business of most of our cities is run are usually contrary to all accepted methods of private enterprises, and the engineer who, as an employe of the city, has been called upon to perform work under the inefficient methods usually in vogue, must have felt the need of some comprehensive research work in this direction. Advanced thinkers will not think it strange that Milwaukee takes the lead in this respect, it being the only city of importance in the United States to have a socialistic municipal government.

A MODERN GERMAN METAL-WORKING PLANT

ARRANGEMENT, MANAGEMENT AND OPERATION—COOPERATION WITH AMERICAN TOOL BUILDERS

By C. A. TUPPER[*]

In writing of European shops, and comparing their practice with that of American plants, it is difficult, because of the vastness of the subject, to avoid mere generalities, and most of the articles published suffer from that defect. On the other hand, if one goes very much into detail, more space is soon covered than the average editor is willing to allow, and the treatise ends with an abruptness which leaves the impression that it is very fragmentary. In the following, therefore, the writer will refer principally to only one of the plants of Europe which now typify the best practice on the Continent, and, by bringing out the features with which he was most impressed, give an idea of what he saw that has suggestive value for manufacturers in this country.

Almost every American who makes a round of German metal-working plants visits the new foundry, machine and assembling shops, show-rooms, etc., which constitute the fine modern works of the Ludwig Loewe & Co. Akt. Ges., at Berlin. These are among the best equipped and most efficiently managed in the Empire, and there are many features of the entire establishment deserving of careful study. In its general layout the plant is stated to have been modeled partially on the lines of the Brown & Sharpe Mfg. Co., Providence, R. I., and there are certainly numerous points of resemblance. Nearly as many men are employed as in the American establishment, operating methods are very much the same, and in the products of the company, German skill and enterprise are seen at their best. One is impressed, on entering, with the excellent provisions for light and ventilation, the facilities for handling material, appliances for saving time and lightening labor, etc., and the intelligent appearance of the workmen, most of whom are in the prime of life. They move about at their tasks with a poise and decision and operate the machines entrusted to them with a quickness and certainty that astound many Americans who, coming straight to Berlin from the United States or from London, *via* Hamburg, visit a German shop of this class for the first time.

In its work the Loewe company combines American and English methods with others that are peculiarly its own, the management having apparently the faculty of picking out the best of various diverse characteristics. Relations with England are very close, and one would say that many ideas have been taken from both the old and new plants of Alfred Herbert, Ltd., Coventry, whose work has undoubtedly made more of an impress on the Continent than that of any other British firm.

Like Herbert, the policy of the Loewe company seems to be to manufacture for stock as much as possible, and the tendency during recent years is towards increased specialization. While a greater variety of tools is still built than many American firms would care to undertake, in accordance with general German practice, the Loewe company is only pushing a limited line, including automatic lathes, automatic screw- and gear-cutting machines, milling machines, drill presses, grinders, etc., as well as high-speed tools of standard design for the same general classes of work.

Handling American Agencies

This concern has, however, put itself in a position to keep on hand a very complete stock of machines of all kinds by acting as agent for many of the most advanced American tool-builders, including the Colburn Machine Tool Co., Franklin, Pa., for boring mills; Fosdick Machine Tool Co., Cincinnati, O., for plain and universal radial drills, horizontal boring, milling and drilling machines, etc.; Cincinnati Planer Co., Cincinnati, O., for variable-speed planers; Norton Grinding Co., Worcester, Mass., for bench and floor grinding machines, car wheel grinders, crank and crankshaft grinders, universal tool and cutter grinders, and a line of special apparatus of this kind for locomotive and car shops; Becker-Brainard Milling Machine Co., Hyde Park, Mass., for plain and universal millers; F. E. Wells & Son Co., Greenfield, Mass., for universal grinders; Ransom Mfg. Co., Oshkosh, Wis., for grinding machines; Whitcomb-Blaisdell Machine Tool Co., Worcester, Mass., for lathes and planers; Springfield Machine Tool Co., Springfield, O., for high-power rapid-reduction lathes; and the J. T. Slocomb Co., Providence, R. I., and others, for a complete line of the best tools and machinists' supplies. There are probably additional firms represented, but the above are the only ones of which the writer made a memorandum, and they are sufficient to show the wide range of apparatus handled. With the large list of American firms whose interests are in the hands of De Fries & Cie, of Düsseldorf, Germany, it is also remarkable as demonstrating the confidence felt by manufacturers on this side in the fairness of these leading German concerns, who are, in part, direct competitors. Much of the Loewe company's construction is distinctively German and stands for the new, independent order of designing that has become current in the Empire within the last few years. The company also manufactures some special machines, peculiar to German shop methods, which have no practical interest for Americans.

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While the workmen employed in various parts of the plant are quick and handy, the average is probably not quite up to the American standard, as, even with the considerable use of automatic tools, it takes a larger force for operating them than would be required in one of our modern plants. More skilled, *i. e.* machinist, labor is also needed.

The works contain many American and some English tools, and the writer was informed, although he did not see for himself and is inclined to doubt the assertion, that they had obtained service from these tools which was not intended by the manufacturers. In fact, applications of standard American machine tools to special work, at various other places in Germany, upon which the Teutons naturally laid stress as examples of native ingenuity, turned out to be the same as those made in many American shops. Special attachments and devices, such as for indexing, could also be paralleled at numerous places in the United States.

The care taken with all work, from the foundry to the shipping department, is, however, worth any American's time to observe, and it undoubtedly results, at the Loewe plant, in a very high grade of product. Everywhere there is neatness, order and system; passages, even in the foundry, are kept unobstructed; there is no misplacing or cluttering of material, and the risk of accident has been reduced to an absolute minimum.

In the sales department, machines are demonstrated to customers by being put at the work for which they are intended; and all apparatus, before being packed for shipment, is tested in the finishing department. Under these circumstances there are few "comebacks," and the system is one of as much advantage to the American manufacturers whom the Loewe company represents, as to that concern itself.

Developing an Efficient Working Force

It is, however, in the systematic development of trained, loyal workmen that the Loewe company has evolved the methods which are most worthy of emulation by Americans. The apprentices, a large number of whom are annually taken into the works, not only learn their trade but are given instruction in a good school, which is recognized by the local authorities as a regular continuation school. There is very thorough teaching of mathematics, including not only arithmetic but trigonometry, algebra and geometry; and any lad who displays an aptitude for drawing is given particular encouragement in that line.

When it comes time for serving in the army, the young graduates from the apprenticeship course take their turn with other German youths; and the most of them go forth as journeymen machinists, with the recommendation and cooperation of the company. Others return directly to its service. When the wanderers come back to Berlin, as a fair percentage eventually do, places are found for them at the Loewe works as soon as possible, and the utmost benefit is derived from the experience which they have had elsewhere. Soon after each man's return, there is very apt to be a communication from him in one of the suggestion boxes. For good ideas, payments or other suitable rewards are made; and, from the first period of their apprenticeship, the men are encouraged to think for themselves. In this respect it seemed to the writer that the Loewe works are ahead of most other German plants, although initiative has, undoubtedly been stimulated all through the Empire, if one is to compare present conditions with what investigators reported even ten years or less ago.

While the men who have graduated from the Loewe shops are serving as journeymen machinists in various other industrial centers, they help to introduce the products of the company by talking about them. This is more or less involuntary, from the fact that the men learn, even as apprentices, to take great pride in the work that is being turned out, and, when they get out among others of their craft, they naturally brag about it. This remains true, also, of the men who marry and settle down permanently elsewhere. Many of them continue to "plug" for the old company.

By the time those who return to Berlin are back in the Loewe shops again, they have become matured and well balanced, which is probably what impresses upon the visitor the fact that so many of the machinists are in their prime. This, of course, constitutes a very desirable class of labor and no doubt contributes largely to the general efficiency of the works.

Future Competition for European Trade

The Loewe tools bring good prices, which is one thing that enables them to be handled with American machines to advantage. They have been placed all through Europe, even overcoming racial prejudices, as in France, Bohemia and Poland. A large percentage of trade is with England. For export to other countries over-seas there is also a growing volume of orders, special attention being paid to this business as a steadying influence on the European market and a desirable asset for the future.

From the side-lights cast by the above on the activities of a first-class German machine-tool plant, it will be seen by anyone not already informed, that Americans no longer have a "walkaway" when it comes to the best work in that line.

The writer cannot, however, agree with the people on this side of the Atlantic who see in the rise of German manufacturing the doom of the American machine tool trade in Europe. The enormous industrial expansion that has taken place there, of late, and is still in progress, brings with it a demand for new equipment which it will tax European tool builders to supply, particularly as they have entered upon a fixed policy of maintaining their export trade over-seas, no matter what the market at home may be. There will be room, for at least many years to come, for the sale of the best American and European tools side by side; and the independent designing entered upon by such firms as Ludwig Loewe & Co. Akt. Ges. will benefit all manufacturers in this line, without regard to country, for the reason that it tends to raise the general standard of mechanical efficiency demanded by users. The increasing use of high-speed, modern tools, and the application of improved shop systems in one plant forces similar betterments in those that compete with it, and the circle of demand is thus rapidly extended. Such concerns as the Loewe, Herbert and Brown & Sharpe Cos., or others equally representative of their respective couutries can, therefore, well afford to cooperate in every possible way, instead of retarding each other's progress, for the general promotion of trade which results is of direct benefit to all.

* * *

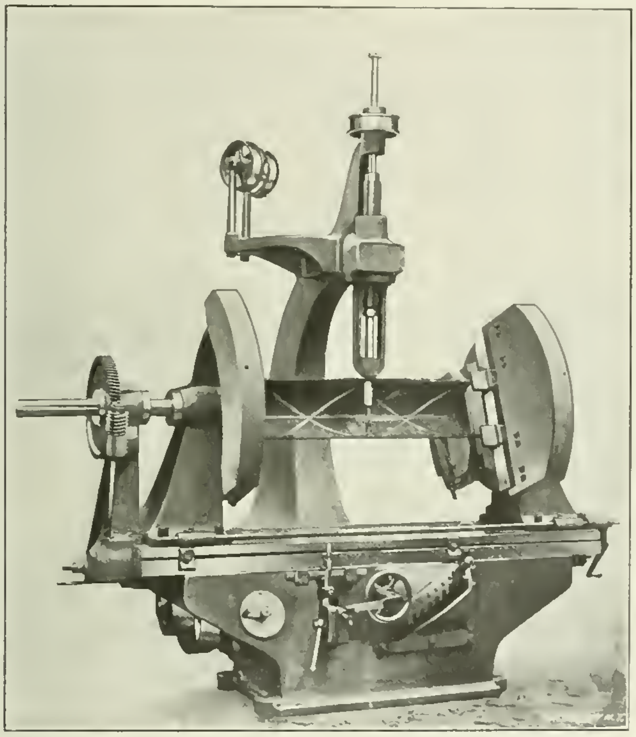
One of our British contemporaries mentions that an electrical concern in London, wanting to send an urgent consignment of metallic filament lamps to a town some distance from London, adopted the method of sending them through the air by a monoplane. The journey was successful, but there is a doubt in our mind whether the company considered the consignment very urgent when it adopted the monoplane method. It would seem that this would have been the very worst way to send it, had it been very important.

OIL-GROOVING MACHINE

By W. H. HAGGAS

In the May number of MACHINERY, the writer noticed a paragraph in which a regret was expressed that there are no oil-grooving machines made in America; for that reason the writer wishes to bring the attention of the readers of MACHINERY to such a machine made by Ward, Haggas & Smith, Keighley, England. This particular machine is designed not only to mill oil grooves in half-bushings, but also to chamfer the edges. In capacity, it is designed to handle half-bushings, ranging in size from 48 inches long by 24 inches inside diameter to 6 inches long by 4 inches diameter, and is adapted for milling these grooves either straight or spiral. In the latter case half-spirals can be made in a range of from 4 to 24 inches in length. Needless to say, the machine produces a much neater job than is possible by hand, and, on the average, can make the grooves about six times as fast, having the additional advantage of making it possible to save the brass cuttings.

The construction of the machine is very simple. The bed is of an inverted T-shape in plan and carries a stiff section table with square guiding surfaces and long taper gibs. On this table are mounted two bearings which carry the chuck or faceplate which is designed to hold the bushing to be milled concentric with the bearings. The bearings may be adjusted along the length of the bed by means of a right- and left-hand screw in order that bushings of various lengths may be accommodated. As will be seen from the illustration, the left-hand chuck plate carries a splined shaft which slides through the boss of a large worm-wheel. This worm-wheel is geared to the table traverse so that the two move in unison.



Oil-grooving Machine for Cutting Oil Grooves in Bushings

By means of the plunger handle in a notched plate in the front of the machine, the relative movement of the worm-wheel and table may be changed so as to give from a half circle in a 4-inch travel of table to a half circle in a 24-inch travel; ten changes are possible by this selective gear arrangement. The right-hand chuck plate has no means of power drive other than through the bushing being milled, but as both chucks are balanced, no strain is placed upon the bushing. The direction of rotation of the bushing can be changed at will by means of the handle on the dial plate so that instead of cutting right-hand across from corner to corner, a saw-tooth course may be followed. This is accomplished by letting the table travel along half its course and then reversing the revolving motion. The vertical handle and short rack seen at the front of the machine will reverse the direction of both the table travel and the bushing rotation. The dogs shown along the side of the table are set to limit the travel of the table. The ball handle at the front of the machine operates a drop worm which when out of gear permits the table or chuck plates to be adjusted by hand.

The upright carrying the milling spindle has a 9-inch crosswise adjustment on the back part of the bed and is operated by the handwheel at the front of the bed. This adjustment is introduced so that chamfers may be milled on the edge of the bushing. The cutters used are usually short twist drills, the spindles having a Morse taper to suit. The spindle is vertically adjustable by means of the handle in the center of the handwheel for adjusting the column.

The machine is driven by pulleys shown on the left of the machine, two sizes being provided to give the two required speeds, one for brass and the other for cast iron. This motion is carried through a short shaft in the bed on which are mounted pulleys for driving the spindles and feed gear. The feed gear, driven from this shaft by a belt, is transmitted through a friction reversing clutch and then by worm and worm-wheel in the bed under the table. This worm-wheel is mounted on a screw which moves the table.

Care has been taken in the design to have all the adjusting levers at the front of the machine within easy control of the operator. In addition, the machine is easily and quickly changed to accommodate either a large or small bushing, and the notch plate is calculated to suit various lengths.

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MACHINES VS. MANUAL LABOR

At a time when the use of machinery for performing nearly all operations in the manufacture of products of iron and steel has been so thoroughly established, and when its effect on the industries and on the general economic conditions of nations has been so fully recognized, it is rather surprising to find the following paragraph in one of our British contemporaries:

> "At a conference of the Factory and Cable Chainmakers' Association, held at Cradley Heath on the 10th of July and attended by delegates from South Wales, Staffordshire, Worcestershire, Chester and Lancashire, it was stated, according to a report in the *Manchester Guardian*, that there was a great revival in the cable chain trade. Satisfaction was expressed that the wonderful machines imported into England to displace hand-made chain had proved absolute failures. Some, it is said, had been thrown onto the scrap heap, and a communication from America states that the big machines erected there had also proved failures. One was draped in mourning in memory of the vast amount of money spent on it."

The idea that the introduction of machines to perform operations which have formerly been carried out by manual labor is a development injurious to the best interests of the worker at a trade is one that seems to be imbued in the minds of a great many people. No doubt examples can be pointed out where the introduction of machines has thrown a number of men out of work temporarily, but, nevertheless, in the long run, not only has the community in general, but these men as well, been benefited by the introduction of the machines. No doubt, if it were not for agricultural machinery, thousands of men could be employed on the farms in the United States, for example, that are now displaced by highly developed modern agricultural implements, but does anybody believe that the average standard of living in the United States would be as high as it is, were all the farm labor performed in the manner of a hundred years ago? The development of new machines which make it possible to produce more quickly and cheaply will, in the long run, react satisfactorily on all, and if—due to social and economic mal-adjustment—the man who is displaced by a machine cannot without difficulty find some other occupation which will yield him as good a living, he should not blame the machine, which in the main has a beneficial influence, but the incongruous economic conditions which are permitted to remain unaltered.

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The supply and condition of wrenches is often a guide to the characteristics of the man using—or abusing—them.

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THE DISAPPOINTING AIR RECEIVER*

By FRANK RICHARDS†

In speaking here of air compressors, and more particularly of the air receivers which always accompany them, the writer has in mind those installed for service sufficiently permanent to warrant the provision of safe and economical working conditions. This includes air compressors which are installed in most of the plants of any considerable capacity. Compressed air is used as a necessity for operating rock drills, when sinking shafts, driving tunnels, and in general mining work, etc. It is also used as a time and money saver in still greater volume for a much wider range of service. Every extensive manufacturing plant must have its compressed air supply distributed throughout its works; for the larger engineering operations, such as dams and waterworks construction, and in the most extensive quarries, compressed air is superseding the isolated steam-operated pumps, hoists, shovels, stone crushers, concrete mixers, etc.

In all these extensive lines of air service, and, in fact, in all air practice, it makes a great difference as to the condition of the air when used, and especially as to the moisture which may be carried in it, much inconvenience and loss of time occurring when the air is not kept dry and clean. There is always a pretence made of attending to this necessity. Who would think for a moment of installing an air compressor without a good sized air receiver as close to it as possible? The man who would set up an air compressor without an air receiver would lose all his respectability among engineers. Respectability has, perhaps, a good deal more to do with the installation of an air receiver than anything else.

If you were to ask the whys and wherefores of an air receiver, you would probably be told that "everybody always uses them." If you pressed the matter still further, you would mostly likely be told that the receiver is needed for the storage of air and the steadying of the flow. Well, the total capacity of the air receiver usually installed with an air compressor does not exceed the output of the compressor for one minute. If the compressor is running continually, and if the air is being used as fast as it is delivered, the apparatus driven by the air must come to a standstill within a single minute. So it can be readily seen that the air receiver as a storage adjunct is of little value. Builders and sellers can afford to have you pooh-pooh the storage service of air receivers, but they will still assert the two-fold need of them for cooling the air and for getting rid of the moisture in it, the presence of the latter being the most serious objection to the air in use and the cause of the most trouble. Now as to the cooling of the air, how can the receiver do it? To cool the air as it comes from the compressor, there must be a cooling surface or material for the air to come in contact with, and to which it may impart its heat. The air receiver, however, is a plain cylindrical shell with no pretence of a cooling device or any arrangement of the sort within it, and the air merely passes through it hurriedly, emerging at the other end practically as hot as when it entered, giving up its heat more or less rapidly to the inner surface of the pipes through which it travels, for which cooling effect the pipes and not the receiver should have the credit.

It is a curious fact that the air receiver, so far from being an air cooler, has often been transformed into a combustion chamber. Numerous authenticated instances are cited of receivers which have become red-hot while compression and transmission were going on, and flames have been emitted at the ends of the pipe at a considerable distance from where the air was used; receivers have also sometimes exploded, which is much worse. When single-stage compressors are worked up to desirable service pressures, say 80 to 90 pounds gage, the temperature of the air discharged (water jackets having very little effect upon it) is high enough to volatilize the lubricating oil used; this oil-gas mingling with the air in such proportion as to form an explosive mixture, may be diffused through the receiver and into the pipe lines. Then if there is a sufficient increase of temperature to cause spontaneous ignition, or if there is a friction spark, disastrous and often fatal explosions result. It is well known that for the formation of an actively explosive mixture of oil-gas and air, the two constituents must be mingled in certain proportions, the limits of which, in either direction, have been quite precisely determined, and if either the oil-gas or the air be in excess when ignition occurs, there is no sudden explosion, but simply the active combustion which makes the receiver and air pipes hot. Although this is sufficiently alarming when discovered, it may be assumed that the danger of explosion is past.

If lubricating oil is used to excess in the air cylinder, it may accumulate in pockets or upon the horizontal surfaces for a considerable time, and when favorable conditions occur it may take fire and burn from the surface, just as the soot in a chimney takes fire. The activity of the combustion is not to be wondered at when it is remembered that on account of compression, the quantity of oxygen per unit of volume has increased six-fold or more, according to the pressure carried.

While the air receiver is not, thus, a cooler of the air, it also is not, for the same reason, an abstractor of the moisture in the air, this being the most desirable service which it could render, and which it has been too readily assumed to do. It is well enough understood that atmospheric air—free air—always carries moisture and also always has capacity, or as we might say appetite, for more, up to the point of saturation, when its avidity suddenly ceases. The moisture-carrying capacity of the air rises very rapidly with its rise in temperature, and diminishes, but not so rapidly, with rise of pressure. As the pressure must always be at the highest point just when the air is leaving the compressor, if we can then reduce its temperature to the lowest point, the air will be in a condition to surrender so much of its moisture that none will be found later to cause trouble, when lower pressures and perhaps higher temperatures are reached further along the line. It being thus sufficiently evident that the best place for drying the air is as near the compressor as possible, the first requisite is an efficient cooler or, rather, aftercooler for the air.

The air receiver, as has been said, has never been a cooler of the air, and the builders are now testifying to this fact by the number of aftercoolers they are offering. The best of these are highly efficient, and the air after going direct from the compressor and through the intercoolers is in the precise condition desired—that is, of high pressure and low temperature—for the surrender of its moisture. For the important service which the aftercooler may render, nothing could be expected to work more cheaply. There is only the first cost of the apparatus and connections, and then a sufficient supply—not large—of free running water.

Now, surely the air receiver is available for depositing the excess moisture which the aftercooler has liberated, and for sending forth the air sufficiently dry for all subsequent employment. Unfortunately, the typical air receiver still persists in its inefficiency, and the air passes through and out of it wet, or carrying a considerable amount of free moisture. It is to be remembered that when the saturation point is lowered by the lowering of the temperature of the air, and there is a relinquishing of the surplus moisture by condensation into water, that water still remains in the air, as mist or fog, and what is then needed is a separator. Any of the separators which are successful in drying steam are equally efficient in taking the liberated water out of the air, when it is in the condition here spoken of.

An air receiver of the common type, preferably horizontal, if merely provided with a series of baffle-plates (which might be added without much additional cost) would be an efficient separator, provided that the air passing through it is in the prescribed condition of high pressure and low temperature. Indeed it would seem to be quite possible to combine in one apparatus the two functions of cooling the air and separating the freed water from it, and it might also be made large enough to constitute a storage capacity equal to that of the plain air receiver.

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* For additional information previously published in MACHINERY, see "Air Compressor Design," June, 1911, engineering edition, and other articles there referred to.

† Managing Editor, *Compressed Air Magazine*, New York.

NEW CAN-SEALING MACHINES OF THE MAX AMS MACHINE CO.[*]

By FREDERICK H MOODY[†]

An interesting description of the manner of making solderless cans for food products was given by Mr. Ralph E. Flanders in the September, 1909, number of MACHINERY, the machines considered being those produced by the Max Ams Machine Co., Mt. Vernon, New York. With one exception the machines and processes are still substantially the same as then described, and it will be unnecessary to cover the ground again, the interested reader being referred to the previous article for details not shown here.

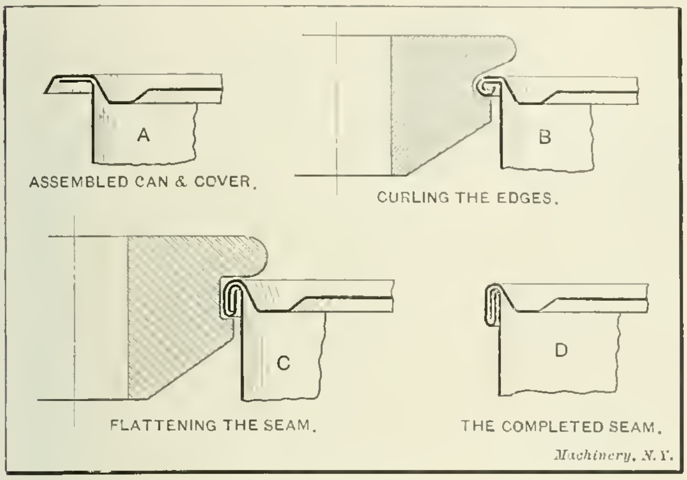

Fig. 1. The Sequence of Operations followed on the Double-seaming Machine

The Seaming Principle

The particular change in the process lies in the newer application of rollers to double-seaming the covers, making the devices more compact. In order that the process may be more readily understood it is advisable to first consider the principle of seaming. Fig. 1 shows the successive steps. At *A* the flared can body and formed cover as they come from the preceding operations, are shown assembled. The first operation is that shown at *B*, where a round-grooved roller gradually runs up against the flared edges, the can spinning around in front of it. This operation curls the edges to the shape indicated. Subsequent to this action of the round-curling roller, a square-grooved roller as at *C* flattens out the curled edges, finally tightening them down to the form shown at *D*, making a complete double seam, tightly locked. As no solder is used in seaming, the assembled parts at *A* are first coated along the contact surfaces with a thin emulsion of an odorless compound of a sanitary nature which fills all crevices as the seam is formed, making a perfectly air-tight joint.

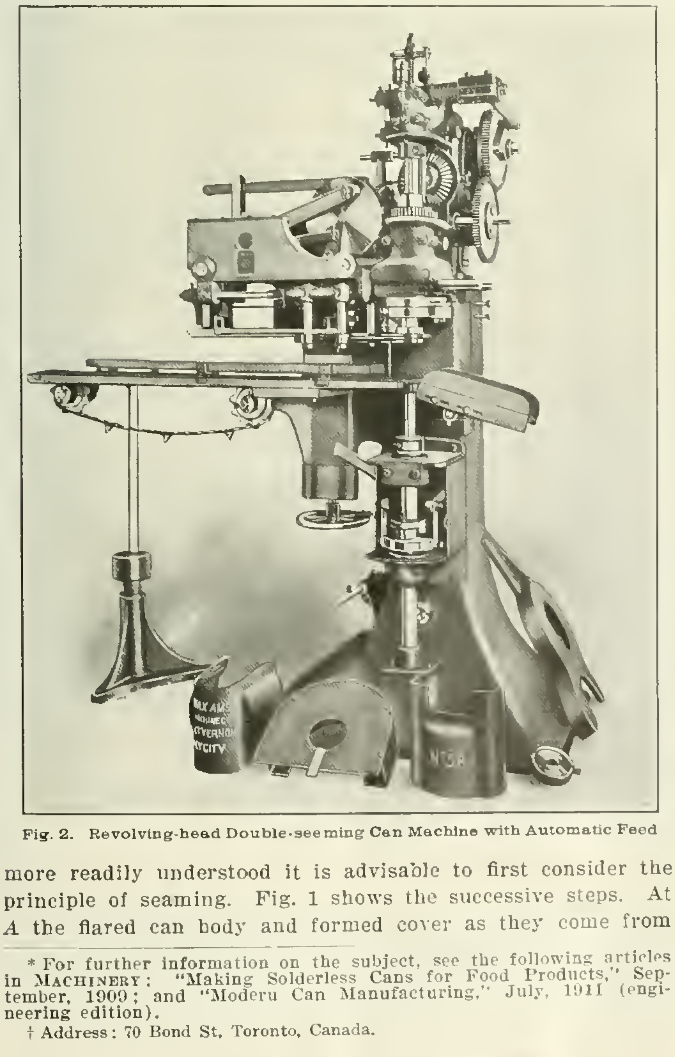

Fig. 2. Revolving-head Double-seeming Can Machine with Automatic Feed

In the old type of double-seaming machine, these two round- and square-grooved rollers were held on sliding parts at the rear of the machine, and as the can, held vertically between the circular faceplates, spun around, the two rollers in succession came forward and performed their duties. To replace this form of machine, two new types have been developed, in which the two rollers are held in the upper chuck making the machine very compact and self-contained. These two machines are the No. 58 with a revolving roller head, and the No. 68 with a stationary roller head.

Revolving-head Double-seaming Machine

A revolving-head double-seaming machine is shown in the half-tone Fig. 2. The mechanical construction of the head is very ingenious; the most important part of the mechanism is shown in Fig. 4. The two rollers (one of which is shown) are attached to the seaming ring *A* by pins on which they are free to revolve. This ring *A* is bolted to head *B*, which, in turn, is connected to a sleeve *C* by a radially-sliding pin connection, the object of which will be explained later. On the upper end of this sleeve *C*, a gear *D*, is keyed. The seaming ring *A* is thus driven through the train of gears, *D*, *E*, *F* and *G* from the main drive shaft *H*, the can meanwhile standing stationary and centrally located with regard to the path of the rapidly revolving rollers fitting over plate *I* on the shaft *J*. Shaft *J* is operated by a forked lever and a cam so that chuck-plate *I* is lowered when no can is fed to the seaming rollers. When a can comes under the chuck-plate, both can and plate are raised to the right height for the rollers. This height is regulated by the adjustable collar *K*. When a can is seamed, the chuck-plate drops again, collar *K* resting on the shouldered pin to the left. An interior rod acts as a knockout, to free the finished can.

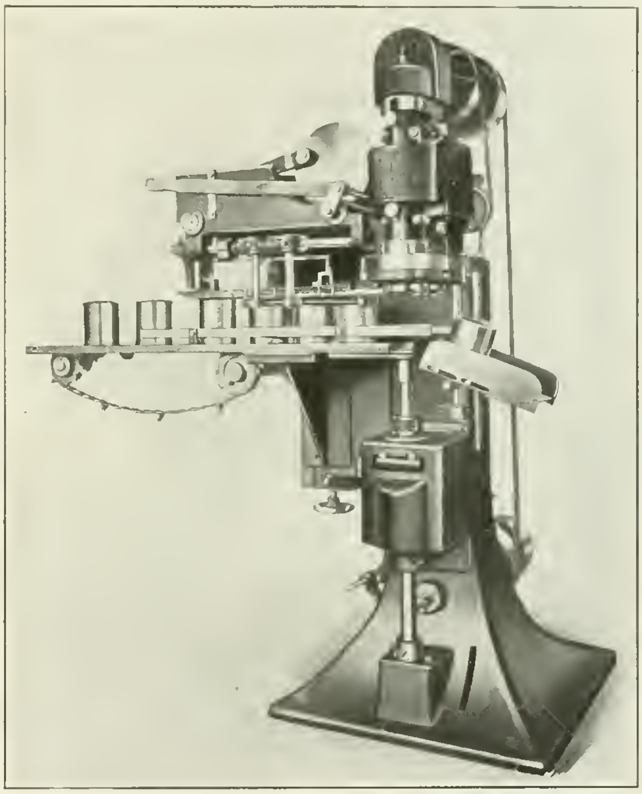

Fig. 3. Stationary-head Double-seaming Can Machine with Automatic Feed

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[*] For further information on the subject, see the following articles in MACHINERY: "Making Solderless Cans for Food Products," September, 1909; and "Modern Can Manufacturing," July, 1911 (engineering edition).

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Thus far, a very neat provision has been made for having the head revolve around the stationary can, but some means must be provided for having the rollers come up to, and recede from, the work at the proper instant. This is taken care of by having a central sleeve *L* driven from the gear *F* through gears *O* and *M*. The lower end of this sleeve *L* is made eccentric as indicated at *N* where it will be noticed that one side of the sleeve is thicker than the other. Now, the outer sleeve *C* driving the head *B*, is revolving at a certain speed through its train of gears *D*, *E*, *F* and *G*; similarly eccentric *N* is revolving at a certain speed through its train *M*, *O*, *F* and *G*. If the gears *M*, *O*, *E* and *D* are all of the same size, the relative angular velocity of eccentric *N* and head *B* would be zero. So, in order to give the eccentric a slight relative movement, the gear *M* is given one more tooth than gears *E* and *D*, making its motion a little slower than that of gear *D*. This makes the eccentric lag behind the roller head, drawing in and out the rollers, the movement of the head on sleeve *C* being provided for by the radial keyway between *B* and *C* which was mentioned before.

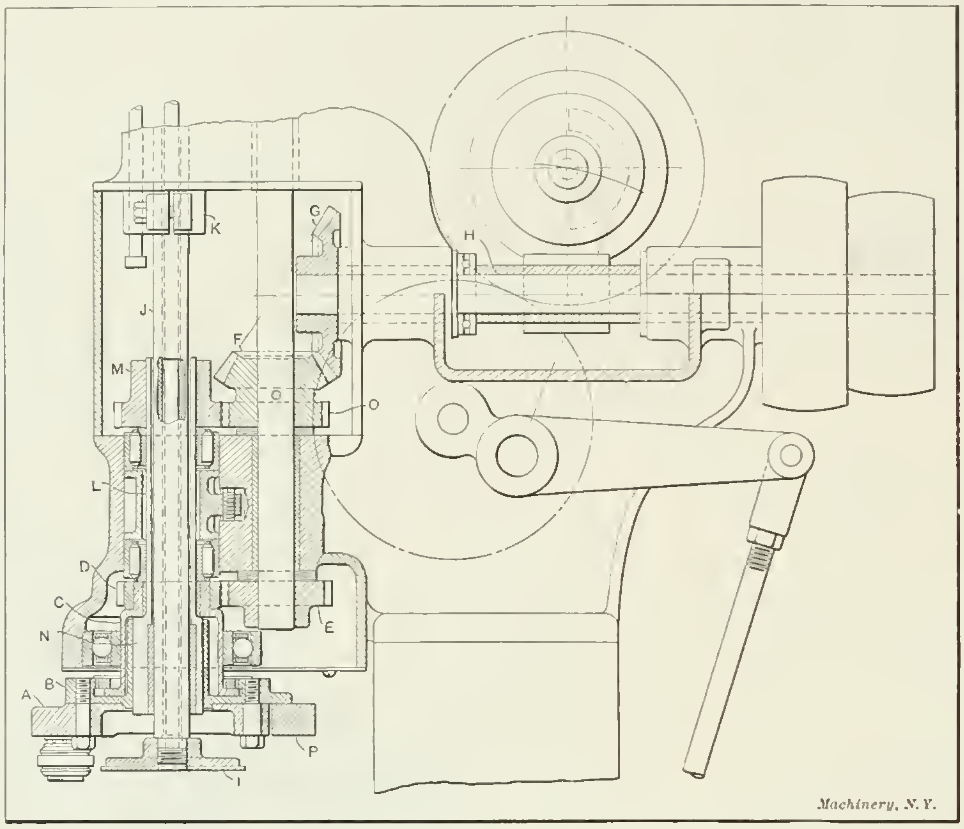

Fig. 4. Head of the Revolving-head Double-seaming Can Machine

It will be noticed that all bearings are either of the ball or roller type, making a very smoothly operating machine. On account of the high speeds of revolution of the roller head, the latter is counterbalanced by a weight *P* opposite the rollers. It will also be noticed that the rollers are double ended so that they may be turned end for end as the spinning grooves wear out. These grooves are of special design and have to be given an exact curvature depending upon the weights of the material to be seamed. The central pin on which the roller revolves is held in an eccentric bushing so that it may be given a certain amount of adjustment to provide for the correct degree of pressure to be applied to the form of the can.

Stationary-head Double-seaming Machine

The construction of the seaming head of the double-seaming machine is somewhat different from that of the revolving-head type previously described. The assembled machine is shown in Fig. 3, while Fig. 5 shows the main details of the head. As the name implies, the seaming head is stationary while the can revolves around in front of the rollers, these rollers being given an in-and-out motion by an eccentric operating in unison with the revolving can. The can, being held up against plate *A* by pressure from below, is driven by spindle *B* through bevel gears *D* and *C* from the main drive shaft *E*. The rollers are held as in the former case on pins in the seaming ring *F*, which is bolted to head *G*. This head *G* is guided by means of a radial keyway in sleeve *H* which is held stationary by cap *I*. A sleeve, the lower end of which is eccentric at *K*, gives the motion to the rollers, and is driven from gears *L* and *M* through the worm gear *N* from the shaft *O*, which derives its power from pulley *P* driven from pulley *Q* on the main drive shaft *E*. By means of a friction arrangement, the drive, instead of being direct from *P* to *O*, is transmitted through a friction disk *R*. Pulley *P*, which is free to slide on shaft *O*, is engaged with disk *R* by a lever that is operated by the spring shown, when a foot-lever is released.

The illustration of the head also shows the arrangement adopted for automatically clamping the can between the chuck-plate and base-plate. The lower base-plate is similar to the upper one shown at *A* with the exception that it is mounted on a shaft, which is vertically adjustable as shall be explained. Gear *S*, keyed to *L*, drives gear *T* which runs

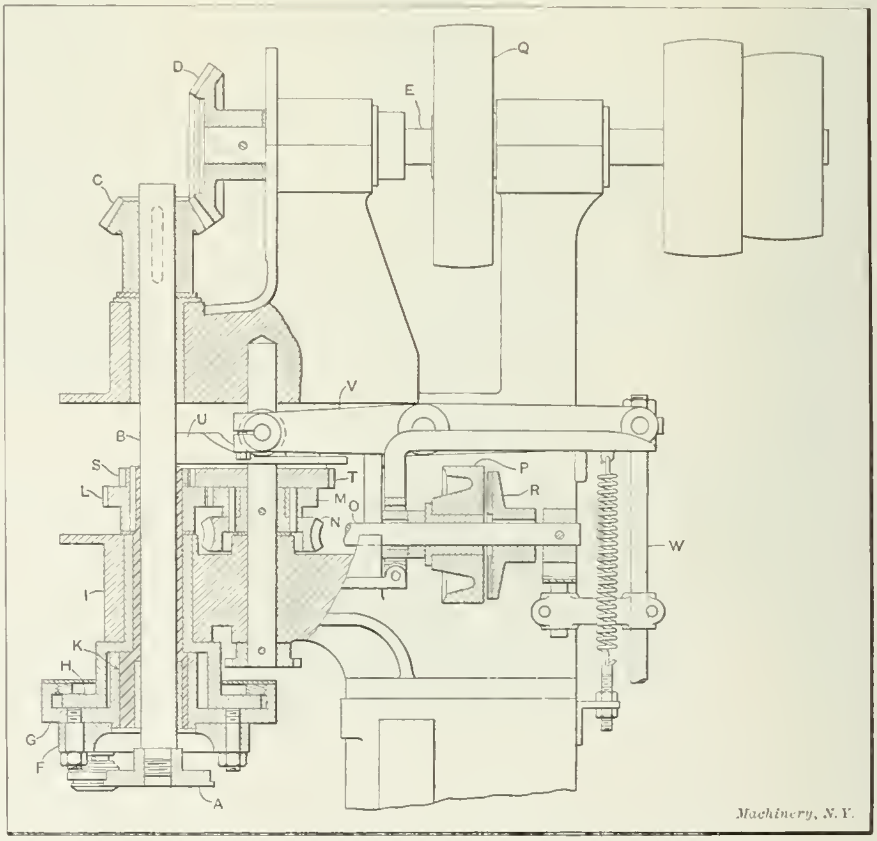

Fig. 5. Head of Stationary-head Double-seaming Can Machine

free on the same shaft as gears *M* and *N*. This gear *T* has keyed to it a cam *U*. A lever *V* fulcrumed near its center is connected through rod *W* to a similar lever below which actuates the lower base-plate as the roller on the inner end of lever *V* rises on the cam. As the mechanism for controlling the rollers and that for lifting the base-plate and can are geared together, they act in unison, successively pressing the can against the chuck-plate, seaming and releasing, the relative adjustments of the different operations being so set as to accommodate these successive movements at the correct instant.

Can-feeding Arrangement

The feeding mechanism for both types of machines is shown in Fig. 6. Cans placed on the outer end of table *A* are fed forward to a certain point by a chain shown in the half-tones. At this point the cans are grasped by the feeding mechanism and fed forward into location between the spinning plates, the one being pushed into location shoving off the completed can at the far end. The mechanism is very simple. The crank *B* is driven in the direction indicated, from a shaft geared to the main drive shaft through the clutch arrangement shown in Fig. 7, which will be explained later. The crank as it revolves carries forward a crosshead, the latter sliding on the ways *H*. The end of the connection-rod *D* has a plate *E* bolted to it, and this plate, in turn, has a minor connecting-rod *F* joining it to the bellcrank *G*. This crank is fulcrumed on a carriage which is free to slide along the ways *H*; the lower arm of the bellcrank actuates the two bifurcated rods *J* clamped to sleeves *K* which slide on the before-mentioned ways *H*. These sleeves and the main carriage are so fixed with regard to each other as to have no relative longitudinal motion. On the same sleeve *K*, are clamped the can gripping arms *L*, the lower ends of which have formed jaws to grip the cans.

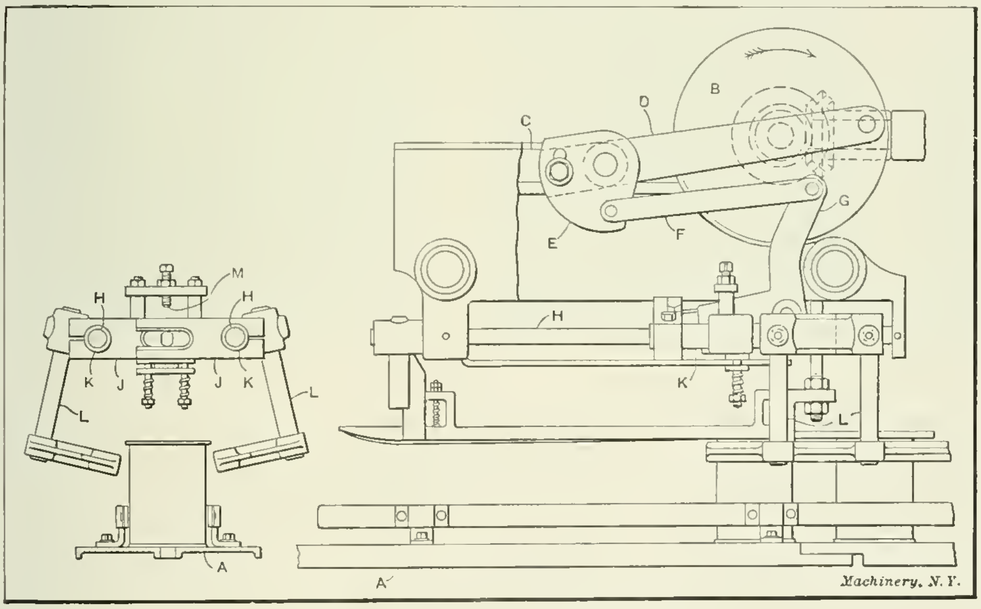

Fig. 6. Automatic Can-feeding Mechanism

Consider the operation of the mechanism with the crank *B* revolving in the direction indicated. As the crank-pin passes below the center, the bellcrank will turn counter-clockwise, forcing down the bifurcated arms *J* into the horizontal position shown in the end elevation; at this point a stop prevents further downward motion, causing the clamp jaws to remain open. The upper end of the bellcrank continuing to the left, forces the whole carriage with it stopping in the extreme left position. Motion is there reversed, the clamp jaws first closing in on the cans, being prevented from gripping them too tightly by the bellcrank arm striking stop *M*. The carriage then moves to the right, carrying three cans forward, placing the forward one in its correct location to be seamed. When the jaws withdraw and recede, the operation is again repeated. In order that the machine may be used with either an automatic or hand feed, it is necessary that the automatic feature be arranged in such a manner that it may be disengaged at will; likewise as it must be operative at the exact point of the circular operations there must be just one point of engagement between the drive and feed mechanism. This is provided for by a one-jaw clutch. Also, in order that no damage might be done by a can sticking on being fed forward, the drive for the latter must be provided with a safety device consisting of a shearing-pin connection of a type well known to most mechanics.

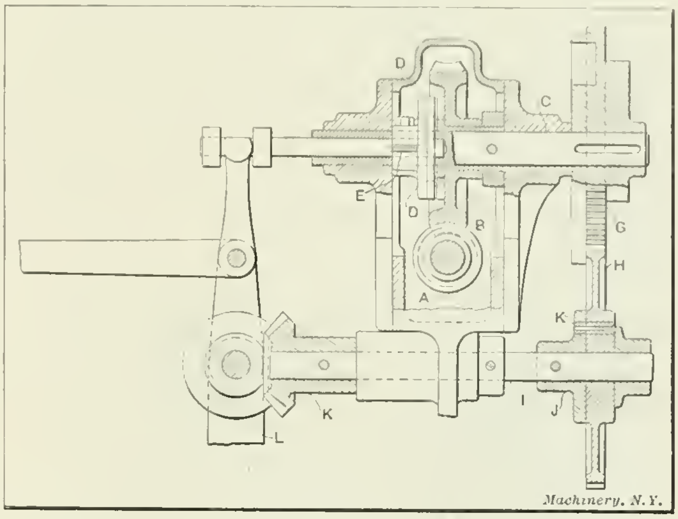

Fig. 7. Driving Part of the Automatic Can-feeding Mechanism

This drive with safety device is shown in Fig. 7. *A* represents a worm on the main drive shaft, meshing with the worm gear *B*, which is free to turn on a bushing on cross shaft *C*. A one-jawed clutch *D* (*i. e.*, a clutch that has only one place of engagement in a complete revolution of the worm gear *B*), is secured to a sliding shaft which enters shaft *C* and is driven by the latter through worm-gear *B* when engaged with it. The shaft has a slot which allows lengthwise movement of the clutch in it. A movement of the sliding rod to the right or left by means of its levers, respectively engages or disengages the clutch. Power is transmitted through shaft *C* to gear *G* and thus to gear *H*. This gear is free on the shaft and it is in it that the safety arrangement is provided. A collar *J* pinned to the shaft has a hardened steel bushing inserted at *K*, while the gear *H* has a corresponding bushing. A thin wire nail inserted in the registered holes of the bushings transmits the necessary power, and should anything obstruct the mechanism, this pin shears off, freeing the machine from breakage. The drive is transmitted by shaft *I* to bevel gears *K* and *L*, the latter being on the same shaft as crank *B* in Fig. 6. The operation of the machine is automatic throughout, and the successive operations are so timed that about three-eighths of the cycle is consumed in actual chucking and machining work, and the balance of the time in feeding the cans forward.

* * *

Some time ago experiments were conducted in the United States in order to ascertain to what extent coal stored under water retained its combustible qualities as compared with coal stored in the air. It was found that the saving from storing coal under water was comparatively small. Experiments have now been made in Germany which verify the American experiments. In this case samples were analyzed after two weeks, three weeks, and six months. These experiments indicated that but little is gained by keeping coal under water or in special atmospheres, such as carbon dioxide, flue gases or sulphurous acid vapors.

TITANIUM STEEL

By E. F. LAKE[*]

Titanium is one of the elements that have been successfully used to improve the quality of steels. It has also been very successfully used for cast iron and for some of the non-ferrous metals. The first heat of titanium steel made in America was poured in 1907, and since that time a great deal of investigation and experimentation has been conducted. These tests have shown that when ferro-titanium has been added to steel or iron in very small quantities, it has greatly strengthened these metals and improved their qualities in other ways; it can now be considered one of the best of purifying elements that have been used in the manufacture of steel.

Titanium belongs to the same chemical group as silicon, and three other elements that are quite rare. It forms a compound with oxygen, called titanium dioxide (TiO_2), occurring in nature in three distinct forms, the principal one being the titaniferous iron ore so often encountered. In some respects it resembles carbon. Like many of the other elements, it is very difficult to control and make use of when a natural ingredient of the iron ores; it is therefore necessary to separate it in the electric furnace and manufacture it into ferro-titanium containing from 12 to 15 per cent titanium, about 6 per cent of carbon and 5 per cent of all other impurities, with the balance iron. This, when correctly added to steel or iron, can be made very beneficial. With this percentage of titanium, it enters into almost instant solution; but as titanium has a much higher melting point than iron, a higher percentage would cause the titanium to segregate and no beneficial results would be obtained.

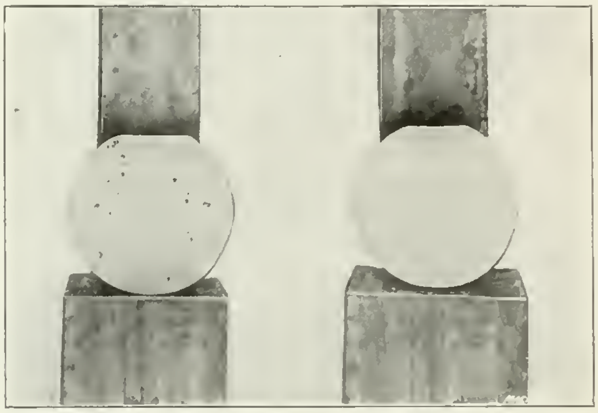
Fig. 1. Blow-holes removed from Cast Iron by Titanium

While nickel, chromium, molybdenum and tungsten add certain good qualities to steel, none of these combines with nitrogen, thus removing it from the metal, in the way titanium does. Its combination with nitrogen gas is attended with the evolution of heat, and it is the only undisputed example of the combustion of an element in nitrogen. When heated in oxygen it creates an instantaneous dazzling flame.

That oxygen and nitrogen are very injurious to steel and decrease its strength, wearing qualities, etc., is now a recognized fact; that these elements are present in larger quantities than has been previously supposed is also recognized. When titanium is added to the molten metal, it combines with these gases, which otherwise are liable to become occluded in the steel and carries them off into the slag. These gases also form miniature bubbles that, when segregated, form holes large enough to be plainly seen. If segregated in large enough masses they form good-sized blow-holes.

Oxide forms when oxygen comes in contact with iron, and is present in very small black specks throughout the steel. This oxide can only be seen when the surface has been perfectly polished and magnified at least 1000 times. It is invariably found in steels that produce blisters when pickling, and this leads to the conclusion that the blisters are formed by the reduction of oxide by the nascent hydrogen evolved during the pickling process. High-carbon steel rods that contain the same impurities occasionally fracture in the pickling bath, and doubtless the same pressure that blows a blister in mild steel will cause a rupture in hard steel.

Owing to the gaseous nature of both oxygen and nitrogen, it has been difficult to analyze steels for these contents. Some recent investigations, however, showed that the percentage of oxygen in some twenty-four samples of steel ranged from 0.021 to 0.046 per cent. These percentages may seem to be so extremely small that they could be ignored. But the amount of an element present, however, should not alone be considered, when judging its influence on steel; the combinations that the element forms should be taken into consideration. When mention is made of 0.05 per cent of sulphur, it is in reality the 0.13 per cent of manganese sulphide that affects the quality of the metal. Oxygen has only half the atomic weight of sulphur and is capable of forming larger quantities of compounds; therefore, it exerts a greater influence. Thus where 0.05 per cent of sulphur corresponds to 0.13 per cent of manganese sulphide, 0.05 per cent of oxygen corresponds to 0.22 per cent of ferrous-oxide. This percentage is therefore high enough to very materially affect the qualities of steel.

It was shown by some recent investigations that at first an increase of nitrogen causes the toughness of steel to slightly increase, but reduces its ductility; each increase of nitrogen causes the elongation to rapidly diminish. When the nitrogen content reaches 0.030 to 0.035 per cent, there is, practically speaking, no further elasticity and the metal becomes absolutely brittle. Steel with 0.5 per cent carbon loses its ductility in the presence of 0.040 to 0.047 per cent of nitrogen. In a one per cent carbon steel, the elongation and contraction become nil when the nitrogen content reaches 0.03 to 0.035 per cent. In the softer steels, this happens when the nitrogen content reaches 0.05 to 0.065 per cent, and in the very soft steels, with about 0.08 per cent of nitrogen.

Open-hearth steel usually contains from 0.020 to 0.025 per cent of nitrogen; Bessemer steel from 0.018 to 0.062 per cent; and crucible steel runs from 0.010 to 0.015 per cent in nitrogen. Thus, a nitrogen content of at least 0.012 per cent must nearly always be reckoned with. Steels made in the resistance electric furnace are an exception to this, as they are practically free from nitrogen. Steels, however, that are made in the arc electric furnaces, in the presence of basic slags, are liable to contain injurious amounts of nitrogen.

Titanium has a very strong affinity for both oxygen and nitrogen; it forms with oxygen an oxide, and with nitrogen, a stable nitride that shows as tiny red crystals under the microscope. Both of these are then carried off into the slag and the quantity of slag that is lifted from the molten metal is quite materially increased. The deoxidation of steel is usually accomplished with manganese and silicon, but these never remove the oxides and occluded gases as thoroughly as is desired. Titanium is a much more powerful deoxidizer than either or both of these; when added to steel at the time of tapping, it completes their unfinished work and reduces the oxygen and nitrogen to mere traces. If a greater amount of titanium is used than is needed to remove the oxides and nitrides, it will afterward attack the sulphur and phosphorus and if it does not remove them, it counteracts their injurious effects upon the steel. The phosphorus may be made to pass into the slag as phosphate of titanium by using special means. The reaction of titanium on the sulphur has a tendency to carry it off in the form of a sulphide or sulpho-cyanide of titanium. Cupro-ammonium etching tests show the low sulphur and phosphorus content of titanium treated steel.

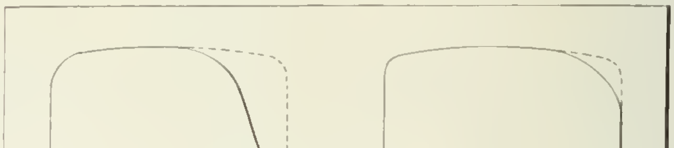

Fig. 2. Ordinary Bessemer Steel Rail as worn in Nine Months. Fig. 3. Titanium-treated Bessemer Steel Rail as worn in Nine Months on the Same Curve

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The very energetic reaction of the titanium and nitrogen takes place at a temperature of about 1475 degrees F. The good effects of their union can easily be lessened by a careless shutting off of air, thus permitting the formation of titanium and nitrogen combinations that are of no value.

How easily nitrogen finds its way into steel is shown by a heat of Bessemer steel that had been over-blown three minutes. This was found to contain 0.032 per cent of nitrogen, whereas the normal steel contained only from 0.012 to 0.022 per cent. Another heat of Bessemer steel containing from 0.013 to 0.014 per cent of nitrogen was treated with one per cent of titanium and this reduced the nitrogen to from 0.004 to 0.005 per cent.

When possible, it is always best to add the ferro-titanium to the steel while it is being tapped into the ladle, and after the ferro-manganese has been added. It is lighter than iron and would not sink and disseminate if it were added near the top; hence, it should be shoveled in gradually while the steel is flowing into the ladle. Titanium treated steels should be held in the ladle for from 5 to 15 minutes before pouring, in order to allow the titanium to do its work and scavenge out the oxygen and nitrogen. It is difficult to influence steel makers to hold the steel that long in the ladle, as without the titanium it would become chilled in a much shorter time. Titanium, however, raises the temperature and the metal is in better condition for pouring after standing than before. Owing to an accident, one ladle had to be held 20 minutes after tapping and adding the titanium and it was then found to be in better condition for teeming into ingots than the ordinary steel that is teemed as soon as the ladle is filled. This is a statement that is very difficult to make steel makers believe; but the evidence is very conclusive and can easily be obtained.

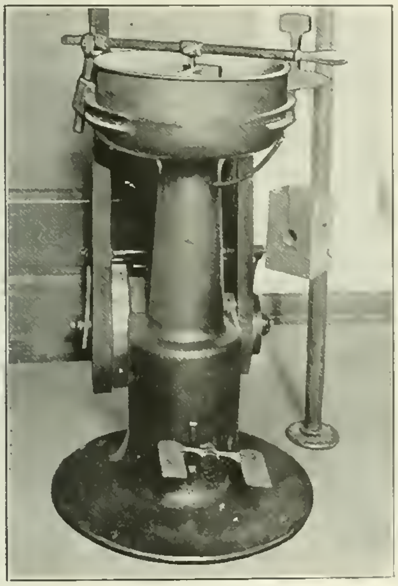

Fig. 4. Testing Rail Section for Abrasive Wear, in a Special Machine

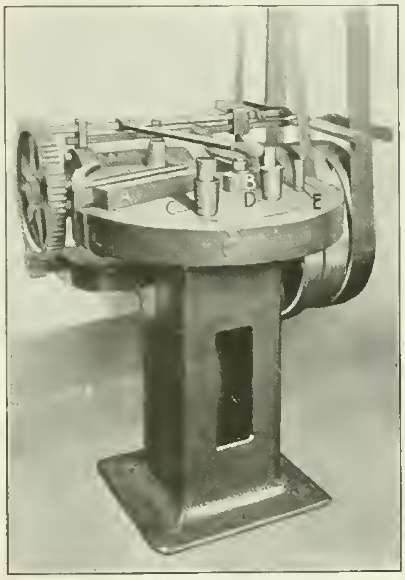

Fig. 5. Machine for Making Bending Test on Titanium-steel Bars

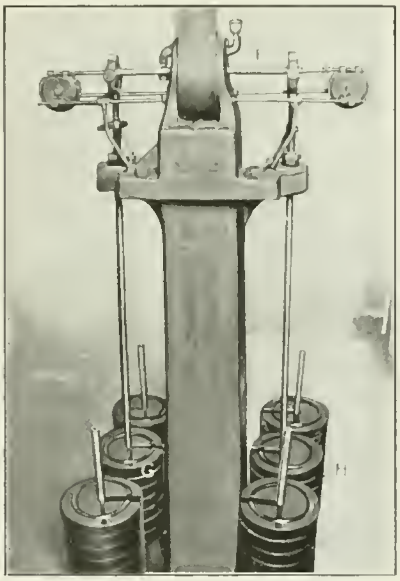

Fig. 6. Testing Endurance of Titanium Steel in a White-Souther Rotary Vibrational Testing Machine

When commencing the use of titanium, one per cent should be added to the bath; this can gradually be reduced until the beneficial results obtained reach the high point and begin to diminish. In most cases one-half of one per cent is all that can be made to benefit the metal. In manufacturing Bessemer steel rails, this latter percentage only increases their cost about $1.50 per ton. It is antagonistic to aluminum and the two should never be used together, for aluminum adds brittleness to steel, while titanium removes brittleness.

By removing the oxygen and nitrogen, titanium prevents the formation of blow-holes in steel. This is well illustrated by the two pieces shown in Fig. 1. The one containing blow-holes was cast without any titanium, while the piece without blow-holes was cast from the same metal after 0.5 per cent of titanium had been added. The reaction of the titanium raises the temperature of the bath and makes it more liquid by freeing it from the free oxide and slag. This allows the metal to subside in the mold while cooling and the pipe is smaller and flatter. The metal invariably lies dead in the ingot molds and does not boil. By removing the occluded gases and slag from steel, titanium increases the density of the metal and retards any tendency towards segregation, thus making a much more homogeneous metal. It also increases the tensile strength, elastic limit, contraction, transverse strength and ductility of steel. It greatly improves its resistance to frictional or abrasive wear, and resistance to shock, torsional and impact strains.

Tests of Titanium Steel

One example of its ability to withstand torsional strains was obtained by twisting through seven complete revolutions, a bar four feet long and one and one-eighth inch square; there was no sign of a fracture. The Brinell hardness test shows a titanium treated steel to be softer than one not treated with titanium, and this is doubtless due to the finely divided ferrite net-work.

One recent test of some structural steel showed that before it was treated with titanium, it had a tensile strength of 67,000 pounds per square inch and an elastic limit of 42,000 pounds, the elongation being 24 per cent and the contraction, 40 per cent. After this same metal had been treated with 0.50 per cent of titanium, the tensile strength was 77,120 pounds per square inch, the elastic limit, 51,750 pounds, the elongation, 25 per cent and the contraction, 43 per cent.

Another heat of steel that was rolled into billets and then into iron rods of slightly less than ¼ inch diameter, gave a tensile strength of 114,400 pounds per square inch, an elastic limit of 91,000 pounds per square inch, an elongation of 28 per cent, and a contraction of 52 per cent; ordinarily, 90,000 to 95,000 pounds per square inch is the tensile strength of this metal. This 20 per cent increase in tensile strength was doubtless due to the titanium removing the occluded gases and slag.

The resistance of titanium steel to abrasive or frictional wear is well shown by comparing the steel rails illustrated by Figs. 2 and 3. In Fig. 2 is shown an ordinary Bessemer rail that was laid October 7, 1908, and measured July 8, 1910, to get the shape as shown and thus show the amount of wear. Fig. 3 shows the shape of a titanium treated Bessemer rail that was laid next to that shown in Fig. 2, on the same date and measured on the same date. The ordinary Bessemer rail lost 7.03 pounds per yard during the 9-month wear, while the titanium treated rail only lost 1.39 pound per yard. Another method of testing for abrasive wear is performed with the machine shown in Fig. 4. This shows a section of a steel rail placed upon the top of a revolving plate, coated with abrasives, in the top of the machine, and held down by a lever. On the handle of this lever a block of iron of known weight is hung, as shown.

Titanium treated steels have recently been extensively tried for gears, plates, rolls, tires, castings, etc., and they have almost invariably shown a reduction of brittleness and an increase of durability. One method of testing this is shown by the machine in Fig. 5. In this test, bar *A* is held in the machine and bent around a 1-, 2- or 3-inch center, as the case may be, located at *B*. Different sized centers are shown at *C*, *D* and *E*.

A steel that contained 0.25 per cent of carbon, 0.30 per cent manganese, 0.40 per cent silicon, 0.04 per cent phosphorus, and 0.03 per cent of sulphur, would frequently crack in many directions when forged under a hammer at a bright red heat. When this same steel was treated with 0.030 per cent of titanium it worked down smoothly and evenly without a flaw. Good results might be obtained if the manganese and silicon were reduced by nearly 50 per cent and the sulphur and phosphorus slightly increased.

The endurance of titanium treated steel has been well demonstrated by tests that were given it on the White-Souther rotary vibrational testing machine shown in Fig. 6. An open-hearth steel that contained 0.25 per cent carbon, 0.64 per cent manganese, 0.425 per cent silicon, 0.04 per cent phosphorus, and 0.035 per cent sulphur, withstood 2,660,000 revolutions at a fiber stress of 38,870 pounds. After this same steel had been treated with titanium, it was given 4,052,200 revolutions at the same fiber stress, namely, 38,870 pounds. The stress was then increased to 40,600 pounds and the piece stood 10,800,700 additional revolutions without a fracture. The fiber stress was again increased to 42,400 pounds and the piece given 1,918,600 more revolutions. The stress was increased a third time to 44,200 pounds and the piece was given an additional 1,006,300 revolutions before it broke. This was a total of 18,274,900 revolutions for the titanium steel, many of which were given it at an increase of fiber stress, as against 2,660,000 revolutions of the untreated steel.

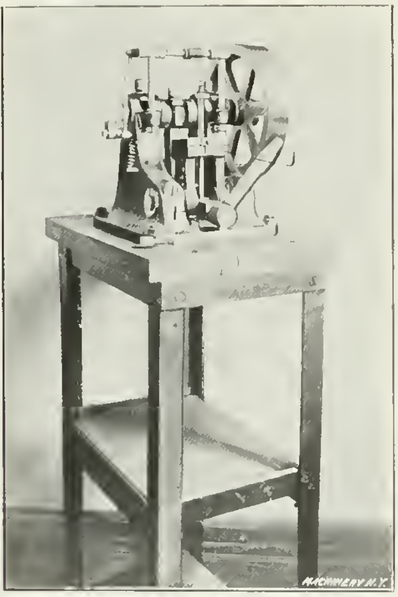

Fig. 7. Testing Titanium Steel by subjecting it to Alternating Vibrational Strains

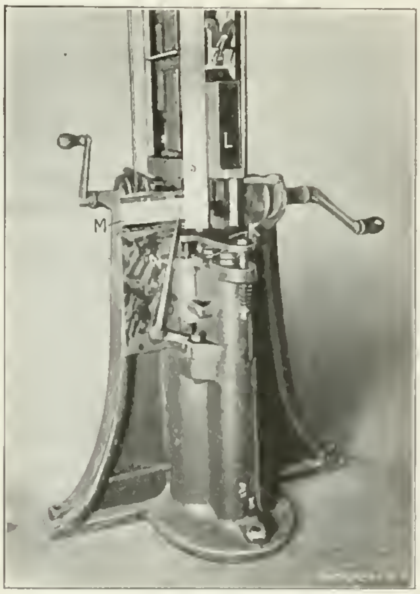

Fig. 8. Machine for giving Impact Tests to Steel

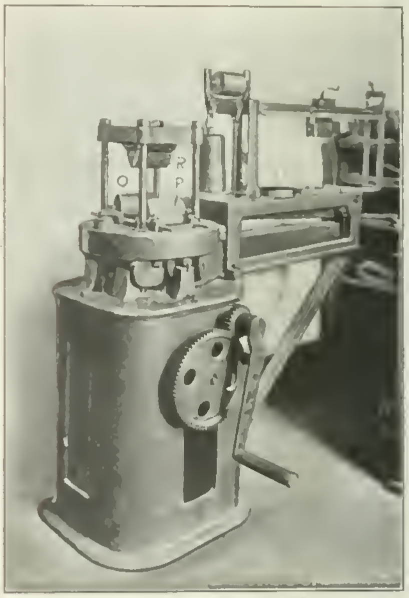

Fig. 9. Machine for Testing the Strength of Titanium-treated Cast Iron

For these tests a bar is placed in the machine as shown at *F*, and revolved by the belt and pulley while the weights located at *G* and *H* give it the fiber stress. As it is well known that iron is ductile in proportion to its purity, this increase in rotary vibrational strains can only be attributed to the purifying properties of the titanium which by removing the oxygen, nitrogen, etc., increases the cohesive force between the molecules and makes the steel more homogeneous. In increasing the ductility it does not soften the metal enough to weaken it, but on the contrary increases its strength. By removing the occluded gases and other impurities it also increases the resistance of the steel to corrosion.

Alternating vibrational strains are given the metal by the machine shown in Fig. 7. In this the test piece is held at *I* while the part of the machine shown at *J* is rocked back and forth to alternately bend the sample ¼ inch either way from the vertical. This also has given some very good results for titanium steel. Both machines have a cyclometer attached to register the number of revolutions or alternations given the sample.

Impact tests are given the steel by the machine shown in Fig. 8. In this, only the lower part of the machine could be shown, as it passes through the floor. The upper part is only a guide for the weight and, in this machine, extends 20 feet above the platen. The test piece is placed on platen *K*, and weight *L* is dropped on it, from a given height. When weight *L* strikes the test piece, the springs under platen *K* give, and pointer *N* registers the foot-pounds of the blow, on dial *M*.

Some tests on titanium treated steel rails that were 85 pounds to the yard, were conducted in a similar way. Rails were cut up into 3-foot 6-inch lengths, laid on supports three feet apart, and a weight of 2000 pounds dropped on them from a height of 17 feet. Three blows were given on the head and the deflection measured. Then the rail was turned over and the fourth and fifth blows were given on the base. Table 1 gives the results of these tests.

Titanium in Tool Steels

Titanium treated steel can be made by the crucible process and only increases the cost of the metal $2.50 per ton when one per cent of titanium is used. This, with the properties given steel by titanium, caused some experiments and tests to be conducted on tool steels in Sheffield, England. In these, enough titanium was used to give 0.25 per cent and 0.35 per cent of the titanium in the finished steel. An ordinary tool steel with a tensile strength of 127,000 pounds per square inch was used. Six lathe tools were made from it before the titanium was used. The metal was then treated with titanium and six more tools made. One tool with titanium and one without turned the same bar at the same time. Thus tools 1 and 3, 5 and 7, and 9 and 11 were used together and

TABLE I DROP TESTS OF RAILS

Number of Drop				
1	2	3	4	5
Deflection in Inches			Condition	
1.3	2.5	3.5	Straight	Broke
1.4	2.5	3.6	Straight	Broke
1.4	2.6	3.9	Straight	Broke
1.5	2.7	4.0	Bent other way	As before
1.5	2.1	4.1	Straight	Broke
1.5	2.1	4.1	Broke	....
1.4	2.7	3.1	Straight	Quite straight
1.4	2.7	4.1	Straight	Broke
1.4	2.2	3.4	Straight	Broke
1.5	2.7	3.9	Straight	Quite straight
1.6	2.9	4.1	Straight	Flange broke
1.6	3.1	4.4	Bent	Flange broke
1.6	3.1	4.2	Bent	Flange broke

tools 2 and 4, 6 and 8, and 10 and 12 were used likewise. The tools were all given the same heat treatment and the results that were obtained are shown in Table II.

In some experiments that were made by tool-steel makers in the Pittsburg district, it was found that if 0.50 per cent of titanium was retained in the steel, it would give cutting tools much greater durability and high-speed qualities. A special method is required, however, to retain any of the titanium in the steel, as its great affinity for oxygen and nitrogen causes it to go off into the slag. By removing the impurities, the titanium causes the metal to heat more slowly in the forge and also to retain the heat longer after it has been worked and become cold. This property of heating more slowly causes the cutting edge to last longer, as the temper is retained longer. The resistance to corrosion will also keep the tools from rusting as readily when laid away.

TABLE II. TURNING TESTS WITH TOOL STEEL

Number of Tool	Titanium Content, Per Cent	Depth of Cut in Inches	Width of Chip in Inches	Speed in Feet per Minute	Minutes Tool was Used	Condition of Tool at End
1	None	1/64	1/4	27	70.0	Blunt
2	None	1/64	1/4	27	71.5	Blunt
3	0.25	1/64	1/4	27	109.2	Blunt
4	0.35	1/64	1/4	27	117.2	Blunt
5	None	1/64	1/5	32	28.2	Blunt
6	None	1/64	1/5	32	42.8	Blunt
7	0.25	1/64	1/5	32	63.3	Blunt
8	0.35	1/64	1/5	32	76.4	Blunt
9	None	1/64	3/32	50	25.4	Blunt
10	None	1/64	3/32	50	70.6	Blunt
11	0.25	1/64	3/32	50	97.2	Blunt
12	0.35	1/64	3/32	50	133.2	Blunt

As steel treated with titanium shows greater resistance to abrasive and frictional wear, it heats up more slowly from friction. Thus whether it be the tool or the work that is treated with titanium, the machine work can be performed more quickly, as the cutting speed can be increased; whether the tools be of the carbon or high-speed kind, makes no difference about increasing the speed. One instance of the slow heating of titanium treated metal was shown in some ingot molds that did not show red in the dark when filled with molten metal; whereas ordinary ingot molds filled at the same time and standing beside them, were distinctly red hot.

TABLE III. TESTS OF GRAY IRON CASTINGS WITH AND WITHOUT TITANIUM

Without Titanium			With 0.5 Per Cent of Titanium		
Sample	Crushing Strength in Pounds	Deflection in Inches	Sample	Crushing Strength in Pounds	Deflection in Inches
1	2,240	0.10	1	3,050	0.09
2	2,260	0.10	2	3,140	0.10
3	2,010	0.09	3	3,150	0.10
4	1,840	0.08	4	3,230	0.10
5	1,970	0.08	5	2,850	0.10
6	2,150	0.10	6	2,990	0.09
Average	2,078	0.09	....	3,068	0.10

Steel castings that have been treated with titanium are more blue in color, freer from blow-holes and brittleness and heat up more slowly from cutting tools than ordinary steel castings; they can thus be machined more easily and rapidly.

The No. 3 Government specifications for cast steel have been difficult to meet without resorting to several heat treatments. They call for a tensile strength of 85,000 pounds per square inch, an elastic limit of 45,000 pounds per square inch, an elongation after rupture of 12 per cent, and a contraction of 18 per cent. By the use of 8 pounds of the 10 to 15 per cent ferro-titanium to a ton of metal, the difficulties have been overcome by one foundry.

In fifteen heats before the titanium was used, the average tensile strength of castings after the first annealing was 81,633 pounds per square inch, the elastic limit was 47,233 pounds per square inch, the elongation 15.1 per cent and the contraction 18.9 per cent.

The fifteen heats after this, that contained titanium, produced castings with an average tensile strength of 91,533 pounds per square inch, an elastic limit of 50,000 pounds per square inch, an elongation of 19.2 per cent, and a contraction of 24.3 per cent. The steel that entered into the castings was made in a Tropenas converter, and was free from blow-holes, homogeneous, and very uniform in its properties.

Very exhaustive tests have been made of the effect of titanium in cast iron and Table III shows the comparison between gray iron as cast without titanium and with 0.5 per cent of titanium added. These tests were made in the machine shown in Fig. 9. The test bar is laid on the supports O and P while block R is forced down on it. The deflection and number of pounds required to break the piece are then measured.

The transverse strength has been increased from 17 to 23 per cent by the use of titanium. It also increases the breaking strains, wearing qualities and hardness in the chill of cast iron; but it decreases the chilling effect.

* * *

INDUSTRIAL CONDITIONS IN SWEDEN

The industrial development in Sweden during the last decade has been very remarkable, and reminds one rather of the booms of the West than of the slow and normal development of an old country. Hydraulic power plants have been built in great numbers, and the industries furnishing the machinery and equipment to these plants have been steadily engaged. The Swedish firms making water turbines and electrical machinery have a high reputation for the quality of their product, and the requirements of the country in these branches are largely met by the local firms. The general industrial development has, of course, had a favorable influence on the machine tool trade, and as the country does not supply the demand in this respect, American and German machine tools have been sold to a considerable extent. The only class of machine tools built in the country in sufficient quantities to meet the demand is lathes, and these are built of such high quality that competition is very difficult. The demand for small tools is also largely met by the manufacturers in Sweden. Milling machines and grinders are the machine tools for which there is the most promising market, and a considerable number of the leading American machines of these classes are seen in the Swedish shops.

Unfortunately, the boom has been somewhat overdone, and in many instances, the past year was not a prosperous one for the Swedish machine shops. This, however, was frequently due to mismanagement and a lack of understanding, on the part of those in authority, of the requirements of modern efficiency in shop practice. Only a few Swedish firms have as yet understood that the secret of success is a specialized manufacture. One large plant builds internal combustion engines, steam engines, boilers, wood-working machinery, kitchen ranges and heaters, and a few other "specialties." Swedish engineers who have received a few years' practical training in American factories are in charge of many of the best shops, and the influence of their American training is clearly in evidence. This, coupled with their native mechanical inclinations, results in a high standard of engineering.

* * *

At the beginning of this year there were about 3000 passenger cars in service in this country, built of all steel construction. The total number of passenger coaches is about 54,600 so that the number of steel cars is about 5.3 per cent of the total. Of the cars constructed during the present year, 62 per cent will be all-steel construction, so that at the end of this year fully 9.3 per cent of all passenger cars will be of steel, while 3.5 per cent have steel under-frames. The percentage of wooden cars in service has dropped in the last three years from 98.2 to 87.2 per cent. According to an estimate in the *Railway Age Gazette*, the cost of replacing all the present wooden cars with steel cars, which has been advocated in some quarters where apparently the magnitude of this undertaking is not fully understood, is estimated at about $630,000,000.

JOINING TIN BY FOLDED SEAMS*

The folding-over process is one of the elementary methods of joining pieces of tin, especially as used in cans; riveting is not satisfactory for this purpose, as it does not hold the pieces in close contact. To overcome this difficulty, the overlapped parts are often soldered; and to make this soldering more effectual, the edges are usually bent over to form a fold. Three classes of joints are formed by this folding-over process—those running lengthwise of cylindrical bodies or frames of tin made from one piece, those formed where the bottom or top of a can is joined to the main body, and finally those formed by a spinning operation on the contact edges of cylindrical bodies.

We will consider first the longitudinal seam: Suppose it is desired to form the body of a four-cornered can, such as that shown at *A*, Fig. 1. The stock is bent around a mandrel to the shape indicated, forming the four corners and overlapping the two edges as shown. This part of the process may be done automatically in modern machines. When the edges overlap, as in this case, they may be clamped securely in one position and the solder applied, but this is a rather tedious process. The most objectionable feature of this method is that the edges of the tin tend to spring apart, requiring to be clamped during the soldering. It is therefore better to put the seam at the corner, as indicated at *B*, but even then the edges have a tendency to slip, notwithstanding the use of clamps. Reversing the relative positions of the lapping edges as at *C*, largely obviates this springing effect, but does not form a neat seam. Therefore, if a neat job is desired, it is advisable to bend both edges as at *D*. In this case the soldering surface is much greater, and in addition, one edge of the seam is invisible. Forming as at *E*, makes a seam that is even less noticeable. Here the solder works into all parts and a very good seam is produced. This double bend may be made in one of the sides, but it has the objectionable feature of being easily sprung open; the formation of a double bend in the side is shown at *F*. To overcome this tendency to spring apart, both bends may be slightly depressed as at *G*, which brings the ridge due to the seam on the outside. At times it is objectionable to have the seam on the outside so a similar seam may be produced on the inner surface of the can, as at *H*. The same type of seam may be applied to circular cans, as indicated at *I*. In the latter case the process may be carried on by automatic machinery; in fact, there is a patented machine in Germany at present, which will produce upward of 30,000 seams in a ten-hour day.

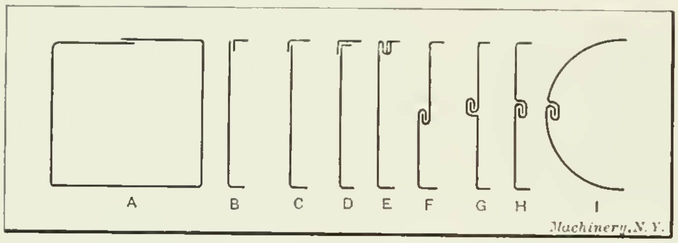

Fig. 1. Types of Longitudinal Seams

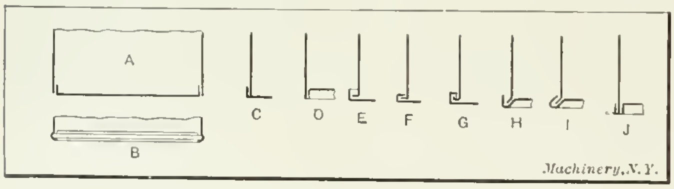

Fig. 2. Types of Soldered Cover Seams

The second type of seam referred to is that which joins the cover to the body of a can; this is illustrated in Fig. 2. It is not customary to solder the cover to the body of the can edge to edge, in the rough state; one edge at least should be bent to form a soldering surface. In Fig. 2 at *A* is shown a cover with its edge bent upward to fit into the body of the can, thus forming a soldering surface. When the bottom of the can is made of especially strong stock, it is possible to join it to the body by pressing the body down over the end after the bottom has been fitted into the body as at *B*. A method similar to that shown at *A* is indicated at *C*, where the upturned edge of the cover is outside of the can body; this is quite a common construction, but it is objectionable in many cases because the bottom is resting on the surface, whereas with a construction such as shown at *D*, the bottom rests on a rim. This latter construction is particularly advantageous for riveting purposes, being much better than that shown at *C*.

The double flare shown at *E* was used to a considerable extent formerly, assuming the shape shown at *F* when sealed. The latter form is obtained by bending over the upturned edge of the cover in a machine, or else by hammering the rim. This construction is not practicable, however, for all receptacles, so for that reason it is modified to the form shown at *G* with the double seam bent back against the body of the can.

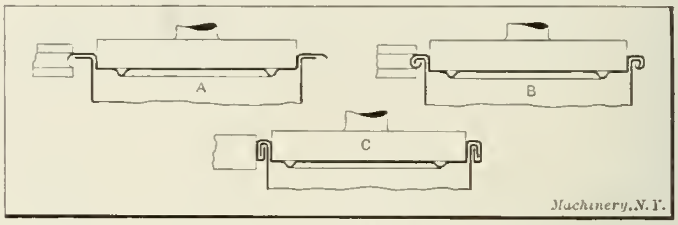

Fig. 3. Successive Stages in Cover Seaming by the Spinning Process

Conical flares, such as those shown at *H* and *I*, are often made. *I* shows the seam closed by bending the upturned edge of the cover back against the conical flare of the body. This is done between two rollers.

When joining very thin pieces of tin, seams are made by spinning as indicated in Fig 3, the successive steps being shown at *A*, *B* and *C*. Grooved rollers of the proper shape spin the metal, forming the seam. This forms such a tight joint that solder is unnecessary, but in most cases the contact surfaces are spread with a thin emulsion or fluid of an organic nature which fills any crevices that may still exist. These seams are usually made, as indicated in Fig. 3, by placing the can and cover vertically between two rapidly revolving disks which rotate it, during which movement the rollers perform their functions.

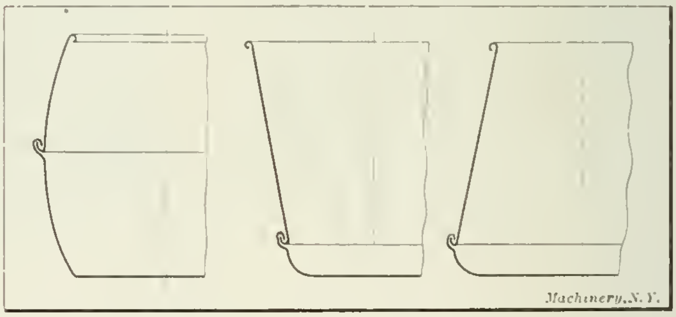

Fig. 4. Types of Bodies that can be Joined by the Spinning Process

During this seaming process, can bottoms are subjected to strain, and for this reason an annular groove is formed in the cover which takes up any spring due to the pressure of the rollers. Not only is this method of seaming applicable to circular bodies, but it may also be applied to square and oblong bodies. Tin cans of complex or fancy shapes can be made by this seaming process in special presses; they are flared and joined in the usual manner. Such cans are shown in Fig. 4.

In all these methods of joining it must be remembered that at the point where the seams come together a small corner of the body should be removed so that there will not be too many thicknesses of tin at that particular point, otherwise the rollers would tend to skip over these places entirely.

* * *

Sometimes when a man gets restless and wants to make a change and go somewhere else, says one of our contemporaries, all that he needs is a vacation and a rest.

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* Abstract of article by A. Bauschlicher in the *Zeitschrift für Werkzeugmaschinen und Werkzeuge.*

MILLING, CROSS-DRILLING AND BURRING ATTACHMENTS*—1

APPLICATION TO THE BROWN & SHARPE AUTOMATIC SCREW MACHINE

By DOUGLAS T. HAMILTON†

The Brown & Sharpe Mfg. Co., Providence, R. I., has designed a number of standard and special attachments for its automatic screw machines. These attachments are used for performing various second operations on a piece of work, such as slotting, milling, cross-drilling and burring, at the same time that another piece is being operated on by the cross-slide and turret tools. Thus extra operations are performed without taking additional time.

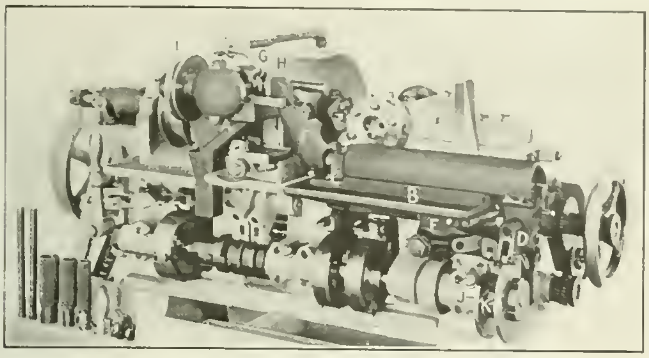

Fig. 1. No. 00 Brown & Sharpe Automatic Screw Machine equipped with a Screw-slotting Attachment

While the attachments—as such—are widely known, the methods of laying out the cams for operating them are no doubt unfamiliar to a large number of operators and mechanics in general, and, therefore, a description of the methods of laying out the cams for slotting, cross-drilling and burring should be of general interest. The first and best-known attachment designed by the Brown & Sharpe Mfg. Co. was its screw-slotting attachment, which is shown attached to a No. 00 automatic screw machine in Fig. 1. Assembly views of this attachment are shown in Fig. 2.

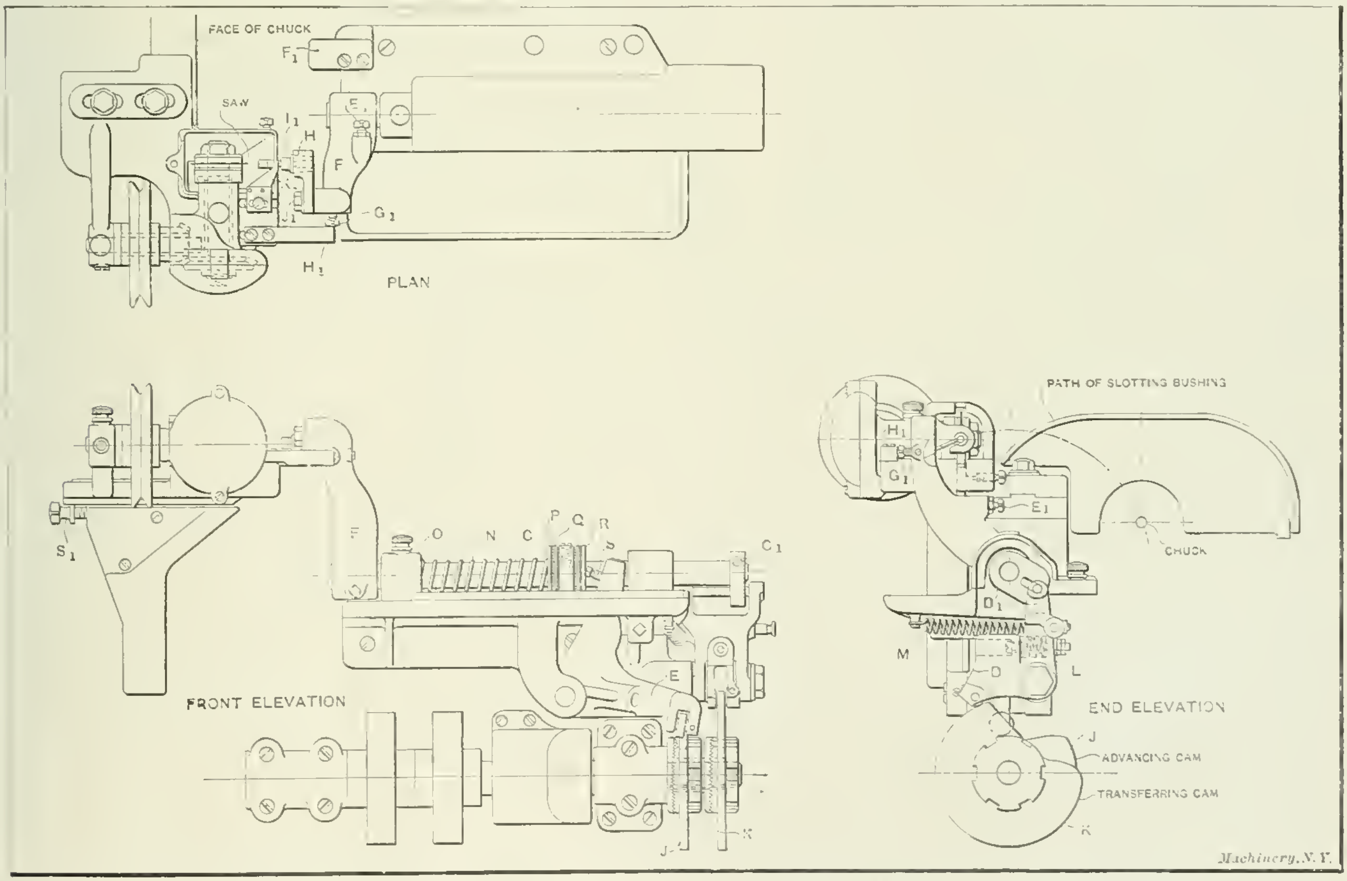

Fig. 2. Assembly Views of the Screw-slotting Attachment for the No. 00 Brown & Sharpe Automatic Screw Machine

Screw-slotting Attachment for the No. 00 Machine

The screw-slotting attachment shown at *A* in Fig. 1 is fastened to a boss, provided for this purpose, on the machine, by two cap-screws. An apron *B*, which is also an additional part, carries the arbor *C* to which the transferring arm *F* is attached. The transferring and advancing cam levers *D* and *E* are also fastened to bosses on this apron by cap-screws as shown. These levers are operated by the advancing and transferring cams *J* and *K*. A block *H* is fastened to the arm *F*, and a slotting bushing or carrier for the screw is driven into it. This bushing grips the screw and holds it while the slotting saw *G*, held on an arbor and driven by a pulley *I* through bevel gears, mills the slot in the head. The pulley *I* is driven by a $\frac{3}{8}$-inch round belt from the overhead works.

A clearer idea of the working mechanism of this slotting attachment can be obtained by referring to Fig. 2 where the transferring and advancing cams, as well as the levers operated by them, are more clearly shown. The transferring lever *D* is kept in contact with the cam by means of two springs *L* and *M*. The advancing lever *E* is kept in contact with the advancing cam by the spring *N*, located on the transferring-arm rod *C*. This open-wound spring presses against the boss *O* on the attachment and the washer *P*, this latter being held up against a ball retainer *Q* which, in turn, is forced against a washer held to the arbor *C* by a cone-pointed screw. The lever *E* does not bear directly against the thrust-washer *R* to advance the arm, but holds a set-screw *S* which can be adjusted in and out and locked with a headless screw. This screw *S*, in conjunction with the screw S_1, is used for varying the depth of the slot in the head of the screw.

The transferring lever *D* is connected to a block D_1, which is fastened to the rod *C* by a screw C_1. This block connects arm *F* with lever *D*. The arms of lever *D* and the arm *F* are so proportioned that a small rise of about $1\frac{1}{8}$ inch on the cam in this case is sufficient to carry the slotting bushing from the chuck up to the saw through the path indicated in the engraving. When arm *F* drops down into a position in front of the chuck, it is stopped at the desired point by a set-screw E_1, which rests on a block F_1, attached to the machine. When the arm moves up into a position in front of the saw, it is stopped by a set-screw G_1, which bears against a block H_1, fastened to the attachment. The set-screws G_1 and E_1 are used for setting the slotting bushing accurately. The slotting bushing is shown at I_1 in position in block H. The shank of this bushing is tapered one-half inch to the foot and is driven into the block. Block H is held to the arm by a cap-screw J_1. When the slot in the screw has been cut and arm F drops back, the screw is removed from the bushing, which has a slot cut in it, by the ejector K_1, which is simply a piece of sheet steel fastened to the attachment.

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* For previous articles on screw machine work, see MACHINERY, January, 1911, "External Cutting Tools."

† Associate Editor of MACHINERY.

Laying Out a Set of Cams for a Screw-slotting Operation

Undoubtedly the method of setting and operating this screw-slotting attachment can best be described by taking a practical example. Suppose it is necessary to make the shouldered steel screw shown at A in Fig. 3 on a No. 00 Brown & Sharpe automatic screw machine. To proceed, first design the cross-slide and turret cams, making allowance for one empty hole in the turret, thus enabling the transferring arm to drop down and pick up the screw while it is being cut off. It will not be necessary to describe the method of laying out the turret and cross-slide cams, as this has been described previously,* so we will confine our attention to the calculations necessary in laying out the transferring and advancing cams for removing and slotting the screw.

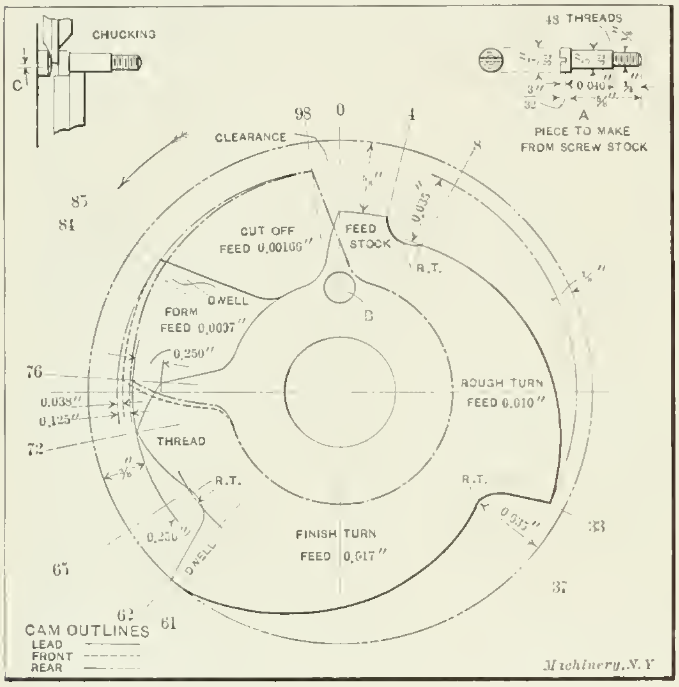

Fig. 3. Turret and Cross-slide Cams for Making a Steel Screw

Before proceeding with the laying out of these cams, it is necessary to make a diagram such as is shown in Fig. 4. Here a diagrammatical view of the necessary movement of the transferring and advancing levers is shown. To the right of the illustration is a diagram of the movement of the transferring arm and lever. For the slotting attachment, the transferring arm does not have to dwell at any intermediate point between the chuck and the slotting saw, so that no calculation is necessary to find the rise on the cam—the full rise or 1⅛ inch being sufficient to lift the slotting bushing from the chuck to the slotting saw. To the left of the illustration is a diagram in which is indicated the least and greatest possible distances between the face of the turret and the chuck, and also the position of the screw-slotting arbor relative to the chuck. Below this, the transferring arm is shown in position on the screw. Here it can be seen that the lobes for placing the bushing on the work and advancing it to the saw will be of the same height, as the distance 3/32 inch is considerably less than the adjustment provided for the screw-slotting attachment; this adjustment is equal to 5/16 inch on each side of the center line.

When the rises or the heights of the various lobes on the cams have been determined, the next problem is to determine their relative positions, or, in other words, the starting and finishing points of the lobes on the transferring and advancing cams, respectively.

Laying Out the Transferring and Advancing Cams

The location hole B in the cam shown in Fig. 3 is not used in the transferring and advancing cams, so that these cams, when made, can be shifted around to the desired position. However, it is best to start from some predetermined point when laying out the cams. After considerable experience in this class of work, the writer has found that less confusion will result if the point at which the piece breaks off is used for the point at which the bushing should be located on the work. This, of course, cannot be determined exactly, but it is easy to locate it approximately.

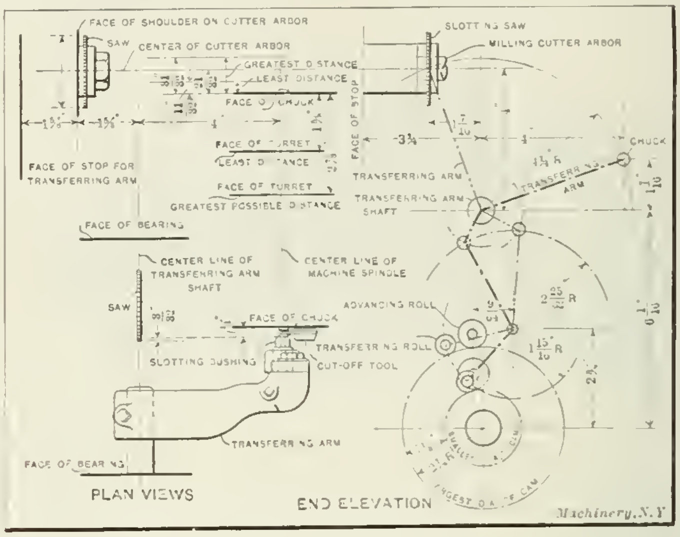

Fig. 4. Diagram used in determining the Rises on the Transferring and Advancing Cams

The method of determining this is as follows: Taking the screw shown at A, Fig. 3, as an example, we will assume that the screw would break off when the teat was about 0.012 inch in diameter; then, assuming that thickness of cut-off tool blade equals 0.061 inch, length of bevel on cut-off tool or distance C (see Fig. 3) equals 0.020 inch, and amount to pass center equals 0.005 inch, we find that the distance the point of the cut-off tool will have to travel after the piece breaks off equals 0.025 + 0.006 = 0.031 inch. To find the hundredth line on the cam circle, divide the rise by the feed per revolution

$$\text{per revolution} = \frac{0.031}{0.00166} = 10.87 \text{ revolutions} = 3 \text{ hundredths.}$$

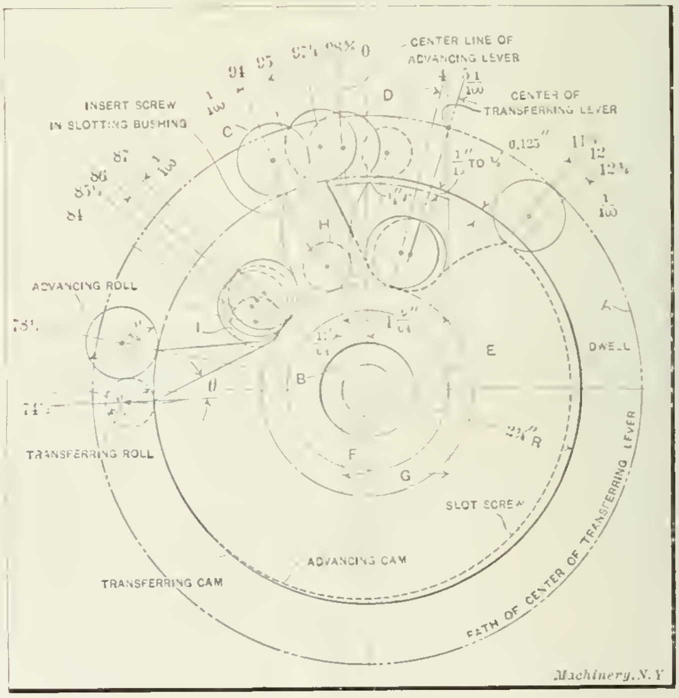
CENTER LINE OF ADVANCING LEVER
CENTER OF TRANSFERRING LEVER
INSERT SCREW IN SLOTTING BUSHING
94
95
0
4
D
C
0.125"
11
12
87
86
85
84
H
ADVANCING ROLL
75
E
DWELL
74
B
TRANSFERRING ROLL
F
G
SLOT SCREW
ADVANCING CAM
TRANSFERRING CAM
PATH OF CENTER OF TRANSFERRING LEVER
Machinery, N.Y.

Fig. 5. Illustration showing Method of laying out Transferring and Advancing Cams

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* See "Designing Screw Machine Cams and Tools," MACHINERY, August, 1910.

Therefore we assume that the screw will break off when the center of the cross-side roll is at 95 hundredths. As this is where the screw will break off, it is necessary to have the bushing on the work previous to this; if we add 1/100, it will be sufficient.

Having determined the point where the slotting bushing should be located on the work we can proceed to lay out the transferring and advancing cams. The method of laying out these cams is shown in Fig. 5. As previously determined, the advancing cam is not cut down below the outer circumference except for the rise for feeding the screw to the saw and dropping back, so a circle is drawn with a 2¼-inch radius as shown, which represents the largest diameter of the cams. A circle *A*, representing the path of the center of the transferring lever, is next drawn. Then a vertical line *B*, representing the path of the center of the advancing cam, is drawn. When this line and circle have been drawn, we have the relative positions of the transferring and advancing rolls. The transferring roll is ½ inch in diameter, while the advancing roll is ¾ inch, on the No. 00 machine only.

To find the starting and finishing points on the cams, proceed as follows: Draw a circle *C* representing the advancing roll on the hundredth line marked 94; then draw a quick-rise on the cam with a 1½-inch radius. As the screw will be severed from the bar at 97¼ hundredths, this is the finishing point of the lobe for placing the screw in the slotting bushing. Next construct the quick-drop on the cam and draw another circle *D*, 1/16 inch below the largest diameter of the cam, so that the arm will drop back from the chuck before it begins to rise.

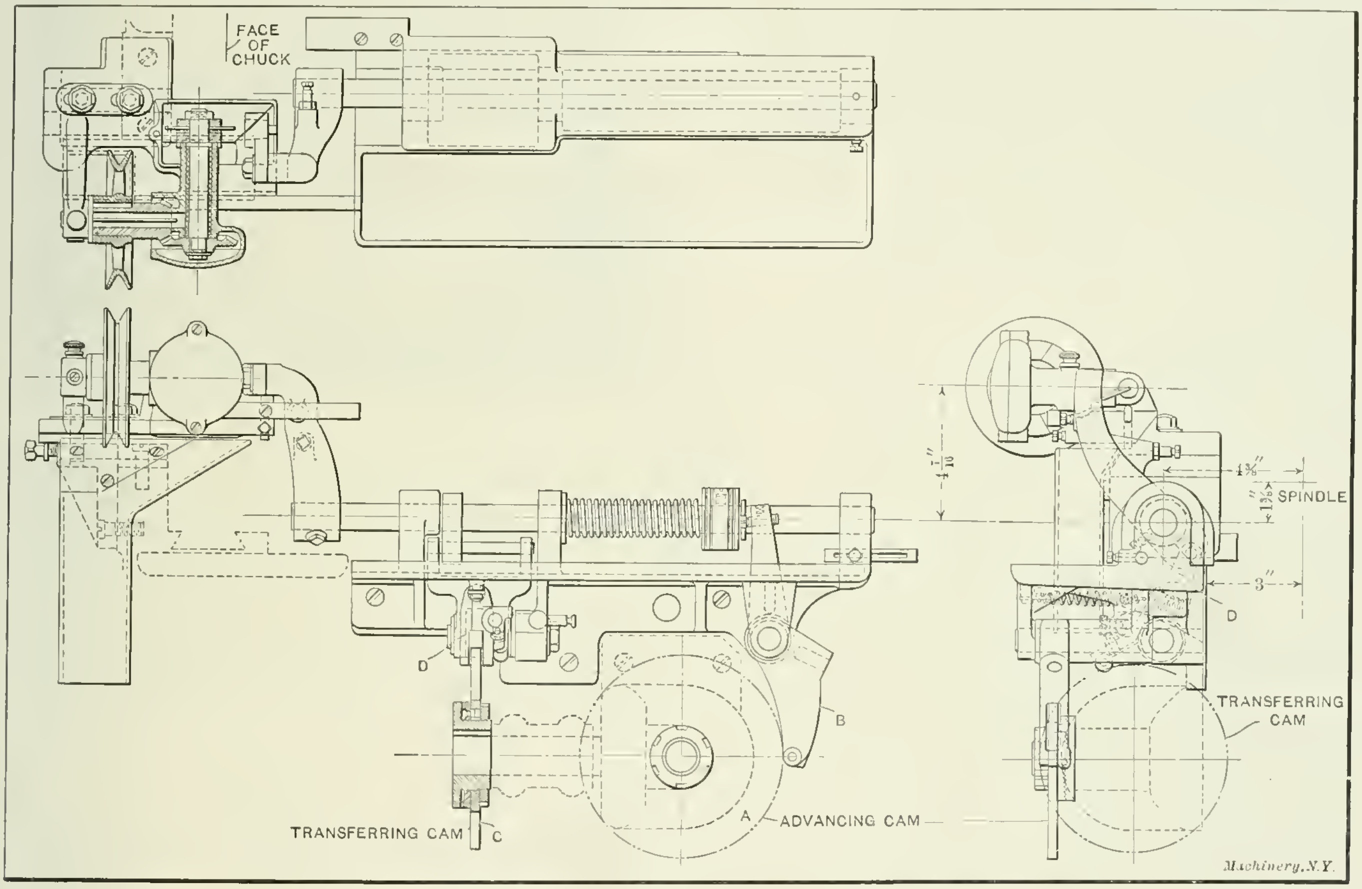


Fig. 6. Screw-slotting Attachment for the No. 0 Brown & Sharpe Automatic Screw Machine

Now, to determine the position of the transferring roll, draw two circles *E* and *F* of such diameters that the distance *G* equals the relative distance between the center of the transferring arm lever and the path of the center of the advancing lever; these levers swing through arcs in planes at right angles to each other.

To obtain the center of the transferring lever, relative to the path of the advancing lever, draw a line through the center of the circle *D* and tangent to the circle *F*. Then draw another line tangent to the circle *E* and parallel to the line which is tangent to the circle *F* and passes through the center of the circle *D*. The point where the last drawn line cuts the circle *A* will be the center of the transferring lever. With this point as center and the compasses set to the radius of the transferring lever, strike an arc, and with its center on this arc draw the transferring roll circle *H*, touching the smallest diameter of the cam. The quick-rise on the transferring cam is then constructed, and the finishing point of this rise is made with a ¼-inch radius, so that the speed at which the arm is traveling will be decreased as it approaches the top of its travel. If this is not done, the arm will hit the stop and rebound, which will have a tendency to knock the screw out of the slotting bushing. When the transferring roll is on the highest point of the cam, the advancing roll should be at the bottom. A clearance of 1/100 is allowed between the point when the transferring roll is on the top of the cam, and the point when the advancing roll begins to advance the screw to the saw. The starting and finishing points of the lobes on the advancing cam for advancing the screw to the saw are constructed in a manner similar to that just described.

Nothing will be gained by dropping the arm down to pick up another screw before the teat has been reduced sufficiently so that the screw can be removed; hence as much of the cam surface as possible is used for slotting, thus preventing forcing the feed too much. To find the finishing point, we work backward, as it were, and locate the transferring roll at the base of the cam, as shown at *I*; then draw the quick-rise at an angle θ, which should be from 15 to 20 degrees for the No. 00 automatic screw machine. When this angle is drawn, we then have the finishing point on the transferring cam. The finishing point of the advancing cam is found by laying out the rolls in their respective positions, in the same manner as before, care being taken to retain the correct relations between the center of the transferring lever and the path of the advancing lever. This problem may seem to be rather complicated at first, but after some practice it will be found to be simple enough. A rise of 0.125 inch is generally allowed on the advancing cam, so that all sizes of screws within the range of the machine can be slotted with this same set of cams.

Screw-slotting Attachment for the No. 0 and No. 2 Machines

The principle on which the screw-slotting attachment for the No. 0 and No. 2 machines works does not vary from that used on the No. 00 machine, but the advancing and transferring cams are located differently. On the No. 00 machine, these cams are held side by side on the front cam-shaft, while in the No. 0 and No. 2 machines, the advancing cam is held on the stud which holds the lead cam, while the transferring cam is held on the front cam-shaft. The movement of the levers, of course, in this case differs from that on the No. 00 machine. Referring to the illustration Fig. 6, which shows the attachment used on the No. 0 machine, *A* is the advancing cam and *B* the advancing cam lever; *C* is the transferring cam, and *D* the transferring lever. The method of carrying the screw to the saw is similar to that on the No. 00 machine, as are also the other movements, so that this will not need further description. It is, however, necessary to describe the method of laying out the transferring and advancing cams.

The method of laying out the transferring and advancing cams is illustrated diagrammatically in Fig. 7 where the advancing and transferring levers, as well as the cams, are shown in the same plane. The method of finding the starting and finishing points of the lobes on the transferring and advancing cams is the same as that used for the ordinary cross-slide and lead cams. The only point to remember is to retain the proper distances between the centers of the levers, and to swing them into their proper positions. A templet could be made for these cams, which would simplify the problem of laying out the starting and finishing points. A templet of this type was illustrated and described in the November, 1910, number of MACHINERY. However, when a templet is not available, the method previously described for the No. 00 machine can be used; that is, keeping the center distances in the same relation, in their respective paths, and swinging the rolls into the desired position.

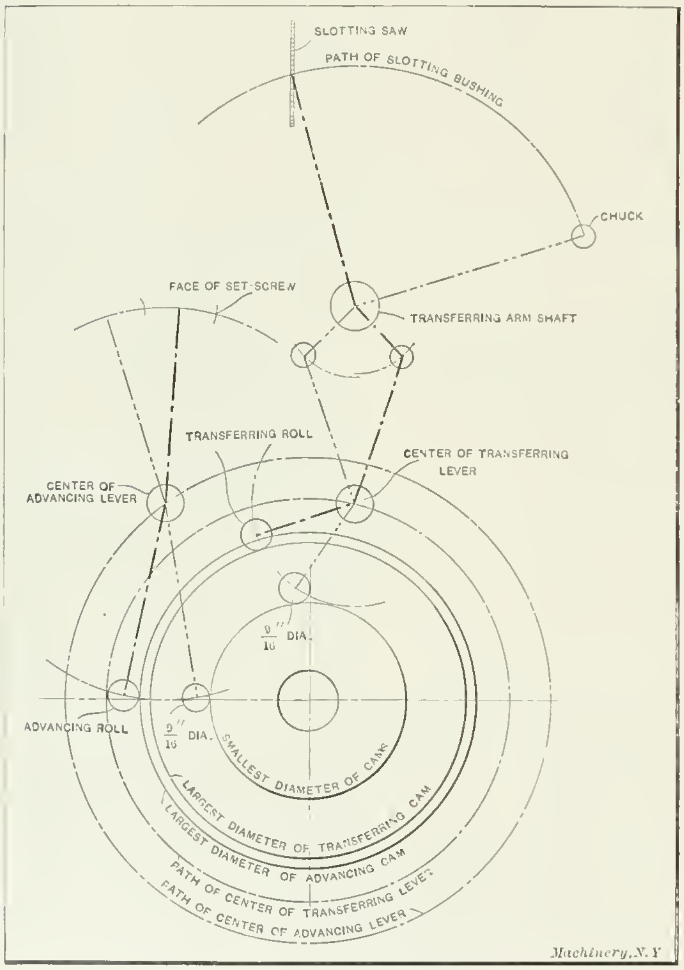

SLOTTING SAW
PATH OF SLOTTING BUSHING
CHUCK
FACE OF SET-SCREW
TRANSFERRING ARM SHAFT
TRANSFERRING ROLL
CENTER OF TRANSFERRING LEVER
CENTER OF ADVANCING LEVER
$\frac{9}{16}''$ DIA.
ADVANCING ROLL
$\frac{9}{16}''$ DIA.
SMALLEST DIAMETER OF CAMS
LARGEST DIAMETER OF TRANSFERRING CAM
LARGEST DIAMETER OF ADVANCING CAM
PATH OF CENTER OF TRANSFERRING LEVER
PATH OF CENTER OF ADVANCING LEVER
Machinery,N.Y

Fig. 7. Diagram used in laying out Transferring and Advancing Cams for the No. 0 Brown & Sharpe Automatic Screw Machine

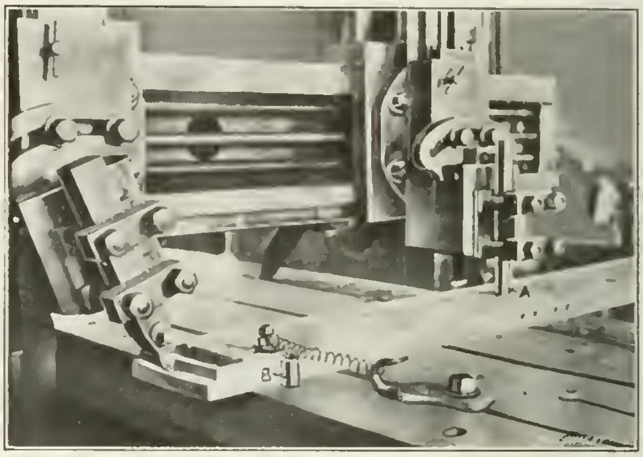
The screw-slotting attachment for the No. 2 Brown & Sharpe automatic screw machine does not differ from that for the No. 0 machine. The transferring cams in both these machines are made in two pieces, as it would be impossible otherwise to assemble them on the front cam-shaft. As there are no intermediate points at which the transferring arm is to dwell between the chuck and slotting saw, there are no calculations necessary for determining different heights on the transferring cam, the rise from the lowest to the highest point of the cam being sufficient to lift the screw from the chuck to the slotting saw.

The diagram shown in Fig. 4 should be laid out so that all the dimensions required for laying out the height of lobes on the cams can be found. It is always advisable to allow at least one-hundredth of the cam surface for clearance, between the starting or finishing points of the lobes on the transferring or advancing cams. This allows the transferring arm to become steady before the direction of its motion is changed.

* * *

METHOD FOR PLANING A CIRCULAR ARC

The accompanying illustration shows a method used in the shop of the Thompson Grinder Co., Springfield, Ohio, for planing a surface, having the shape of a circular arc, on the end of the tables of the grinding machines manufactured by the company. The method by means of which this is accomplished is simple and is clearly shown in the illustration. A plug *A* held in one of the tool-holders on the cross-rail enters a hole in the center of the grinding machine table and acts as a pivot about which the table can swing when actuated by the motion of the platen. The swinging motion is given to the grinding machine table by means of a stud *B*, inserted into the platen, which forces the grinding machine table to move past the planer tool each time the platen moves forward. A spring attached to a stud in one of the T-slots in the grinding machine table holds it against the stud on the return stroke. The simplicity and effectiveness of this method will undoubtedly appeal to mechanics.



A Simple Method for Planing a Circular Arc

* * *

The successful termination of the "ocean to ocean" journey of the "Pioneer Freighter" built by the Saurer Motor Co., New York, marks one of the important steps in the advance of the practical application of the motor car to commercial purposes. The truck carried a load of 3½ tons, its capacity being 5 tons. One of the interesting features in connection with this trip was that the truck arrived in New York from the Pacific coast with the original set of tires, and considering the kind of roads the truck had encountered, this must be admitted to be a remarkable performance. In many places the truck was run for a mile or more on the ties of the railway track, in the absence of better roads. Part of the way it was run across prairies where no road existed.

* * *

Among the most refractory metals known we have platinum, with a melting point of 1775 degrees C. (3227 degrees F.), yet platinum alloys with tin and lead at a temperature of the melting points of these two metals. Many a young chemist has undergone the sorrowful experience of accidentally getting a small amount of these metals into his beautiful new platinum crucible, and seeing a hole form in the crucible when it was heated. The fact is simply that the high melting point of the platinum does not protect the crucible from the dissolving action of the metals mentioned.—*Dr. Hans Goldschmidt in Reactions.*

MACHINE SHOP PRACTICE

THE MAKING OF REAMERS—3

By J. C. CUSTER

A slender reamer should be supported in the middle when fluting, because nothing will ruin the edge of a cutter as quickly as work that springs or "gives" under the strain of the cut. Milling machines are generally provided with a support or jack for such purposes, but for supporting short work, such as taper pin reamers, a "home-made" block sometimes answers the purpose better. Such a block—an adjustable wedge—is shown in Fig. 10. Such a wedge can be easily and cheaply made if a corrugating mill is available for cutting the teeth, but if no such mill is at hand, the block shown in Fig. 11 is to be recommended.

The Adjustable Reamer

The adjustable reamer spoken of in the following, having blades inserted as indicated in Fig. 14, is sometimes called the Clough reamer, after the original maker, R. M. Clough, of Tolland, Conn. The seats for the blades are first roughed out. This is done with a narrow cutter or saw of about the same width as the seat for the blade at its narrowest point. In case the body is of tough material, rough out with a saw having its cutting face ground to an angle of 10 degrees with the axis. Set this saw central with relation to the work, and start the cut for the first blade; then index 10 degrees, and move the table crosswise so that the saw will enter the slot previously started. Now cut the slot to the desired depth, and proceed with the rest of the seats the same way. Then index back 20 degrees, and again move the table crosswise so that the saw will enter the slot, but use in this case a saw ground to an angle of 10 degrees in the opposite direction. Now cut through the same slots once more in such a way that there is about 0.020 inch of stock left to be removed by the finishing cutter. To index 10 degrees when the worm-wheel has 40 teeth, move the index crank 1 3/27 of a turn.

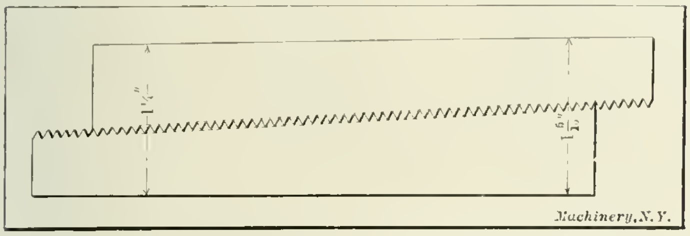

Machinery, N.Y.

Fig. 10. Adjustable Wedge Block for Supporting Slender Reamers while Fluting

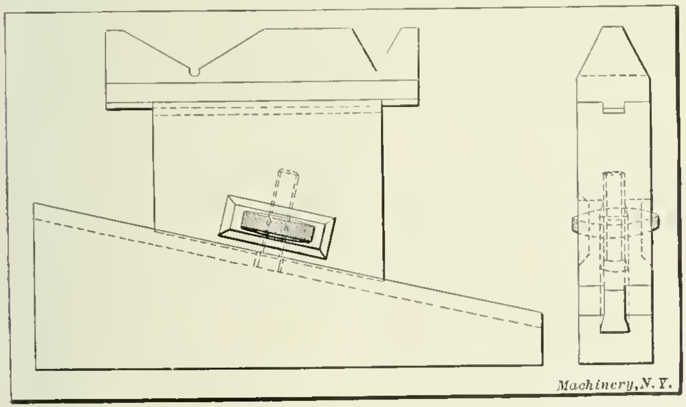

Machinery, N.Y.

Fig. 11. Another Adjustable Block. The Top Shoe is removed when Supporting Wide Surfaces

It can readily be seen that the seats, if roughed out in this manner, will have an angle of 10 degrees on each side. We could finish the seats in the same way if the bottom of the seats ran parallel with the axis of the body, but since the bottom makes an angle of 2½ degrees with the axis for the purpose of adjustment, the bottom of the seats will be narrower at the shallow end. On account of this, the work is swung sideways ½ degree each way when roughing with a 10-degree saw. This swinging sideways is effected by shifting the tailstock or the dividing-head on the table and not by swinging the table or saddle. Swinging the table will only bind the saw in the slot, and will not have the effect we are trying to obtain. An auxiliary platen is, however, the best that can be used when angular work of this kind is milled.

After the roughing cut is finished, put on the vertical milling fixture and finish with a dove-tail cutter. The cutter should be run at a fairly high speed for this finishing operation, as a cutter of this kind is more liable to break under slow than under high speed. The feed, however, should be fine.

In case this work is done without a vertical milling attachment, the method used must be somewhat different. An auxiliary platen or table, such as is used when milling bevel gears, is employed. On this platen the dividing-head and tailstock are placed in the usual way. Then set the auxiliary table to an angle of 2½ degrees and bring the center of the work to the center of the spindle holding the dove-tail cutter. Use a high-speed milling attachment for this work, as the speed of the spindle is too slow, especially if the machine is geared down to suitable speeds for tool steel. If an auxiliary table is not available, take the tongue out of the dividing-head and set it sideways 2½ degrees and strap it down to the table. A still better way, however, is to hold the work in a vise set at an angle of 2½ degrees.

If no high-speed attachment is available then the situation is somewhat difficult, as the spindle runs too slow and the feed is too coarse for this work. In such a case, however, provide a few extra cutters before starting, guard against "back-cut", and feed by hand slowly and steadily. Not infrequently adjustable reamers are made very long for jig work. These reamers, as a rule, cannot be milled in the dividing head, because of their length, but must be held in a vise; the process of milling is otherwise the same as described.

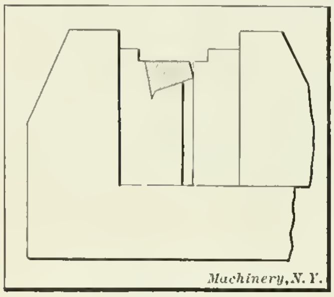
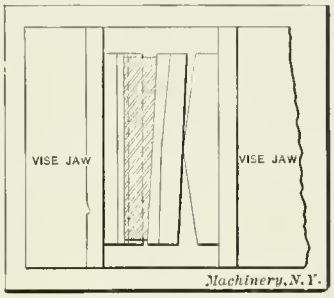

Machinery, N.Y.

Fig 12. Reamer Blade held between Blocks on the Vise



Machinery, N.Y.

Fig. 13. Old Reamer Blade held between Blocks for Re-milling

It is common practice to make these reamers in such a manner that the blades project at the end of a new reamer. This is a decidedly bad feature, for even a careful operator will sometimes get too close to the bottom of a hole and break off the unsupported ends. Wherever possible, the taper for the adjustment should be reversed, so that the shallow end of the blade is in front, in which case a new reamer has the ends of the blades flush with the body, while the back-ends of the blades are left longer for adjustment. A reamer made in this way is adjusted for a larger diameter by driving the blades forward, and the ends are kept flush with the body by grinding at the end. Small reamers, however, should not be made in this way, as it would weaken the shank just back of the body too much. Besides, the shallow end of the seat in a small reamer would not give adequate support to the cutting end of the blade.

The blades for dove-tailed reamers may be planed or milled. If we are making or re-blading reamers of this kind on a small scale only, then milling is to be preferred. The stock for reamer blades, if not rolled into dove-tail shape, should be rectangular and no larger than necessary. It is cut in single lengths, the blades being from 3/16 to 7/16 inch longer than the body. Now one side—the bottom of the blade—is finished, and then an 80-degree cutter is used to mill the sides of the blades. Blocks, as shown in Fig. 12, may also be used in connection with an ordinary straight milling cutter of the right width. If it only rarely happens that new blades have to be made, then, of course, it does not pay to make these blocks, especially since a block will fit only one thickness of blade properly.

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* Address: 819 Broad St., Bridgeport, Conn.

The old blades of reamers may be annealed, cut shorter (from the small end) to fit a smaller reamer, and then used over again; in Fig. 13, a method is shown for holding old blades for re-milling.

After a reamer is bladed, it is returned to the lathe, the ends are faced off and turned to about 1/64 inch over size. Then the faces of the blades are milled radial with a 90-degree cutter, at the same time cutting into the body of the reamer to a depth of about 1/32 inch. This gives additional room for chips. Finally, reduce the land to the proper width, without cutting into the body, as the blades should have all the backing possible. (See Fig. 14.)

Center Reamers

The small center reamer is held in the chuck and the end supported with a jack-block; for four teeth use a 95-degree cutter, run it in a right-hand direction and sink it into the work by raising the table. The center reamer with a teat is held in the same way, but the end is supported by the center. In this case we may run the machine in the usual way, *i. e.*, left-hand.

The "bull" center reamer can be cut on centers if the teeth are not too long; otherwise cut it with the head raised to an angle of about 22 degrees. This angle depends on the number of teeth cut, and the form of the cutter used. The cut should be started at the back end of the flutes and proceed towards the front; if much of this work is to be done, use an arbor with a right-hand screw and nut.

Grinding

After the hardening process, which does not differ from that used for any other tool of a similar nature, and after the centers have been cleaned from scale and grit, ascertain first how much the reamer has warped in hardening; this is done by holding it between the centers of a lathe and spinning it around by hand. A novice at this should use an indicator rather than trust his untrained eye. It will be remembered that the solid reamer previously referred to was turned 1/64 inch larger than the required size. If it be found that it will not finish up in the grinding, because of the warping, then it must be straightened previous to being ground. Certain types of reamers as well as certain steels warp more in the hardening than others. Some reamers ought to run very nearly true before being ground, as for instance a taper pin reamer, 5/32 inch at the small end and 3 1/4 inches long. If this reamer is 1/64 inch over size and runs out 0.014 inch, and is then ground, it will "clean up", but the result will be that the teeth will be ground down close to the roots and leave no room for chips on one side, while the opposite teeth are correspondingly weak.

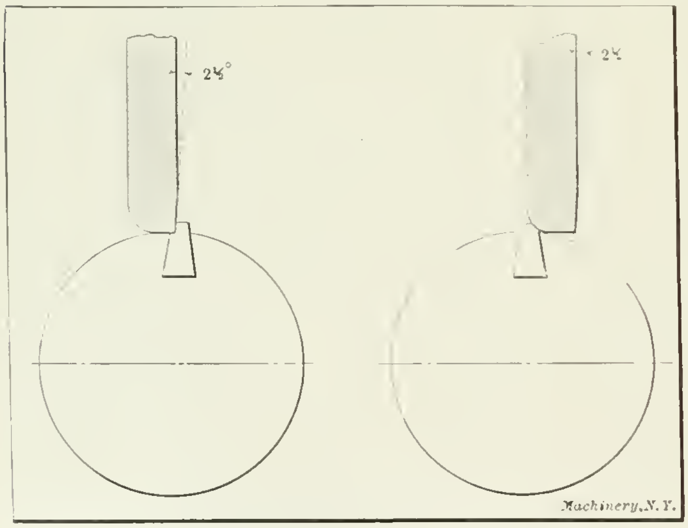


Fig. 14. Cutter for Milling the Face and Reducing the Land of Inserted Blade Reamers

A suitable grinder for the work considered is the regular plain grinder, which will grind taper as well as straight work. Assume that we start by grinding the taper shank on the one-inch reamer. This is done to the gage used when turning the blank, but if such a gage is not available, an adjustable taper gage can be used. A reliable gage of the adjustable type is shown in Fig. 15. This gage is set to a No. 3 Morse taper, using preferably a plug gage for that purpose. The shank is then ground to fit the gage. Now proceed to grind the straight part of the shank which was turned approximately to the required size, and, therefore, only is ground for finish. The shank must, of course, be smaller than the reamer. Next in order grind the reamer proper, which should be left about 0.004 inch over size. The order in which the various parts are ground may be reversed. If, for instance, the grinder is set for straight work, and we know that it will grind absolutely straight at that setting, then we take advantage of this by grinding the straight parts of the reamer first. The reamer is now ready to be backed off, an operation which is done in another machine. Before taking up this matter, however, we will consider the plain grinding of some of the other types.

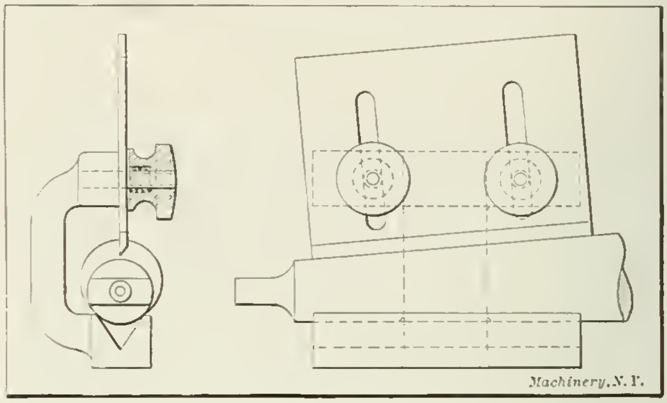


Fig. 15. Adjustable Taper Gage

The taper reamer is generally ground to a gage, but in the absence of a gage, we must rely on the graduations on the grinding machine. These generally indicate the taper per foot, and reamers ground by setting the table to these graduations are satisfactory for a large class of work. If the taper of a reamer is expressed in degrees, and is to be ground without a gage, ascertain first how the angle is to be understood, *i. e.*, whether it is to be measured from the center line or if it is the "included" angle. Then convert the degrees into "inch taper per foot", and set the grinder according to the figures thus obtained. Sometimes grinders are graduated to give degrees as well as taper per foot.

End cutting reamers are used for various purposes, for example, for straightening holes, particularly deep ones. If the hole is to have a good finish the reamer should be ground from 0.002 to 0.004 inch under size so that a finishing reamer may be used afterwards, because an end cutting reamer generally leaves the hole somewhat rough. If the finish of the hole is not important, then grind this type of reamer to size. A reamer for straightening holes should have a slight taper backwards, say 0.002 inch per foot, and the flutes ought to be longer than in the chucking reamer to insure a straight course of the reamer. An end cutting reamer is also used in automatic machines when it is desired to have a hole reamed clear to the bottom. The feed in an automatic machine is much finer than when feeding by hand in other machines, and for this reason the reamer is apt to cut "full". The experience of the writer is that good results are obtained by grinding such a reamer about 0.001 inch under size at the end, and with a back taper of about 0.005 or 0.006 inch to the foot. Since this reamer is not used to straighten the hole, the flutes are shorter than in any other type for ordinary work. As the teeth of an end cutting reamer are not backed off, we do not grind it 0.004 of an inch over size as in the case of the one-inch machine reamer, but grind it to size in the plain grinder. Sometimes it is well to remember the fact that a hole, reamed while heated, will contract when cooling off. Other types of reamers need not be considered in detail, as the operation of grinding is more or less the same as already described.

Next in order is the backing off or relieving, which can be done in various ways. A good method is to use a so-called cutter and reamer grinder. Another method is to use an electric grinder held in the tool-post of a lathe while the reamer is held between the centers. The most economical and best results, however, are obtained with a grinder specially built for the sharpening and backing off of reamers. Such a grinder is made by the Bullard Machine Tool Co., Bridgeport, Conn.

The sharpening or backing off of reamers in a lathe is a poor makeshift, and should never be resorted to unless no other means are at hand. Sometimes it happens that a large reamer must be sharpened that is either too long or too large in diameter for the capacity of a grinder. In such a case the electric grinder, used in a lathe, will answer the purpose.

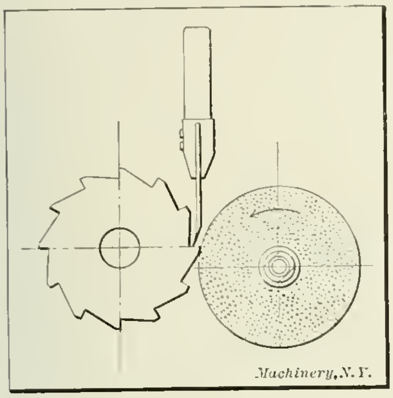


Fig. 16. Finger or Tooth-rest used from the Top

Now assume the one-inch reamer being made is to be backed off in a cutter and reamer grinder, say of the Brown & Sharpe Mfg. Co.'s make. This backing off is an important operation. The amount of clearance that a reamer tooth should have is a point on which "the learned are not agreed" as yet, and it, therefore, may be inferred that a little more or less will not affect the cutting qualities of the reamer to any great extent. Too great a clearance angle is apt to cause the reamer to chatter, particularly when working in brass or bronze. A newly ground reamer has a greater tendency to chatter than one that has been used for some time. If there be too little clearance, the reamer will not cut freely, as the lands will rub against the walls of the hole. In many cases the outcome will be a rough hole, or the reamer may "get stuck", and something will break if there is sufficient power behind it. A point well worth remembering is this: A suitable clearance for reamer teeth, expressed in degrees (the face of the tooth being radial) is not a fixed amount, but varies for different diameters—the smaller the reamer the greater should be the angle of clearance. Note also that if the cutter and reamer grinder is set about right to produce a suitable clearance on a large reamer, a small reamer would not get suitable clearance at that setting.

A simple method to regulate the clearance on a straight reamer is by raising or lowering the finger or rest that the tooth slides on in pasing in front of the wheel. The clearance of the taper reamer, however, must not be regulated that way. When sharpening or backing off a taper reamer, the rest should stand in the plane of the axis of the reamer, and the desired clearance should be obtained by raising or lowering the reamer, relative to the wheel center. This can be done by the bar carrying the centers as well as by means of the adjustment provided in the swivel-head. The tooth-rest can be secured in the swivel-head, and if so secured, the tooth does not slide on the rest, but the rest moves with the work. This method, while it is an excellent one for grinding certain tools, cannot be recommended for reamers because of the possible irregularity on the face of the teeth, due to the warping in hardening. The tooth that is being ground should always slide on the rest, because of the irregularities otherwise introduced, due to the uneven spacing of the reamer teeth.

If a tooth is ground against the face it has a keener and smoother edge than when ground in the opposite direction. In spite of this good feature, the beginner should never attempt to grind a reamer that way, since there are several disadvantages connected with this method, which more than outweigh the advantages gained. The principal disadvantage is that the rest has to be used from the top (see Fig. 16), and if so used, it gives no support to the tooth; the tooth is held in contact with the rest by hand, while the tendency of the wheel is to draw it away from the rest. If this happens, it usually means damage to the reamer, the wheel or the operator, and the chances are that all three get "banged up".

If the lands of reamer teeth were of uniform width we could support the tooth from below, *i. e.*, we could let the back of the tooth slide on the rest instead of the face and then grind against the face, but an uneven spacing produces a difference in the width of the lands on straight reamers, while taper reamers have a tapering land whatever the spacing.

The wheel used for backing off or sharpening reamers should be of fair size. Small wheels produce a cut of too great a curvature. The wheel should be of medium grade, as soft wheels produce a rough cut, and the hard ones become easily glazed, which is apt to draw the temper. The swivel-head is graduated to degrees, but for work required to be absolutely true, such as reamers, we cannot rely on these graduations exclusively. The swivel-head is to be set to the 90-degree graduation when backing off the straight part of a tooth on a straight reamer, but since the swivel-head is only about four inches in diameter, the graduation, reading to degrees, is rather crowded, and therefore errors in this setting are easily made. The reader no doubt knows how seldom it happens that work comes straight in the lathe without resorting to the cut-and-try method when setting the tailstock, and in the case of our one-inch machine reamer, which is 12 inches in length, the chances for error are about six times as great in the cutter and reamer grinder as they are in the lathe, when turning the same reamer; *i. e.*, if there is an error of 0.001 inch in the setting of the tailstock of the lathe, it will result in an error of 0.002 inch in the entire length of the work. But an error of 0.001 inch in the setting of the swivel-head in the grinder will produce an error of 0.002 inch in each two inches of length of the work—two inches being the radius of the swivel-head. As the reamer is 12 inches long, the ratio of error between grinder and lathe in this case is as 6 to 1; the longer the work, the greater this ratio.

The rest should be made of tool steel and hardened, and the corners rounded to insure smooth action. It should be a trifle wider than the wheel. When backing off spiral reamers, the rest is set over to correspond with the angle of the spiral. A better way, however, is to make a special rest for spiral work, and grind this rest to the angle of the spiral.

After the reamer is backed off and brought down to size (measurements are generally taken with micrometers), grind a lead or taper at the end. This lead may be of various lengths to suit various conditions. It must be very short or entirely absent if the reamer is intended to ream down to the bottom of a hole, but if the hole runs through a piece of work then good results ought to be obtained with a lead of about ½ inch in length. The taper should be about 0.005 or 0.006 inch. The back end of the reamer is also slightly tapered to prevent the ends of the teeth from scratching when passing through the hole. Finally, the chamfered corners are backed off, which finishes the reamer. The corners may be rounded instead of chamfered, but chamfered corners are easier to grind even, as the grinding can be done on centers.

Sometimes a new reamer will ream a hole "full" at first. To overcome this, when standard holes are wanted from the beginning, we stone by hand after the reamer has proved to cut large. Stoning a spiral reamer should be done at the end only, for a stone cannot be brought in proper contact with a helical tooth.

The foregoing is, in the main, the writer's way of making reamers. If other methods "just as good" or better are employed elsewhere the writer hopes that they will be made public. If he has not made himself clear enough on some points, he asks to be excused on the grounds that he has but little time for writing, as he is too busy—making reamers.

* * *

An old building completed in 1852 was recently demolished in Hamburg, Germany. The iron anchor bolts used were completely encased in concrete and were found as fresh and bright as would be new iron, with no traces whatsoever of rust. This indicates that iron will be perfectly preserved in concrete for an unlimited time if properly encased.

* * *

In designing machine parts, avoid blind threaded holes wherever possible. A hole running clear through the piece is much easier to tap, and if many holes are required to be tapped, the saving is quite considerable.

MOUNTING BLUEPRINTS

By D. U. B.

Many good suggestions for mounting blueprints have been offered in the columns of MACHINERY, and here is still another.

Our company discarded cardboard-mounted prints in preference to tin long ago, but our method of mounting is somewhat different from that mentioned by J. B. & Co., in a recent issue. Our tins are made of No. 28 galvanized iron sheets, which is probably as thin as can be used without warping, especially as the treatment received at the hands of some shop men is rather rough. However, lighter material might be used in some cases and this would reduce the cost somewhat. The tins are made ⅝ inch larger all around than the print size, including a ¼ inch lap, which not only stiffens the tins, but also makes the edges somewhat easier on the hands.

We make a paste of flour and water about as thick as that used by paper hangers, and cook it in the patternmaker's electric glue heater. The back of the print is thoroughly covered with paste, but this must be applied quickly so as not to let the print get more wet than necessary; if not done quickly enough, a chemical action takes place between the water in the paste and the galvanized iron, resulting in spots on the prints. The print is then smoothed down well on the tin with the hands or with a rubber roller, taking care to get most of the wrinkles out, and incidentally working all the surplus paste out from under the print, after which it is thoroughly dried. In summer, we dry our prints in the sun; in winter we put them near the radiator, and have never experienced any trouble, unless it was while breaking in a new "blueprint boy".

After drying, the varnish is applied; we use common yellow shellac varnish, which answers our purpose very well, but the white shellac varnish is preferable. To make corrections, we scrape the varnish off with a knife where the change is to be made, and make the correction with ink. After the ink is dry, the print is varnished again.

To remove the prints from the tins let them soak in water an hour or so, when they can be taken off with the utmost ease, and are ready to be used again. For cleaning, the mounted prints can be washed in benzine or soapy water—something you could not do with those mounted on cardboard, even if they lasted long enough to need cleaning. If you wish to use an old tin which has been previously mounted with shellac, burn all the varnish off before applying the paste; otherwise, the print will not stick, and it is likely to become spotted.

We have about 1400 mounted prints in the factory, some of which have been in use for fifteen years, and we find this method better than any other.

* * *

TAPS AND TAPPING

By "A"

While the writer always welcomes criticisms from persons who are familiar with, and thorough in their investigations of, the subject under consideration—without such criticisms and resulting discussion, progress would be slow—he cannot see any use for such criticism as made by Mr. Bliden in the August number of MACHINERY in which this writer referred to an article entitled "Taps and Tapping," which was published in the June number. Mr. Bliden's knowledge of tap making in general seems to be very limited, because he states that the writer "advances a new theory" in tap making. The theory is not new, as many kinds of taps, for example master taps (also called long taper die taps), machine nut taps, and stay-bolt taps, are regularly made as outlined in the article in the June issue by practically all the prominent tap manufacturers, and have been so made for years—by some, of which the writer has positive knowledge, for as long as twelve years. The machine nut taps and stay-bolt taps have been made in this manner on account of the heavy duty to which they are subjected, and the master taps owing to the finish required in the tapped hole. This indicates that the tap makers are aware of the superiority of taps made as outlined by the writer, over those ordinarily made for regular shop use, and the writer is sure that were it not for the added cost in the making of taps in this manner, all taps (even the first tap in a set of hand taps) would be so made, whenever heavy duty or good finish were required. It was not in order to promulgate a new theory that the article in the June number was written, but it was the absence of definite formulas of *how much* to taper the taps that led the writer to make experiments along this line and give to the readers of MACHINERY the benefit of these experiments by compiling the tables accompanying the article.

The critical reader who carefully reads the article referred to will find that the writer did not deal with tap making in its entirety, but that he only suggested "further means and methods for making not only square-threaded taps, but taps with any form of thread whereby the ultimate object—a straight-threaded hole and a smooth and correctly formed thread—may be obtained." The writer did not state that the defects with which he dealt in the article criticized were the most serious in taps as generally made, as Mr. Bliden seems to have interpreted it in his criticism; one particular phase of the subject only was dealt with.

Mr. Bliden also remarks that nothing was said about the relieving of the tapered thread, and seems to think that they were not to be relieved. The writer did not think that it was necessary to call the attention of the readers of MACHINERY to this matter, especially as the subject of relief was not dealt with. The critic might just as well have drawn the conclusion that the taps as described were not fluted, as nothing was said about fluting; because the relieving of the thread in a taper-threaded tap may be considered fully as important a feature as the fluting. The relief of taps has been treated so thoroughly in MACHINERY in the past that it would seem unnecessary to repeat any of the matter previously published. (See MACHINERY, "Relief of Taps," October, 1905; "Machine Taps," February, 1907; "Hobs and Die Taps," March, 1907; "Taper Taps," March and April, 1908; "Special and Adjustable Taps," July, 1908.)

Mr. Bliden's criticism regarding the square-threaded taps indicates superficial reading of the article criticized, because the second and third taps in the set of taps shown are provided with threaded pilots so that the taps will "lead" with the preceding taps, which he thinks they would not do.

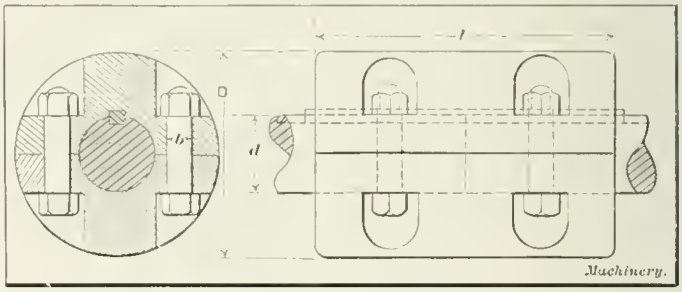
It does not seem to the writer that discussions of this kind add anything to the information given in the pages of MACHINERY, but he considered it necessary to reply. However, he wishes to state that the controversy on his part is closed.

* * *

FORMULAS FOR CLAMP COUPLINGS

By D. TAPPAN

In the How and Why columns of the August number of MACHINERY is a request for a formula for determining the number and diameter of bolts for clamp couplings. The writer submits herewith formulas for complete couplings which have given satisfaction in general practice. Let d = diameter of shaft; then:



Type of Coupling for which Formulas are given

D = diameter of coupling = $2\frac{1}{2}\,d + \frac{1}{2}$ inch.

l = length of coupling = $4\,D$.

b = diameter of bolt = $1/3\,d + \frac{1}{8}$ inch.

For couplings with less than 3 inches diameter of shaft use four bolts, and for larger shafts use six bolts.

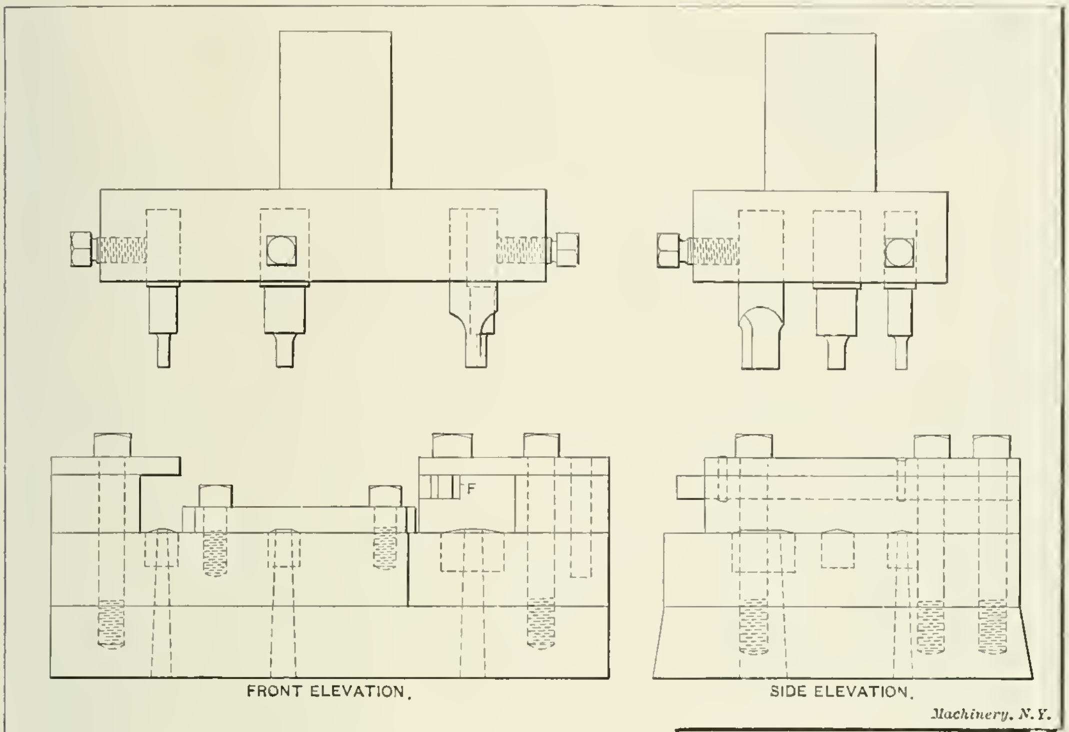
These couplings are usually clamped together and bored to size with a piece of rather heavy paper between the two halves. After boring, this paper is removed, thus giving the necessary space between the halves for clamping tightly.

LETTERS ON PRACTICAL SUBJECTS

We pay only for articles published exclusively in MACHINERY.

DIE FOR PIERCING CAST IRON

The writer has lately had the novel experience of designing dies for the punching of gray-iron castings in power presses. He does not know what experience others have had in working this metal in a similar way, but never having heard or read any articles on this subject, presumes that a short description of the methods and devices used will be of some interest to the readers of MACHINERY. Having a great many thousand gray-iron castings of the form shown in Fig. 2 to drill, and also having had a great deal of trouble and inconvenience in getting the keyhole *A* cast clean and accurately, it was decided to try piercing the holes *A*, *B*, *C* and *D*. Before laying out the plan of the dies, some of the castings were experimented upon with a simple round punch and die to ascertain the effect of the sudden blow on the comparatively brittle material.



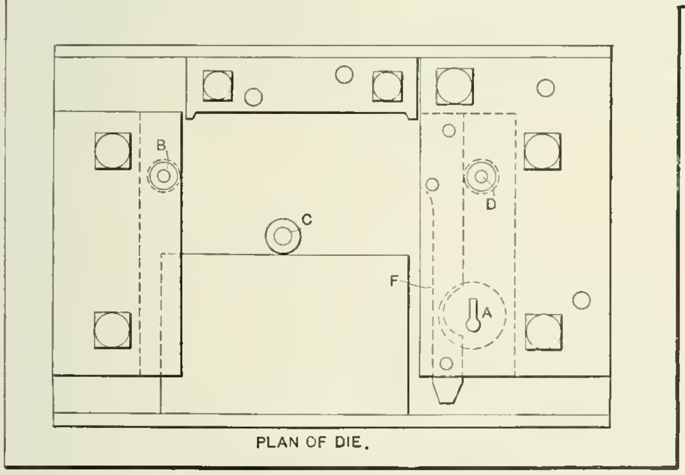


Fig. 1. Punch and Die for Piercing Casting shown in Fig. 2

In this test it was found that it is not practical to approach the edge of the casting very closely, about one-half inch being the nearest that is safe without cracking the casting, unless there is a rib or flange to resist the strain imposed on the iron. The castings used were of a good quality of soft gray iron, made by a foundry well known for its excellent quality of work, and were free from sand and objectionable scale. The first operation was to mill them at *E*, Fig. 2, from which groove the castings were located on the die Fig. 1, by the hardened steel gage shown at *F*.

The faces of all the dies, which are inserted in a machine-steel die-block, are crowned and the crown is brought almost to the edge of the hole (approximately 1/64 inch) to overcome any tendency to spring or strain the casting. The construction of the simple die as shown in Fig. 1 is obvious, and does not need explanation or comment. There are doubtless many other similar manufactured articles on which this process could be used to advantage, if the stock is sufficiently thin and the holes so placed as to make the operation successful.

Previous to making the die shown, when having a similar piece to machine, we would construct a jig for holding the work, and if the quantity of the articles to be made warranted the expense, a multiple-spindle drilling head would also be laid out and made, which, of course, was somewhat expensive, and in the specific case in hand would not help out on the keyhole or other irregular shapes. The die has resulted in better work and has greatly reduced the cost of the work, as well as the cost of tools. It would be of interest to the writer to hear in MACHINERY of processes similar to this, as there is "more than one way to skin a cat," and new methods and kinks appeal to all of us.

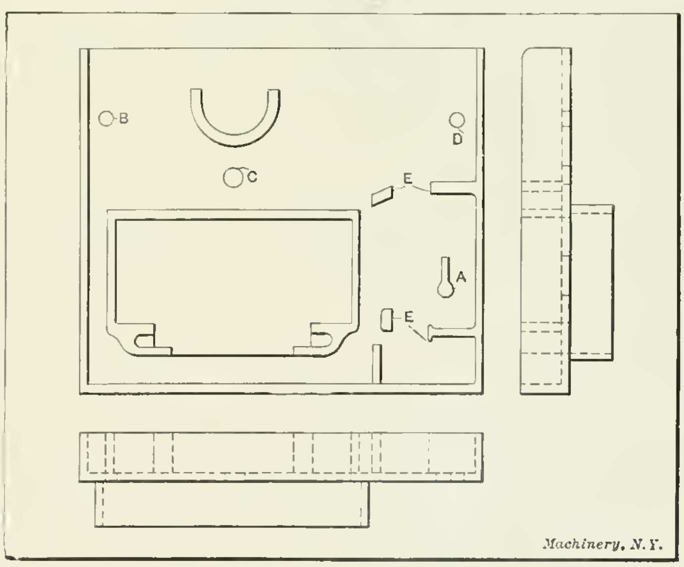


Fig. 2. Casting to be punched

Aurora, Ill. CORWIN LAMOREAUX

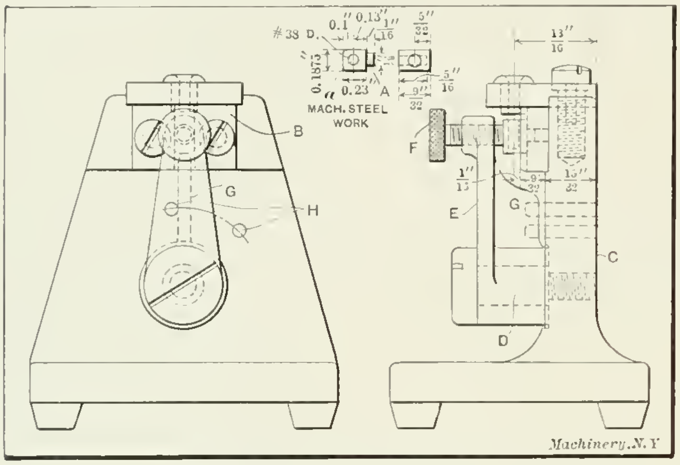
PREVENTING PENCIL POINTS FROM BREAKING

The writer suggests a very simple method for preventing the pencil point from breaking if the pencil falls to the floor. This method answers two purposes, that of making one end of the pencil heavier, and also of preventing it from falling out of the pocket. The method consists in simply twisting a rubber band around the pencil near the top. This method is not as elaborate as those suggested by Mr. W. Thompson and "Designer" in recent issues of MACHINERY, but it fills the requirements, and it overcomes the objections to the methods proposed by them.

RUBBER

DRILLING JIG FOR A SMALL POST

The accompanying illustration shows a simple and efficient jig for drilling the hole *a* in the piece shown, which is a small screw machine part, cut off and formed in a previous operation. The work is located by the teat *A* in a hole in the locating plate *B*, which is made from tool steel and hardened. The locating plate *B* is fastened to the casting *C* by flat-head screws. The casting *C* is tapped to receive the stud *D* on which the swinging or clamping arm *E* works. An adjusting screw *F* is held in the swinging arm *E*, and is used for clamping the work in the jig. The rib *G* on the arm *E* engages with pins *H* which prevent unnecessary movement, only allowing the arm to swing through a small arc sufficient to clear the work. Only a quarter turn of the knurled screw *F* is required to clamp or release the work.

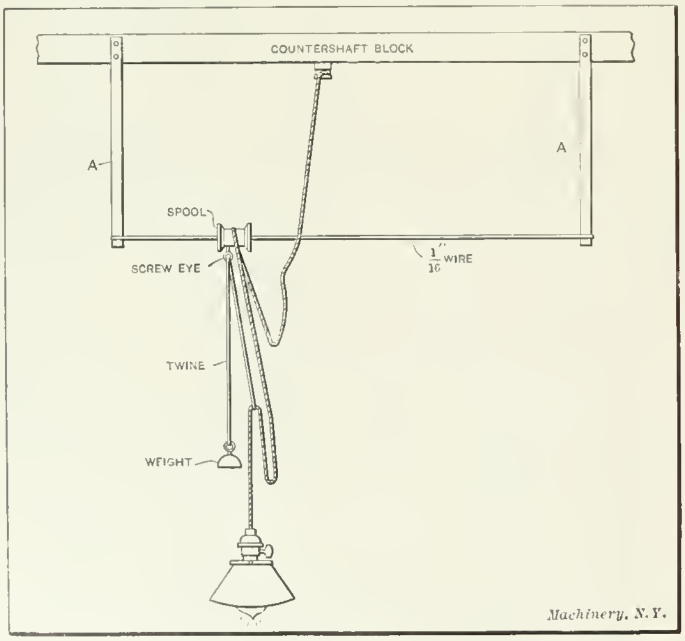


Efficient Drilling Jig for a Small Stud

DAYTON

ADJUSTABLE ELECTRIC LAMP FOR THE LATHE

It is convenient to have an electric lamp which can be easily adjusted to any position along the entire length of the lathe bed, and to any height. A lamp of this type is in use in the Aurora Tool Works, Aurora, Ind.



A Convenient Method of Holding and Adjusting an Electric Lamp

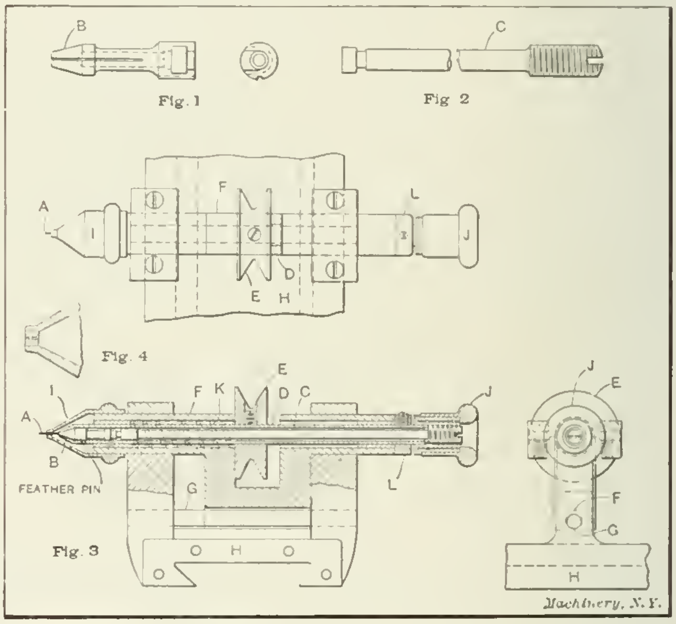
The device for holding the lamp, as shown in the accompanying illustration, is very cheaply made, by taking two wooden strips *A* and fastening them to the block which holds the countershaft. A piece of wire about 1/16-inch diameter is stretched from one strip to the other, and is drawn fairly tight; a small spool is placed on this wire, and can be slid along the wire to any desired position between the strips.

The electric light wire is fastened to the spool, leaving enough slack wire so that the spool can be moved to any position A small screw-eye is screwed into the spool which serves as a pulley for holding the twine used in adjusting the lamp to any height. One end of this twine is tied to the electric light wire, leaving enough slack wire so that the lamp can be lowered or raised. On the other end of the twine is fastened a small weight to balance the weight of the lamp.

Aurora, Ind. ALVIN C. RENNER

A FIXTURE FOR DRILLING SMALL HOLES

The accompanying illustration shows a small fixture designed for drilling very small holes. The drill *A* is held in the chuck *B*, an enlarged view of which is shown in Fig. 1. The chuck is tightened on the drill by screwing up the rod *C* (Fig 2), the end of which engages with the chuck, so that the latter may be opened or closed by screwing the rod *C* forward or backward. The outside spindle or sleeve *D* is rotated by means of the pulley *E*, and the drill chuck rotates in unison with it, as it is keyed with a feather pin as shown in Fig. 3. The spindle *D* is supported by a bushing held in the yoke *F*, which slides forward and backward, the rod *G* preventing it from turning. The yoke *F* is held in the casting *H* which forms a part of the fixture.



Figs. 1 to 3. An Efficient Fixture for Drilling Small Holes

In order to support the drill point as it enters the work, a thimble *I* is fitted to the front end of the yoke *F*. This thimble carries a small bushing through which the drill works, as is clearly shown in the enlarged view, Fig. 4. For convenience in operating, a revolving button *J* is placed at the end of the drill spindle. In operation, the spiral spring *K* presses the pulley *E* back until it strikes against the yoke *F*, and when in this position the drill point is withdrawn until its point is in the thimble bushing, thus protecting the drill and leaving it ready for action.

When the operator presses the yoke forward, the pressure of the spring *K* keeps the drill point back until the end of thimble *I* comes in contact with the piece to be drilled, after which the drill as it is supported by the bushing in the thimble, passes through the piece. After the hole is drilled the spring acts to keep the thimble in contact with the work until the point of the drill is protected again in the bushing; the yoke is then drawn back until the drill is clear of the work.

The distance that the drill may project from the bushing is regulated by means of the collar *L*. In operation the pulley *E* would be set back a slight amount on the spindle *D*, so that the collar *L* would regulate the depth of the hole, and the pulley *E* would come against the face of the yoke on the return stroke, thus preventing the point of the drill from being drawn entirely through the bushing.

This fixture was designed for rapid duplicate drilling, and is adaptable to a number of different jobs requiring the drilling of holes of very small diameter. For convenience in assembling, the upright parts of the casting *H* are provided with caps, which are screwed onto them, thereby allowing the removal of the yoke and spindles without disassembling them.

F. B.

A COMBINATION SURFACE-GAGE AND TRAMMEL

A useful combination tool which has recently been brought out by the Mechanics Tool Co., of Preston, England, is shown in the accompanying illustrations. The base of the surface-gage, or scribing-block, is made of cast iron (see Fig. 1), into which is screwed a 3/8-inch square steel rod, 8½ inches long. On this rod is held a patented form of scriber-holder which may be rapidly moved up or down, and locked in the desired position. The two knurled screws *D*, Fig. 3, are used for fine adjustments. An extension rod, 14 inches long, may be screwed into the top of the 8½-inch rod, thus increasing the capacity for height. The principal application of the longer rod when used alone or when screwed to the shorter one, is as a trammel or caliper-gage. By using two of the scriber-holders, a trammel-rod is evolved, as shown in Fig. 2, and by turning the two bent ends of the scribers so that they face each other, a calipering tool is produced. For internal work or for measuring between inside faces, the bent points of the scriber are reversed.

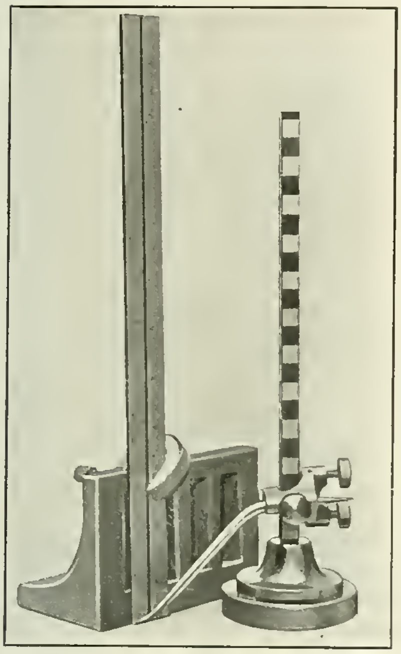


Fig. 1. Scriber-head used as a Surface Gage

Fig. 3 shows the construction of the scriber-head, which has an ingenious mode of adjustment. The head *A*, which is made of brass, has a rectangular hole cut in it to fit the steel bar *B* on two of its faces. A series of concavities are drilled on the under side of the bar *B*, and the rounded point of the screw *C* fits into whichever concavity happens to suit the desired position on the bar. The screws *D* clamp the head to the bar, and by manipulating them the head can be tipped in the required direction. These screws give the fine adjustment to the scriber point. In order to make the head follow the action of the adjusting screws instantly, a coiled spring is placed in the counterbored hole *E*, this spring pressing upon the face of the bar. The upper coil of the spring is straightened and inserted in the hole *F* to retain it in position. After the head has been tilted the required amount, it is securely locked by the screws *D*. When it is desired to shift the head along the bar, screws *D* are slackened slightly, and the head slid along until the screw *C* "clicks" into the required concavity. The screw *G* serves to bind the scriber in the scriber-head. A bent scriber, such as shown in Fig. 1, is sometimes used in place of the usual straight scriber. Various sizes of this tool are being manufactured to meet the requirements of different classes of fitters and machinists.

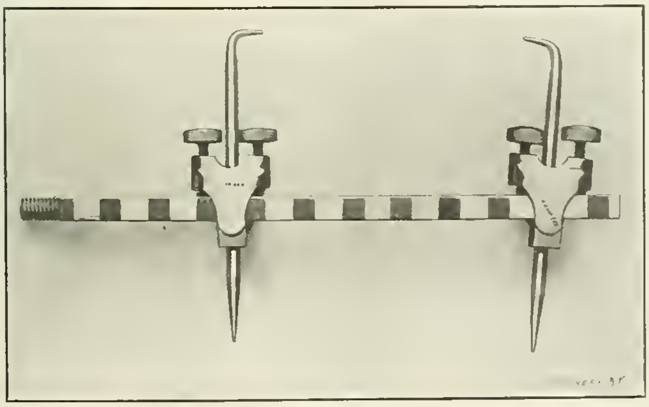


Fig. 2. Scriber-heads used on a Rod constituting a Trammel

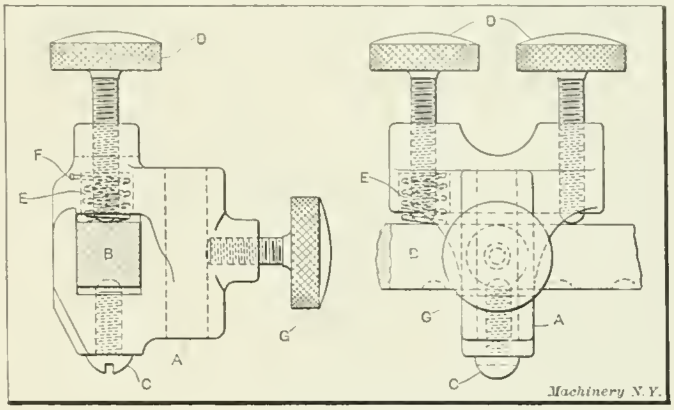
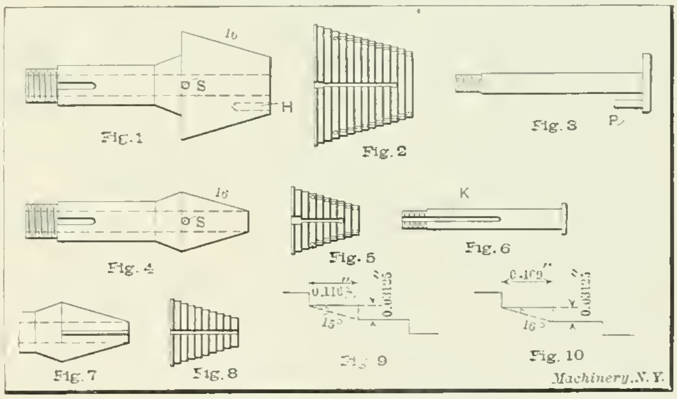


Fig. 3. Construction of the Scriber-head

Bath, England. JOSEPH G. HORNER

EXPANSION CHUCKS FOR THE BENCH LATHE

The expansion chucks shown in the accompanying illustration are quite a desirable addition to a bench lathe outfit, especially for repair work on optical instruments, for it is frequently necessary to grasp a thin tube by the inside. The bench lathe to which these expansion chucks were to be fitted, was already supplied with a reducer to take spring chucks of a smaller size than those regularly supplied with the lathe, and these small spring chucks had an auxiliary draw-spindle to pull them in, so this was used to pull in the bolts Figs. 3 and 6, used in connection with the expansion chucks.



Figs. 1 to 10. Detail Views of the Parts of a Special Spring Expansion Chuck for a Bench Lathe

The chucks were made in the step form, and in order to avoid too long a chuck, there were two taper plugs made of unannealed tool steel, as shown in Figs. 1 and 4. The pull-in bolts for each of these plugs are shown in Figs. 3 and 6, respectively, these bolts having an endwise motion only, in relation to the plug. This was accomplished in the case of the bolt in Fig. 3 by the pin *P* driven tightly into its head; this pin is free to slide in the hole *H*, Fig. 1. The bolt shown in Fig. 6 has a keyway *K* which engages with the point of the screw *S*, Fig. 4.

The chucks themselves were stepped shells of thin cast iron, shown in Figs. 2 and 5, there being four shells to go on the large plug, Fig. 1, and four others to go on the small plug,

Fig. 4. Each step on any of the shells was 1/16 inch larger in diameter than the next smaller step on the same shell, and the smallest step on the larger shell, Fig. 2, was 1/16 inch larger in diameter than the diameter of the largest step on the small shell, Fig. 5. One pair of shells like Figs. 2 and 5 contained all the exact 1/16-inch sizes from 1 3/4 inch down to 7/16 inch. Another pair contained steps intermediate between these, that is, all the 1/32-inch sizes from 1 23/32 inch down to 15/32 inch. Another pair had each of its steps 1/64 inch larger than those on the first pair mentioned, while the fourth pair had each of its steps 1/64 inch smaller; thus there was a step for each exact 1/64 inch in diameter from 1 3/4 inch down to 7/16 inch.

The first shells made had three equally spaced slits running from each end, one of the slits leading in from the large end having a wide opening for a short distance, as shown in Figs. 2 and 5, to accommodate the head of the driving screw *S*, Figs. 1 and 4, screwed tightly into the steel plugs. This seemed to work all right on the large shells, but on the small shells, Fig. 5, it was somewhat of a failure as a method of driving, for when a disk or washer, for instance, was held by its bore on the small end of a shell, and a cut was attempted at the outside diameter of the washer, there was considerable torsional stress set up in the split shell, due to the fact that it was driven at one end, while the resistance to the drive took place at the other end. Some of the shells were broken through this cause. Subsequently, a new set of the smaller shells was made, with but a single saw slit extending from one end to the other, as shown in Fig. 8, and this was driven by a key, or feather, set in the plug, and extending the entire length of the taper side, as shown in Fig. 7.

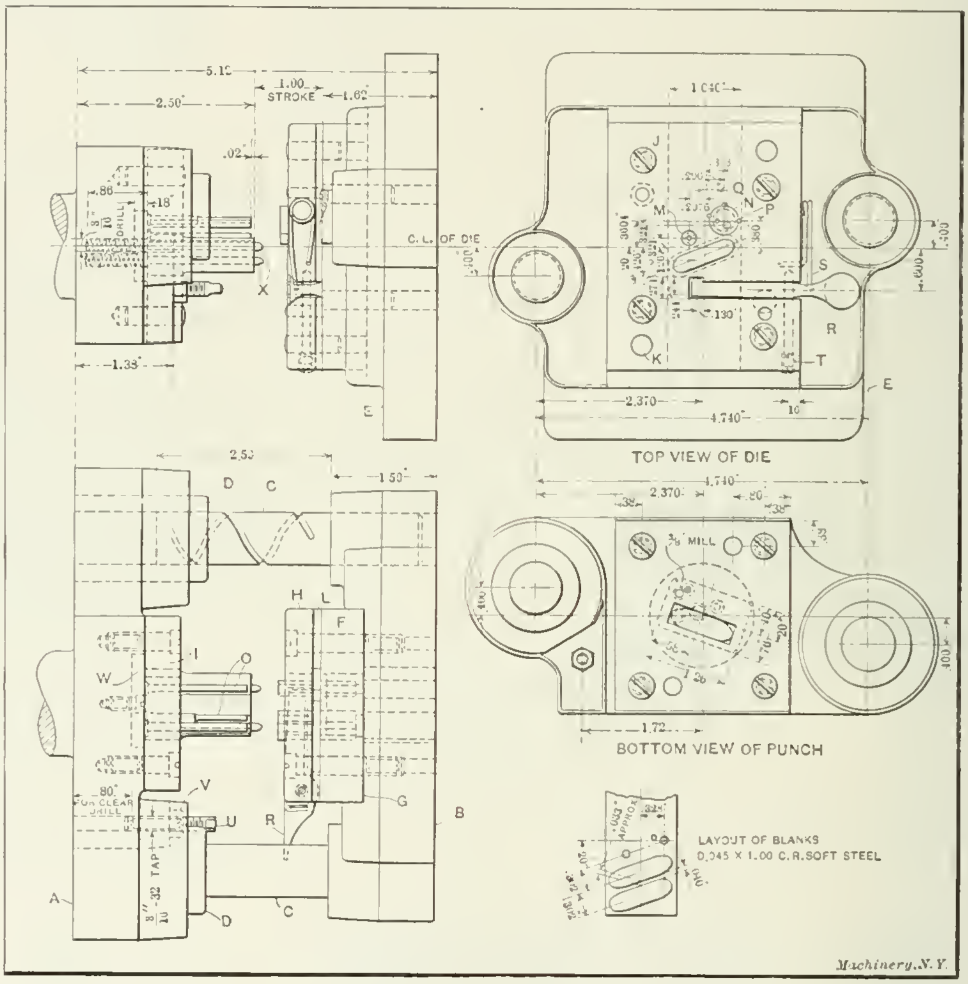


Fig. 1. Punch and Die made from Standard Parts

The driving key or screw must be so made as to be readily removed, as this is necessary when making a new shell with special steps, for instance, or in making a new shell to replace a damaged one, as the shell cannot be split until after all the lathe work on it is completed. The method of holding the key in place was to make it a nice close fit in the keyway in the plug, and then put a slight bend in the key before spring tempering. This made a key that was slightly bent when out of its seat, but that was straight enough for practical purposes when in the plug, as shown in Fig. 7. This straightening out of the key to make it enter the keyway put sufficient pressure against the middle of one of its sides and both ends of the other side to prevent it dropping out when the plug was not in use. The reason for using a screw head in the first place for driving was on account of its being so readily removed when required, and the feature of torsional stress was not considered until it became apparent in actual use of the chucks.

The commercial sizes of brass tubing in use in this country are mostly in sixteenths, but many foreign instruments have tubing that will not go on the sixteenth steps, and as there is very little expansion permissible on any one step, there was of necessity a large number of steps required in the set.

The plugs were turned to an angle of 15 degrees with the center line, and in order to get the shells the same thickness at each end, each step had to be 0.1167 inch in length (0.03125 ÷ tan 15 degrees) as shown in Fig. 9, but if making another outfit complete from the start, the writer would turn the plugs to an angle of 16 degrees and make the steps 0.109 inch in length, as shown in Fig. 10, which would be somewhat easier to handle in the making, as then the fraction of a thousandth would be eliminated.

WALTER GRIBBEN

Brooklyn, N. Y.

STANDARD PARTS FOR PILLAR DIES

A punch and die for blanking and piercing is illustrated in Fig. 1, the blanks produced being shown in the lower right-hand corner. This punch and die is in no way remarkable in itself; it only serves to illustrate the practice of one of the large typewriter manufacturing concerns, where all the punches and dies are made of standard parts, in so far as is practicable. The particular punch and die here shown is merely chosen to give a concrete example of this idea.

The plunger *A* and base *B* are both standard; two sizes have been found sufficient to handle nearly all the blanks used in this shop. For some very large blanks, special bases and plungers are necessary, but these are few in number. Guide pins *C* and bushings *D* are also standard in size; several lengths of guide pins are required, necessitated by the varying strokes of different presses used in the shop. A shelf *E* is provided on the base for fastening to the bed of the press. This shelf is secured by clamps and bolts which are standard, made in various sizes. A standard spanner wrench is used to tighten these bolts.

The die block *F* is tightly fitted in the recess *G*. The punch plate, die block, and the stripper plate are also standard. The former two, serving as very good examples of the method of standardization, are shown in the accompanying Tables I and II. This illustrates the method which is applied to as many of the punch details as possible. In Fig. 1, the punches are secured to punch plate *I*. The die and stripper are fastened to the base and are located, by screws *J* and dowels *K*, respectively. Guide strips *L* are provided, but these are not standard on account of the varying widths and thicknesses of stock. Bushings *M* and *N* are provided in both stripper and die for supporting the slender piercing punches *O*. The bushing *N* is made with two holes and is secured against turning in the stripper by the pins *P* and in the die by the pin *Q*.

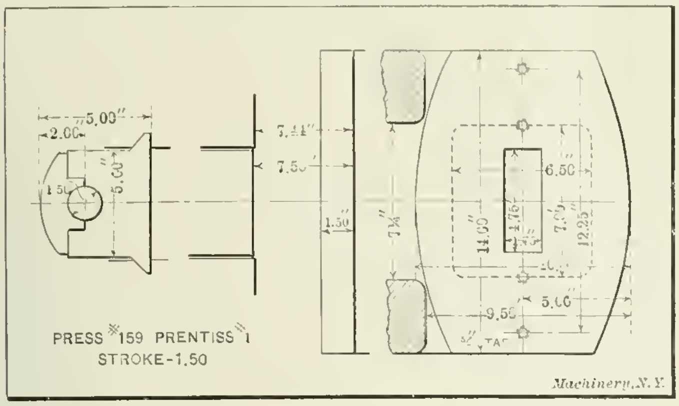
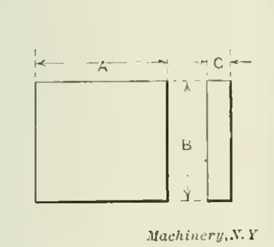
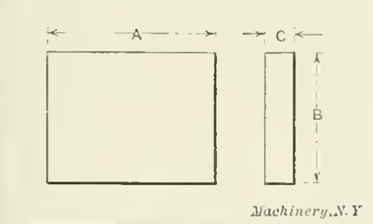


Fig. 2. Office Information Sheets showing Principal Dimensions of Presses for Convenience of the Die Designer

The stock is stopped against the feed stop *R*. This piece serves as another good example of the method of standardizing the die parts and for that reason is illustrated and tabulated in Table III. Two sizes are made. The spring *S*, screw pin *T*, and action pin *U* are also made standard in two sizes; a nut *V* prevents the latter part from turning. The punches are tightly fitted into the block *I*, and have their ends upset to prevent being pulled out, and a backing plate *W* of hardened tool steel acts as a good bearing. Spring pilots *X* accurately locate the pierced hole in the blank.

TABLE I. PUNCH PLATES, M.S. TABLE II. DIE-BLOCKS—TOOL STEEL





				Finished Sizes			Rough Sizes		
No.	A	B	C	A	B	C	A	B	C
1	$2\frac{3}{4}$	$2\frac{1}{2}$	$\frac{1}{2}$	$3\frac{1}{2}$	2.7396	$\frac{5}{8}$	$3\frac{1}{2}$	$2\frac{3}{4}$	0.63
2	$3\frac{1}{2}$	3	$\frac{5}{8}$	$4\frac{1}{2}$	3.4996	$\frac{25}{32}$	$4\frac{1}{2}$	$3\frac{17}{32}$	0.82

The prominent feature of this method of standardization is the fact that in making a die, such as the one just described, it is necessary to detail but very few parts, the dimensions shown in Fig. 1 being all that are required. Nearly all the parts are called for by a bill of material, shown in Table IV, which is added to the lower left-hand corner of the drawing. The parts required are thereby ordered directly from the stores department where all standard pieces are kept in stock for immediate use. The writer believes that nearly every shop would be benefited by the use of such a system.

TABLE IV. LIST OF MATERIAL NOT DETAILED

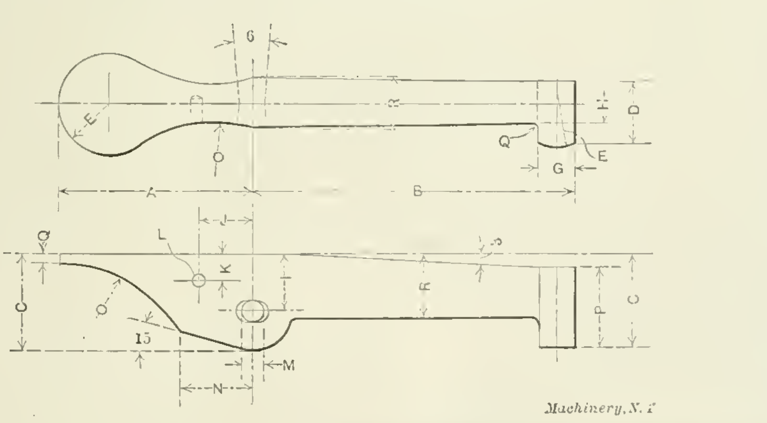
Quantity	St'd No.	Description	
1	1	Feed stop	Dr. No. 189.
1	1	Pin screw	
1	1	Action pin	
1	1	Stop spring	
1	1	Die blank	Dr. No. 185.
1	1	Stripper	
1	1	Die block Patt. No. 515	Dr. No. 188.
1	1	Punch block, Patt. No. 514	
2	1	Guide pins, Dr. No. E 186.	
2	1	Guide bushings, Patt. No. 505, Dr. No. 186.	
1	1	Punch plate, Dr. No. E 190.	

Quantity	Dia.	L'gth	Th'ds	Kind
4	$\frac{1}{4}$	0.88	0.24	Fil. head screws, C. H.
4	$\frac{1}{4}$	1.50	0.24	“ “ “ “
1	$\frac{3}{16}$	0.38	0.32	“ “ “ “
1	$\frac{3}{16}$	0.18	0.32	Hex. nut. “
2	$\frac{1}{4}$	0.82		Dowels, T. S., H., G., slide in punch block.
2	$\frac{1}{4}$	1.00		“ “ “ “ “ “ die block.
2	$\frac{1}{4}$	0.74		“ “ “ “ “ “ die.
2	$\frac{5}{32}$	0.48		Dowels, drill rod, H.
1	$\frac{3}{32}$	0.50		Pin, drill rod.
2	..			Springs, No. 17, 0.038 music wire, 15 sections, 14 working coils, open wound, 0.17 out. dia., 0.056 pitch.

Another very convenient scheme is employed in this same plant. This consists in supplying each of the draftsmen with a full set of drawings of the principal clearance dimensions of all the punch presses in the shop; one of these is shown in Fig. 2. This enables the designer to go ahead with the design, knowing just what conditions the punch and die will meet when set up. It also enables him to know at a glance what press it would be advisable to use for a certain punch and die.

C. A Dinter

TABLE III. DIMENSIONS OF FEED STOP



No.	A	B	C	D	E	G	H	I	J	K	L	M	N	O	P	Q	R
1	1.00	1.34	.48	.244	.20	.16	.17	.26	.28	.14	No. 2 .0635	$\frac{1}{8}$ slide	.36	.76	.42	.04	.20 slide
2	1.00	1.59	.50	.365	.26	.18	.23	.30	.28	.14	No. 48 .076	$\frac{1}{8}$ slide	.36	.76	.42	.04	.26 slide

A BABBITTING EXPERIENCE

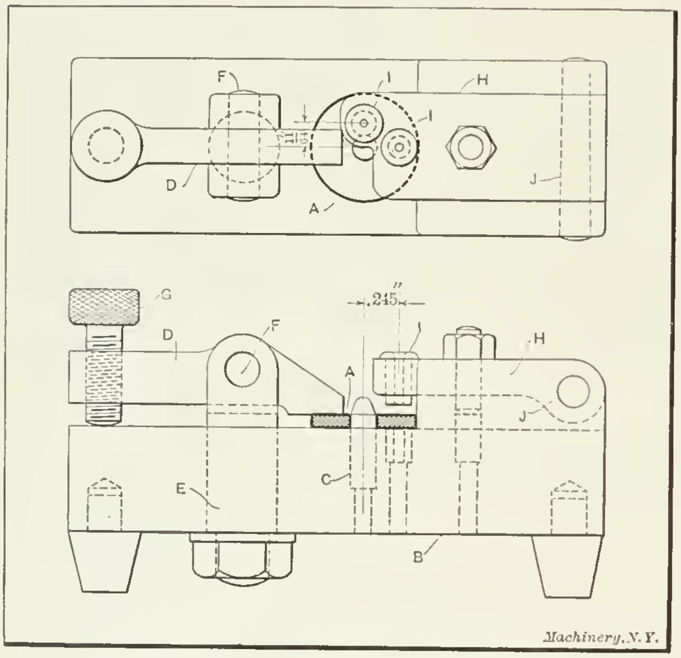
That babbitt mine, so vividly described in the April number that I felt like writing to ask the author if he knew of any more mines and if there was any stock for sale, reminded me of a babbitting incident in a shop in a thriving Indiana town. This town has several steam and gas engine shops, but until recently it had not met with the favor of any machine tool builder, searching for a place wherein to produce his "best-ever" idea of a combination of pulleys, gears spindles, slides, and beds, in concrete form. When an enterprising fellow with the machine-tool building "bug" came and located here, he found few men who had experience on machine-tool work, but he went ahead just the same, rented a building, set up his machines and hired a number of the men from the engine shops. Some of those hired were not machinists at all, but they said they were, and, of course, you ought to give a man the benefit of the doubt until proved guilty. Well, one of them proved guilty—or rather, he proved not guilty of being a machinist by committing a blunder the like of which I never heard of.

We were ready to test the first machine built, when the boss came around and happened to see a blowhole in the gear box casting, and as he wanted everything to look just right about *that* machine, he called upon one of the new "machinists" to see that the blowhole was filled. Some bearings were being babbitted at the other end of the shop, and our new man went over there and got a ladle full of babbitt and returned to fill the blowhole. Apparently, it was a mighty big blowhole, for he went back and got another ladle of babbitt, and about half of that, too, went into the blowhole before it appeared to be properly filled up. No one had paid any attention to the fellow, and when through he merely called the attention of the boss to the fact that the blowhole was filled.

And it was filled all right, as we were soon to discover! Shortly after we were ready to test the machines, and when the belt was adjusted, the power was turned on. We all stood around watching that machine like a baby taking its first steps. There was an ominous silence, a screeching of belts, a cracking roaring noise like that of a stone-crushing machine, and then a concerted lively movement to throw off the belt—but too late. All the teeth were stripped off the intermediate gear between the head and the gear-box. When we took the machine apart to locate the trouble, we found a "babbitt mine" in the gear box! INDIANA

JIG FOR DRILLING AND TAPPING SMALL RATCHET WHEEL

The jig shown in the engraving was designed for drilling and tapping the small ratchet wheel *A*, shown in position. The jig consists of the base *B*, containing the locating pin *C*, on which the piece is centered by a hole previously drilled in the screw machine operation when the piece was cut off. It will be noted that the holes are drilled and tapped before the teeth are cut.



Jig for Drilling and Tapping a Small Ratchet Wheel

The piece is held down by the swinging clamp *D*, pivoted in the post *E* on the taper pin *F*, and is adjusted by the screw *G*. The leaf *H* carries the bushings *I* through which the holes are drilled. It may be swung up out of the way on the pivot *J* for the tapping operation. When the piece is completed, by giving the screw *G* a half turn and swinging the clamp slightly, the work may be released. The jig is then ready for a new wheel.

C. A. DINTER

A CHALK PAD FOR DRAFTSMEN

Mr. G. J. Ney's article entitled "A Chalk Pad for Draftsmen," which appeared in the February issue of MACHINERY, has prompted the writer to send in a few lines on the subject.

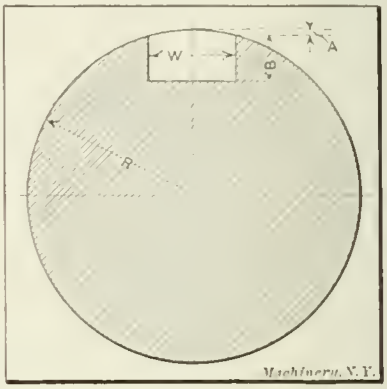
The writer's practice has been to keep powdered chalk in a bag made of cheese-cloth or other loosely woven fabric, and simply rub the bag over the tracing cloth when it is desired to chalk the surface. This method works to best advantage when the bag is only from one-half to three-quarters full. The method followed in preparing these bags is to place the powder in a pile in the center of the cloth, draw the edges together and tie a string tightly around the top, trimming off the surplus with the shears. This forms an oval-shaped bag, similar to the common rubber tobacco pouch or purse, which is very convenient to use. Common dry lump starch has been used for dusting the linen when nothing else was available, with satisfactory results.

The hands of some men perspire to such an extent that it is a practical impossibility for them to keep a drawing clean. This difficulty can be very readily overcome by rubbing the hands with talcum powder, and it is surprising how dirty the hands may be and yet not soil the drawings, when talcum is used. This point came from a printer, and is one that might well be followed, especially in teaching drawing to students who work most of the time in the shop.

Greenfield, Mass. ALBERT L. GRAFFAM

FORMULA FOR KEYWAY MILLING

The formula given below is convenient to use for calculating the depth to which a milling cutter should be fed, in milling a keyway, from the point where it first touches the top of the shaft. The formula gives the height *A* of the arc, as shown in the illustration, and this is added to the actual depth *B* of the keyway. The formula is as follows:



Notation used in Formula for Keyway Milling

$$A = R - \sqrt{R^2 - (\tfrac{1}{2}W)^2}$$

in which

R = one-half the diameter of the shaft.

W = width of keyway.

Example: If the shaft diameter is 10 inches, then $R = 5$. Let the width of the keyway be 2 inches; then $\tfrac{1}{2}W = 1$. Hence,

$$A = 5 - \sqrt{5^2 - 1^2} = 5 - \sqrt{24} = 5 - 4.899 = = 0.101$$

Allentown, Pa. JOE V. ROMIG

RESTORING OVER-EXPOSED BLUEPRINTS

In the How and Why columns in the February number of MACHINERY, "Draftsman" asks for a method of restoring over-exposed blueprints. The following is a method which was used in an office where I was at one time employed. The man who was doing the blueprinting found by accident a method of restoring over-exposed blueprints without chemicals. The method consists in putting the print away after it has been over-exposed in a dark place for a few hours—three or four, or even over night—then wash it as though it had not been over-exposed. At one time we got a roll of paper which did not seem to print evenly, one edge seemed to become burnt before the rest was printed. This difficulty was overcome by over-exposing all the prints, then subjecting them to the dark treatment, and after washing, the prints were found to be all that could be desired. JOHN A. WOOD

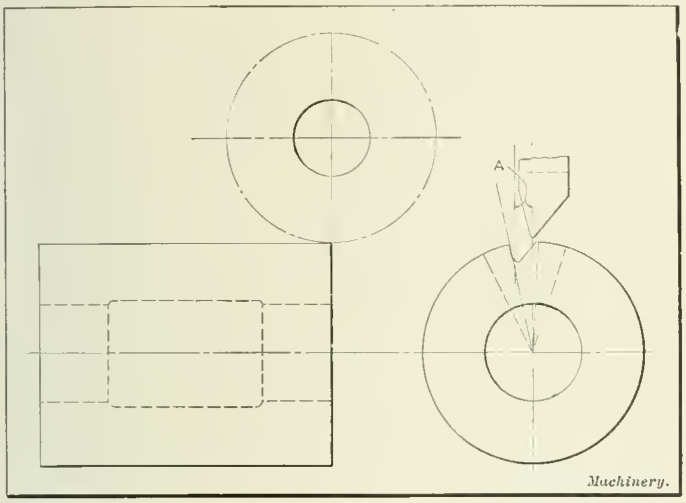
Los Angeles, Cal.

FLUTING SPIRAL MILLS

In the How and Why columns of the July number of MACHINERY, R. H. asks for the simplest and quickest method of setting a milling cutter for cutting the teeth in a spirally fluted milling cutter. The writer assumes that the information R. H. wants is that which will enable him to set the cutter so that the teeth of the mill will be radial on the cutting face. A great many mechanics simply put a mill that is similar to the one that is to be fluted between the centers and set the cutter to this mill, and then replace it with the blank that is to be cut. This is the quickest and simplest method that the writer knows of. It is a crude approximation, however, and is not recommended where accurate results are desired.

The method that the writer follows is to set up the work in the machine, using the table of spirals furnished with the machine for gearing the machine and setting the table to the proper angle. When this is done, take a surface gage and set it to the same height as the center of the index centers, and put the work in the machine and the cutter on the arbor with the twelve-degree side next to the body of the machine, if the mill to be cut is right-hand, and outward, if it is left-hand; then set the cutter so that it is directly over the center of the end of the work on which the cut is to start, as clearly indicated in the accompanying illustration. This can be done by raising the saddle to the lowest position in which the cutter will just score the blank; then, with the traverse feed, move the work from under the cutter, and, using tissue paper as a "feeler," feed it back slowly. When the work just reaches that position in which the paper will be pulled or slightly torn, it is safe to say that the cutter is just over the center of that end of the blank.

With the table standing in this position, index the mill around and scribe off each tooth, letting the scriber marks appear only on that end of the blank where the cut enters. Having outlined each tooth in this way, mark the last line made and turn or index the blank 90 degrees, bringing the marked line to the top of the blank into a perpendicular position. Now, since the angle on the cutter that produces the cutting face of the tooth on the mill is twelve degrees, it is evident that if the marked line that has been brought to the top is thrown over in the direction facing the twelve-degree side of the cutter just twelve degrees, it will be parallel to the twelve-degree side of the cutter, and all that is necessary to do is to feed the cutter into the work with its twelve degree side cutting to the marked line and the other leaving the required amount of land between its cut and the line representing the face of the next tooth. To rotate the blank twelve degrees requires that the index crank be turned one and one-third turn, providing the index head is geared 40 to 1, as the majority of index heads are. Where it requires a different row of holes to index one and one-third turn than it does to index the number of teeth that are to be cut, the hole nearest to one and one-third may be used in the row of holes employed to index the blank, the error from this being in most cases entirely negligible.



Figs. 1 and 2. Setting the Cutter for Fluting Spiral-tooth Milling Cutters

In case the angle on the side of the cutter with which it is desired to make the cutting face of the tooth should not be 12 degrees, the amount to rotate the blank can be determined by the usual plain indexing formula. For instance, should the angle be 15 degrees, then the amount that the index handle would be turned would be 360/15 = 24; 40/24 = 1 16/24, or 1 2/3 turn.

As the amount which the saddle of the machine will have to be moved to get the mill in the proper position (shown at *A*) is governed entirely by the lines which have been drawn on the end of the mill, the importance of having the end of the mill directly under the center of the cutter is readily seen, for if it were not, the amount that the work would rotate, due to the spiral movement, would affect the accuracy.

This method has the advantage of being easily remembered and applied, and may be applied to any angle of cutter on any size blank, regardless of number or depth of teeth. It can also be applied in cutting straight-fluted mills with a double-angle cutter; in that case it is not necessary for the end of the blank on which the teeth are laid out to be under the cutter when sinking it into the work for the trial cut.

Watervliet, N. Y. D. TAPPAN

METHOD OF SETTING CUTTER FOR FLUTING SPIRAL MILLS

In reply to the inquiry of R. H. in the How and Why columns of the July number of MACHINERY, in regard to the simplest and quickest method of setting a double angle cutter for fluting spiral mills, the following practical method, used by the writer, is submitted:

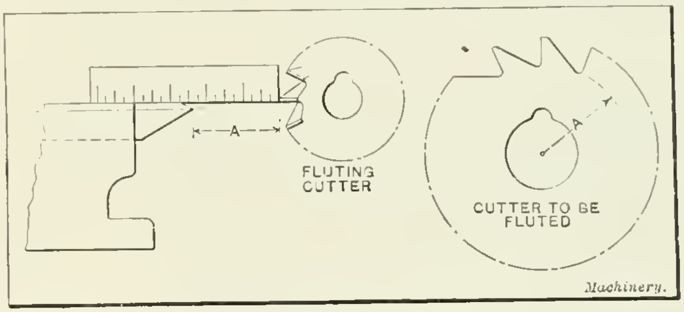


Fig. 1. First Step in Setting Fluting Cutter

After the fluting cutter is placed on the milling machine arbor, but before the work is put between the centers and before the table is swung over to the desired angle, raise the knee so as to bring the index centers approximately in line with the center line of the arbor. Then, by means of the table feed-screw, bring the point of the tail-center to such a location that its distance from the periphery of the fluting cutter is equal to the radius of the cutter to be milled minus the depth of the flute, as indicated in Fig. 1. Next, lay the scale upon the tailstock, pressing the edge against the beveled side of one tooth on the smaller angle of the fluting cutter, and then, by means of the cross feed-screw, shift the saddle over until the point of the tail-center coincides with the edge of the scale, as shown in Fig. 2. Then clamp the saddle, lower the knee, put the work between the centers, and swing the table around to the required angle. The width of the land is now found by taking a trial cut for a short distance, and then indexing to the next tooth for a similar cut. Then index back again and repeat the operation until the desired width of land is obtained. The approximate depth of the flute (required for determining the distance *A* in Fig. 1) may be determined by measuring the depth of the flute on a similar cutter; or by a little practice it can be guessed at close enough for all practical purposes. This method is not mathematically exact, but as the inquiry is for a simple and quick method of setting the cutter, and not for the mathematical calculations for determining exact distances which are very difficult to measure at the machine, it is presented as a more practical method.

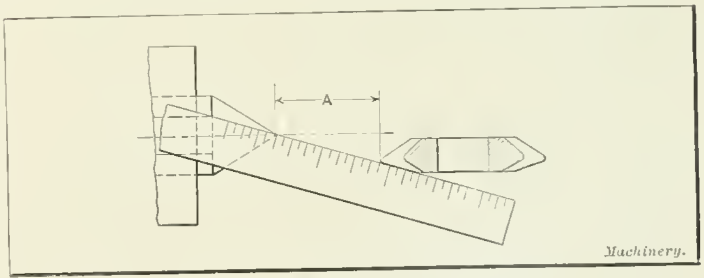


Fig. 2. Second Step in Setting Cutter

L. H.

FRICTION DISKS FOR CUTTING SOFT-STEEL SHEETS

In the How and Why columns of the April number of Machinery, G. F. Co. asks for information regarding friction disks for cutting soft-steel sheets. The best material from which to make friction disks for this purpose is soft steel which has a carbon content of about 0.15 per cent. A brand of steel called "soft-flange steel," which contains very little sulphur, gives satisfactory results.

The peripheral speed of the disk should not be less than 20,000 feet per minute; hence the diameter should be as large as possible to obviate heating the bearings. The disk is used without any abrasive whatever, but the surface should be provided with shallow cross grooves. When the sharp corners of the disk have become worn, it can be "sharpened" by taking a light cut from the periphery.

A large friction saw, in use in the shops of Joseph T. Ryerson & Son, Chicago, Ill., was illustrated and described in the June, 1905, number of Machinery. This saw, which is 52 inches in diameter, is made from ¾-inch soft flange steel, and is run at a peripheral speed of 27,000 feet per minute.

G. Murray

Regarding the question by G. F. Co., in the April issue, I submit the following data on friction saws that may be useful: The proper material for the disk is soft steel, ordinary boiler plate, turned true, and roughened crossways on the edge with chisel cuts, 1/16 inch deep and about 1/4 inch apart. The peripheral speed should be about 20,000 feet per minute. The particular machine with which I am familiar is a rail saw. This uses a 42-inch disk running at 1800 R. P. M. It will cut through an 80-pound rail in about 12 seconds and requires 150 H. P. to drive it. The disks shows very little wear but will become slightly upset in time and requires to be trued up. It will probably be necessary to use a larger disk than the size stated, to secure the required surface speed.

Gary, Ind. H. J. Mastenbrook

In the April number of Machinery in the How and Why columns there is an inquiry for a method of cutting soft-steel sheets with a rotary disk by friction. I notice that the G. F. Co. states that it has tried disks made of tool steel and found them too brittle for the purpose.

I would suggest that a soft wrought-iron disk be tried, using a quality of wrought iron similar to Swedish iron. I am not positive that it will be successful, as the material to be cut is soft also; but hardened tool steel may be cut easily with a wrought-iron disk running at a peripheral speed of from 8000 to 10,000 feet per minute, and a tool-steel disk will not do this, failing in the manner described by the G. F. Co.

Watervliet, N. Y. D. Tappan

AUTOMATIC LUBRICATION OF MACHINE TOOLS

In regard to the editorial in your July issue requesting suggestions for articles that we would like to see in Machinery, would advise that if there is anyone who would see fit to publish recommendations on lubrication for machine shop equipment that will approach other up-to-date methods, we would appreciate them. There appears to be no two machine tool builders who have designed their machines with means for supplying lubrication, other than that depending on the judgment of the operators. We would like to see an account of an investigation that has been made relative to what is required in the way of lubrication of different machines, having bearings of various dimensions and operating at certain speeds. We find that in our shop the practice too often is to leave the lubrication to the judgment of the operator, which in some cases results in an excessive use of oil, flooding not only the machine, but the floor as well, while in other cases the bearings are allowed to go unoiled too long.

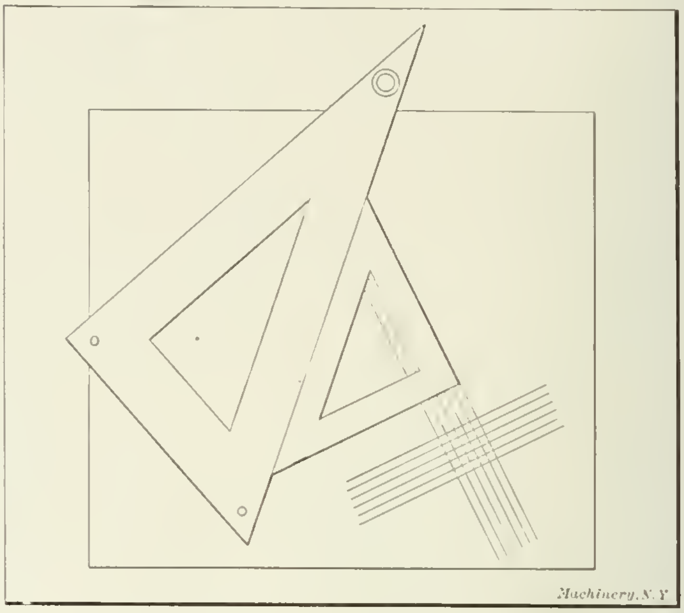
With so much talk at the present on scientific management, it would appear that someone should be able to give us some suggestions on scientific lubrication for machine tool equipment.

J. G. W.

[American machine tool builders have not altogether ignored the subject of continuous or automatic lubrication of important bearings. A milling machine and boring mill on the market provide excellent examples of mechanical lubrication throughout.—Editor.]

DRAWING-ROOM KINKS

In the September number of Machinery is described a method for drawing such parallel lines as come out of the range of the forty-five- and sixty-degree triangles that are customarily used. To my mind there is a very serious objection to this method, as the three pins required to hold the triangle used as a base, would perforate the drawing, which would not be permissible in the majority of cases. A scheme which has been used successfully by the writer consists of drilling three holes in a large triangle, one near each corner; then, by putting a drawing pin in the hole which will give the most convenient swing and holding the opposite end, but little trouble should be experienced in drawing the required lines. As the engraving shows, the pin is inserted clear of the drawing. For making threads and small alterations, the use of a pair of three-inch triangles, one of which is held as a base, has been found to be the best method. If the operative triangle is arranged as shown in the engraving, both vertical and horizontal lines can be drawn at one setting.



Convenient Method of Drawing a Number of Parallel Lines

The following idea has been found very useful: Most draftsmen use two or three different grades of drawing pencils which have no distinguishing marks other than symbols on the end which are not always in a position to be readily seen. This usually means that two or three different pencils are picked up before the proper one is found. To distinguish the different grades, the following method is adopted: 2 H pencil is left plain; 4 H, notched all around the center, the notched part being blackened; and 6 H is notched and left unblackened. This method avoids confusion.

A good kink for users of steel scales is to slide the pencil or metal point down the graduation that marks off the required distance. This will prove to be a great time-saver, relieves the eyes and, in addition, gives more accurate results.

Woonsocket, R. I. Kingston Forbes

PAPER FILE HANDLES—PARALLEL TANGS

I would like to hear from those who have used paper file handles, if they like them as well as wood, or if they find them "sweaty" in the hand. As regards firmness of hold, all files should be made as Prof. Sweet advocated twenty-five years ago, with tangs having parallel sides. That would also lessen the trouble from splitting.

R. G.

[We very much doubt that file tangs with parallel sides would prove satisfactory. Common machine shop practice shows that convenience of applying and removing file handles is an important consideration.—Editor.]

HOW AND WHY

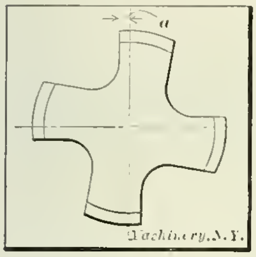
DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST

Give details and name and address. The latter are for our own convenience and will not be published

SETTING CUTTER FOR FLUTING TAPS

R. H.—How should the cutter be set for fluting taps?

A.—The actual methods for setting the cutter must vary according to the form of fluting cutter used, but as a general rule, applying to all forms of fluting cutters, it may be said that the cutter should be so set with relation to the tap that the cutting face becomes radial. This is the general practice for all taps used on steel or cast iron. When taps are to be used for brass, it is common practice to set the cutter so that the cutting edge is slightly in advance of the radial line, or in other words, parallel to a radial line, but ahead of the center, as shown in the accompanying illustration. This provides for a slight negative rake. The amount that the cutting face should be ahead of the center (dimension *a* in illustration) should be from one-sixteenth to one-tenth of the diameter of the tap.



Machinery, N.Y.

MAKING BLUEPRINTS FROM BLUEPRINTS

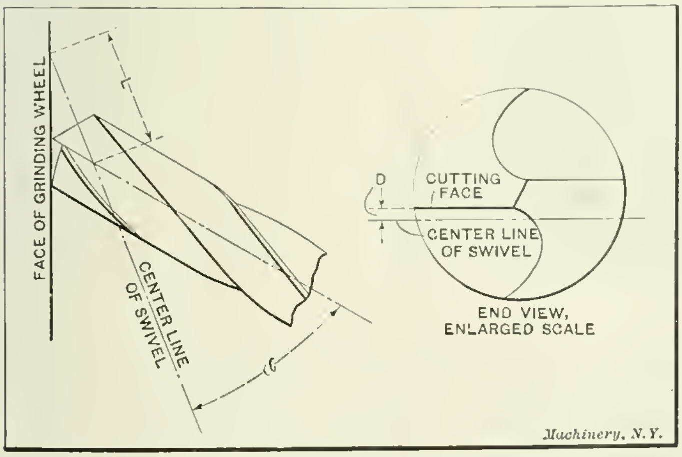
Answered by H. J. Maastenbrook, Gary, Ind.

In answer to Designer's query on, "Making Blueprints from Blueprints," which appeared in the How and Why columns of the March number of MACHINERY, the writer has to say that he has succeeded in doing this on several occasions. To obtain good results, a clear, sharp and rather dark print is essential, for if a print is blurred or light, it will not reproduce satisfactorily.

The method consists in coating the print with a little common kerosene and then printing immediately. The oil used will not affect the printing of the new print unless it is applied very thickly, and it will not spoil the original, as it soon dries out, leaving it in as good condition as before. This process will also work perfectly when it is desired to make prints from heavy drawings. It has been used with success to make blueprints from printed matter. To make the original perfectly transparent, apply a coat of paraffine, boiling hot.

DESIGN OF TWIST DRILL GRINDER

L. K. S.—The following questions relating to the construction of a twist drill grinder are submitted to the readers of MACHINERY: Referring to the accompanying illustration, what should be the angle *a* from the center line of the swivel of the drill grinder to the center line of the drill? What should be the distance *L* from the point where the center line of the swivel intersects the face of the grinding wheel to the point where the same center line intersects the center line of the drill? Give this information for all sizes of drills. What should be the distance *D* from the cutting face of the drill to the center line of the swivel for all sizes of drills?

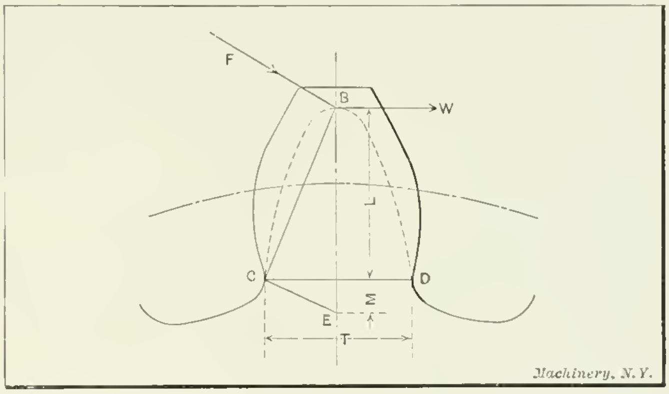


Machinery, N.Y.

STRENGTH OF GEAR TEETH—DERIVATION OF LEWIS' FORMULA

H. B.—Is there any commonly accepted rule for the strength of cast gear teeth? The Lewis formula for the strength and capacity of gear teeth does not exactly meet the requirements as it deals more particularly with cut gears, carefully designed and manufactured. How is the factor *Y* in the Lewis formula obtained?

A.—There is a great deal of discrepancy between the various rules published by different authorities, largely due to the many varying conditions met with in gearing, these conditions depending upon the materials, the methods of producing the gear teeth, the conditions of service, etc. It might be well said that no rule for the strength of gear teeth is complete unless it states definitely for what class of gears it is intended. For cut gears the Lewis formula is accepted as standard. For cast gears it would seem that the best method would be to use the Lewis formula so modified as to give a factor of safety two or three times that required by this formula, depending upon the severity of the conditions in each case. A general rule for cast gears, used under so many varying conditions, could hardly be satisfactorily devised. The designer's judgment must be depended upon to a considerable extent in the selection of the suitable factor of safety which will be required in excess of that required for cut gears.



Machinery, N.Y.

As an indication of the uncertainty of the rules given by various authorities, Mr. Lewis mentions in his paper on the "Strength of Gear Teeth," read before the Engineers' Club of Philadelphia, October 15, 1892, and published in the proceedings of the club, January, 1893, that Mr. J. H. Cooper in making an investigation found that there were not less than forty-eight well-established rules in existence for the strength and capacity of gear teeth, these rules being sanctioned by twenty-four different authorities and giving gear teeth varying 500 per cent in ultimate strength.

The factor *Y* in the Lewis formula is deduced as follows: In the accompanying illustration a $14\frac{1}{2}$-degree involute tooth is shown in outline. The pressure *F* transmitted to the gear tooth at an angle of $14\frac{1}{2}$ degrees to a tangent to the pitch circle, may be considered as having two components, one of which is radial and tending to crush the tooth, and one tangential, tending to break off the tooth. The only component we need to consider in connection with the strength of gear teeth is the tangential component *W*. This component, as shown in the accompanying illustration, is not considered as acting upon the tooth at its top, but at the point *B* where the line representing the pressure *F* intersects the center line of the tooth. The line of pressure, of course, is considered as passing through the corner of the tooth as indicated.

Any parabola having the line *BE* for an axis and passing through the point *B*, so that the line representing force *W* is a tangent to the parabola at this point, encloses a beam of uniform strength. By graphical construction it can now be determined in each case where the point of tangency between the parabola and the contour of the tooth form occurs. The point of tangency determines the weakest section of the tooth, as shown at CD. This weakest section is not necessarily at the very root of the tooth, but may—particularly in gears with a small number of teeth—be located a considerable distance above the root of the tooth; hence the distance L, the length of the beam, is measured not to the bottom of the tooth, but to the line CD.

In order to determine the value Y in the Lewis formula, draw the lines BC and CE, the latter being at right angles to BC and intersecting the center line of the tooth at E. In the following formulas:

S = the fiber stress,

A = the width of the face of the gear,

P = circular pitch of gear,

L, M, T and W denote quantities as indicated in the illustration.

Then we have:

$$WL = \frac{SAT^2}{6}, \text{ or } W = \frac{SAT^2}{6L}$$

But, by similar triangles,

$$M = \frac{T^2}{4L}$$

Hence

$$W = SA \times \frac{2}{3} M = SAP \frac{2M}{3P}$$

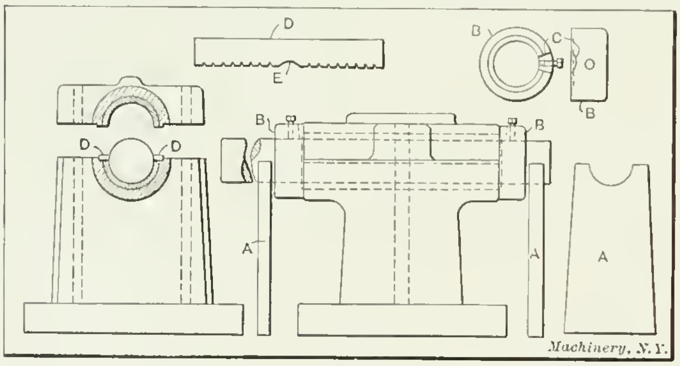
where $\frac{2M}{3P} = Y$, the factor in the Lewis formula.

BABBITTING BOXES

Answered by Charles Iselin, Newark, N. J.

In the "How and Why" columns of the July number of MACHINERY the writer noticed a query from J. P. regarding information on babbitting boxes; the writer wishes to submit the following methods, which from experience he has proved to be simple and easily applied:

Pillow blocks, which are usually very large, require a considerable amount of babbitt metal. They are customarily babbitted half at a time for various reasons, which are obvious and need not be mentioned. The method of locating and securing the babbitt arbor, which is usually a hollow cast-iron shaft, is necessarily governed by local conditions so any complete instructions for so doing cannot be given. As illustrative of performing such work the writer has selected a sample box which he had occasion to babbitt in a jobbing shop, where several engines had to be built on contract; this bearing is shown in Fig. 1. After determining the correct height at which to set the arbor for babbitting the block, two saddle pieces, such as are shown at A, are made and blocked up under the babbitting arbor with collars B at each end to locate them; these collars are slightly recessed on the inner faces in order that the babbitt may protrude a short distance from the end of the bearing. This permits the babbitt to shrink slightly, and at the same time leaves enough for peening over and finishing off to a good surface. These collars have a channel C cut in the top for pouring in the babbitt.

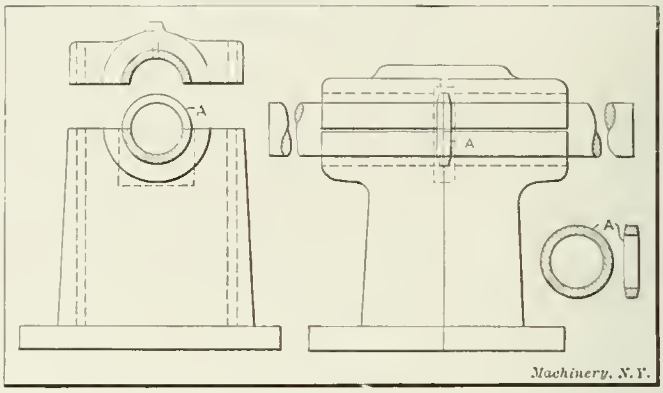


Machinery, N. Y.

Fig. 1

The end view in Fig. 1 shows the bearing set up to be babbitted in halves and the side view shows the bearing prepared to be babbitted as a unit. In the former case the arbor is located, the collar set up and two liners D set up against the shaft as indicated. These liners have a cut-out E into which the babbitt may be poured. When properly located all crevices and openings are stopped up with a coating of soft clay or putty, only the notched edge of the strips D are left to act as vents. These strips should be secured in place either by weights or by the regular bolt holes in order that the molten babbitt will not float them from their correct location. These liners leave the surface in a smooth condition with the exception of the little projections of the vent holes, which are readily removed with a keen-edged chisel. The use of the recessed collars becomes apparent, for without them the shrinkage of the babbitt metal would leave a slight recess at each end which is counteracted as mentioned. On large boxes, 1/16 inch is allowed for recessing, while on boxes 3 inches in diameter and smaller, 1/32 inch is found sufficient.

After the lower section of the bearing is babbitted, the upper section is thoroughly cleaned and placed in its correct location over the lower section with the regular liners intervening, care being taken that all the babbitt surface of the lower section is protected so that none of the molten babbitt of the top will reach it and thereby injure the surface. To facilitate the pouring of the metal it is advisable to build up a dam of clay or putty around the sprue opening C. When the box is completely filled with metal, pause for a few seconds until it is found that the metal has contracted sufficiently to allow a little more to be introduced. When the babbitt has solidified, the bearing is disassembled and all projecting fins scraped or cut off.



Machinery, N. Y.

Fig. 2

As previously mentioned, smaller boxes may be babbitted as a whole, as illustrated in the side elevation of the bearing in Fig. 1. In such a case temporary liners of the same thickness as the regular liners are inserted and the process proceeds as before. After solidification the cap may be taken off by driving a chisel or any kind of a wedge tool between the joint, when the little connecting tips occasioned by the intervening liners will break off freely, not injuring the main body of the metal.

The method of babbitting bearings which have an oil pocket for chain or ring lubrication, is carried on in a slightly different manner. A flared ring, as indicated at A in Fig. 2, is made to fit the babbitt arbor and facilitates the operation of babbitting; the tapered flare makes it possible for the box to be taken apart in halves after babbitting. Soft clay is used by many as a stopper for babbitting and may also be used to fill the oil pocket in the bottom half of the box. The writer's experience, however, has not been very favorable towards the use of soft clay, for, if it is a little too damp, the hot babbitt will sputter, not making a good job. A better method of procedure is to fill the oil-pocket with dry sand and, if necessary, use a little putty instead of the soft clay. It will be found by using this method that the babbitt will run much more smoothly, forming a neater job.

* * *

When screwing pipe into fittings, or "making up joints," the common practice is to put the joint compound on the pipe threads or in the fitting threads alone. An even distribution of the compound is rarely effected in this way and leaky joints are a common result. A better distribution of compound will be secured if it is put on both the pipe and fitting. While it takes somewhat longer to apply the compound in this manner, the number of leaky joints will be decreased sufficiently to make the practice pay.

NEW MACHINERY AND TOOLS

THE COMPLETE MONTHLY RECORD OF NEW DESIGNS AND IMPROVEMENTS
IN AMERICAN METAL-WORKING MACHINERY AND TOOLS

GARDNER VERTICAL-SPINDLE DISK GRINDER

An interesting development in disk-grinding machinery is illustrated in Figs. 1 and 2 which show front and rear views of what is said to be the largest disk grinder ever manufactured, as far as the diameter and weight of the disk wheel itself is concerned. This grinder is a recent product of the Gardner Machine Co., Beloit, Wis., and it is a development of the old horizontal lead lap, in that the principle of operation is the same; there is, however, a decided difference in the efficiency of this new machine, as well as in the class of work to which it is adapted.

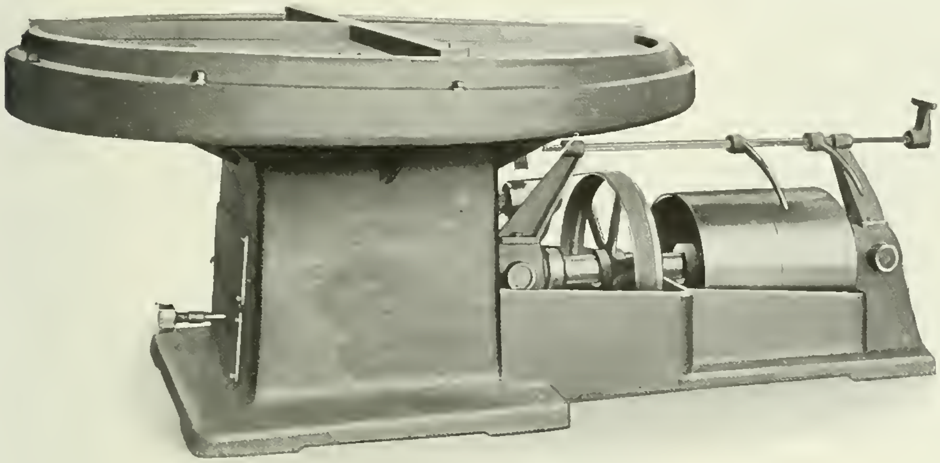


Fig. 1. Gardner No. 24 Vertical-spindle Disk Grinder

As will be noted, this new machine differs from the ordinary type of disk grinder in that the disk is mounted on a vertical spindle and revolves in a horizontal plane. The disk or wheel is 53 inches in diameter and weighs nearly 700 pounds. It is supported by an exceptionally large and heavy cast-iron flange, mounted on the vertical spindle which runs on a ball-bearing step. Power is transmitted to the wheel from a belt-driven horizontal shaft connecting, through bevel gears inside the base of the machine, with the vertical spindle. These bevel gears are of ample size and have planed teeth. One gear is of steel and the other of high-grade phosphor bronze and both are tightly enclosed and run immersed in oil. This construction insures very quiet operation.

As the engravings show, the countershaft with its mounting forms an integral part of the machine. It is provided with tight-and-loose pulleys having a diameter of 14 inches and a face width of 8 inches. The countershaft also carries an 18-inch pulley for driving an exhaust fan which is set on the floor at the rear of the machine, as illustrated in Fig. 2. A tapering air passage, which is cast into the base, extends entirely around and underneath the outer edge of the wheel and terminates at the rear, where connection is made with the exhaust pipe and fan. In this way the dust incident to the grinding operation, is taken care of. The air passage is provided with openings directly beneath the outer edge of the wheel and these openings are graduated in size to produce an even draft of air all the way around.

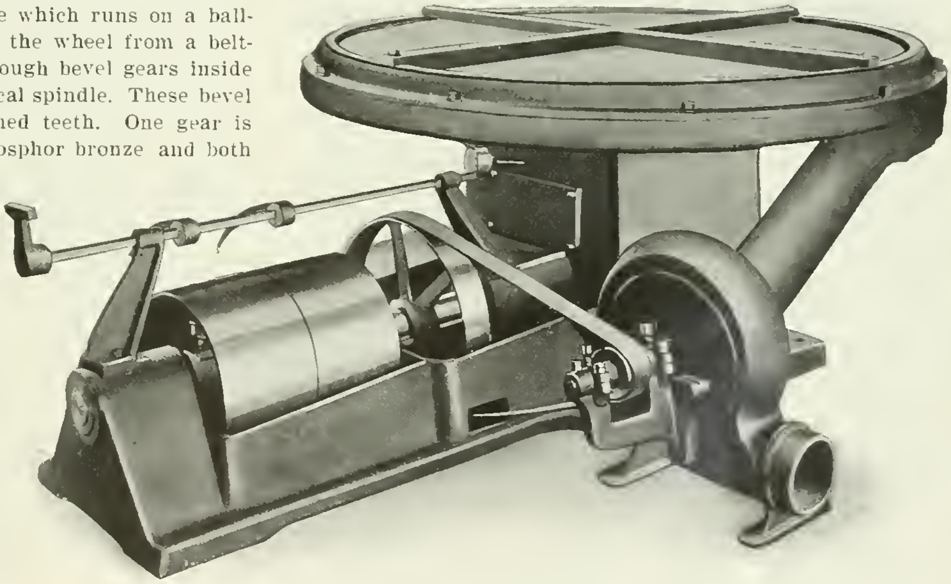


Fig. 2. Rear View of Vertical-spindle Disk Grinder showing Dust Exhaust Fan

A cast-iron ring is fastened to the top of the base with collar-head screws, as shown, and to this ring, different forms of work-holders may be secured. The particular work-holder illustrated is simply a cross made of bars of hard wood and is intended for holding four parts simultaneously. Owing to the size of the disk-wheel, four pieces of considerable size may be held, such as foundry flasks, gear-cases, etc., having diameters up to 18 inches, or rectangular shapes measuring 16 by 18 inches. For still larger castings a single bar may be fastened across the center, thus enabling two large pieces to be ground at the same time. When very large castings need to be ground, these can be held by two short bars at the sides.

In operating this machine, the work is simply laid on the revolving disk. If the weight of the work is equal to three or four pounds pressure to the square inch of area to be finished, no additional pressure is required, but in case it is less than that, the output can be greatly increased by putting additional weight on top of the work. Fig. 3 shows the machine grinding three-horsepower gas-engine base castings, four of these castings being placed on the disk and ground simultaneously. This particular operation was simply to produce a flat even bearing surface without removing any unnecessary stock. The time for doing this work is about one minute per casting. This machine is also very efficient for many kinds of free-hand grinding, no effort being required to support the work, and tests made with different classes of work are said to have shown very efficient results.

The abrasive disks used on this large wheel are made in halves or semicircles; these are cut from sheets 27 inches wide, which, until recently, was about the maximum width obtainable. The abrasive disks are held against the wheel, while being cemented, by a pneumatic diaphragm press. The wheel also remains permanently on its spindle, as it would be difficult to remove without using a crane, owing to its weight. This press, which is shown attached to the grinder in Fig. 4, consists principally of a sheet-metal cone having a diaphragm made of heavy air-proof canvas, cemented to the bottom. When applying the press, the cast-iron shield ring is first removed from the base; the abrasive disk is then placed on the cement-coated wheel, after which the diaphragm press is laid on top. The press is clamped to the wheel around the outer edge, as shown in the illustration, and air is pumped into the cone-shaped enclosure with a bicycle pump, until the gage shows a pressure of about two pounds. The press is kept on the wheel and the pressure is maintained for about two hours. Any slight leakage of air will show on the gage, and if this occurs, the pressure should be kept up to the two-pound mark by additional pumping. To remove the press, the air is first blown off by means of an air-cock, before loosening the clamps. This new method of cementing the disks gives a uniform pressure over the entire surface of the wheel and the required pressure is easily obtained; in fact, this new diaphragm press is said to have made the immense increase in the size of disk-wheel practicable.

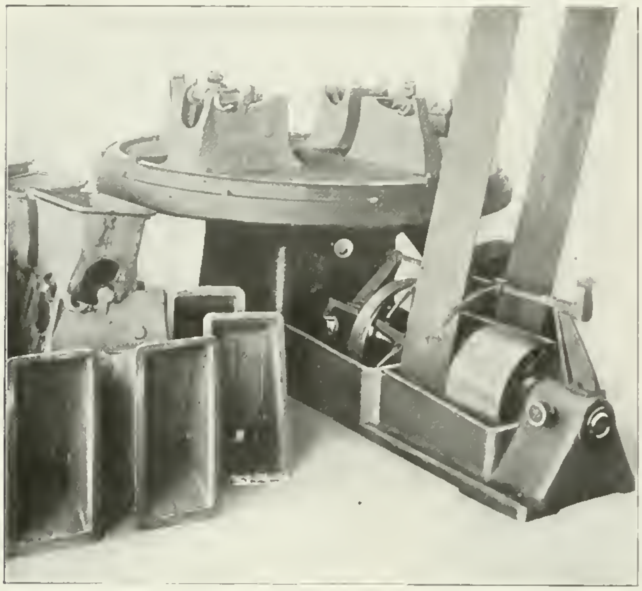


Fig. 3. Four Gas-engine Base Castings being ground simultaneously on Vertical-spindle Disk Grinder

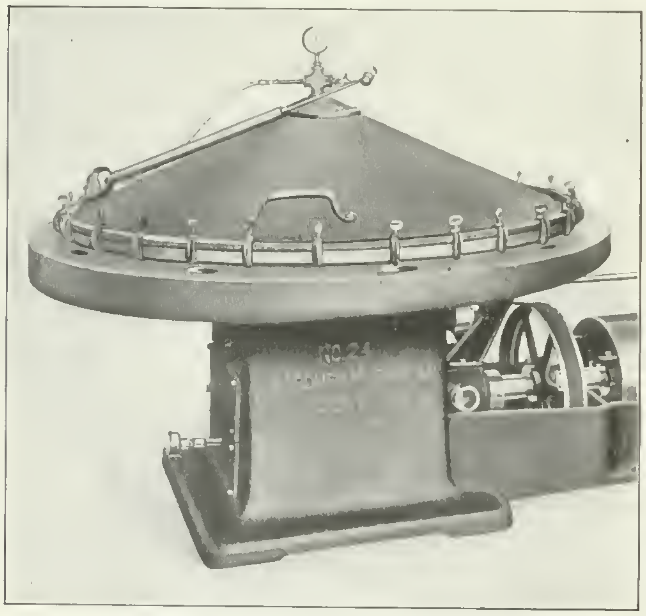
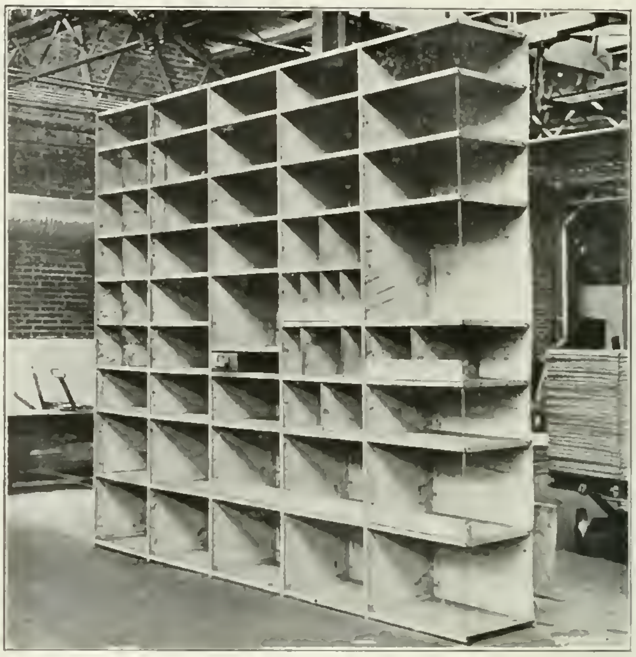


Fig. 4. Pneumatic Diaphragm Press used when cementing Abrasive Disks to Wheel of Vertical-spindle Grinder

BERGER'S SECTIONAL STEEL BINS

The use of steel bins for the storage of material in the shop or foundry not only effects a saving in space but affords considerable protection from fire. A steel bin of the sectional type, for which many advantages are claimed, has been brought out by the Berger Mfg. Co., Canton, O. This type of bin, a section of which is shown in the accompanying illustration, with the end upright removed, is so constructed that each shelf is independently adjustable to different heights and locations to accommodate large patterns, castings, cores, etc. In fact, these shelves can be arranged to suit any of the numerous articles in everyday use in the shop or foundry. Removable bin boards are also supplied to order for retaining small parts in compartments that are filled to their capacity. The vertical partitions, which may be quickly put in position, also add to the utility of these steel bins. Label holders extend the entire length of each shelf so that no matter where a shelf is located or how it is sub-divided, these continuous holders afford a place to easily and plainly mark the contents of each division. Extensions can be added to the lower bins to make them deeper and more roomy, and these at the same time form a convenient shelf on which to rest boxes or heavy articles that are either in use or being placed in the upper shelves. Regular bin boards can be used for these extensions. The shelves are so constructed that each one forms a brace by the manner in which it is fastened to the permanent upright partition, so that each shelf adds to the strength and stiffness of the entire structure. As the illustration shows, the space within the bins is entirely free from braces and supports, thus giving a maximum storage space.


Sectional Steel Bin built by the Berger Mfg. Co.

BROWN & SHARPE CASTELLATING ATTACHMENT

Automobile manufacturers and others building machinery requiring locking nuts will doubtless be interested in the new attachment brought out by the Brown & Sharpe Mfg. Co., Providence, R. I., for use on the No. 2 automatic screw machine. This attachment is designed for the purpose of castellating hexagonal nuts after the latter are cut from the bar, thus finishing them completely in the same machine. In this way an appreciable saving in time and labor is effected, and the necessity for special machines to do this work is obviated. The attachment is a compact, efficient, mechanism and can readily be placed in position or removed from the machine when not in use.

The accompanying engravings show front and rear views of the attachment. The mechanism consists of a set of three saws for slotting the nuts, an indexing mechanism for locating the nuts in the proper positions to be slotted, a feeding mechanism for the cutters, and a transferring arm for taking the nuts as they are cut from the bar and carrying them to the attachment. With the exception of the saws, the mechanism is driven from the cam shaft of the machine. The saws are driven directly by a belt from the overhead works. The nuts to be castellated are inserted in the bushings held in a magazine plate fastened to a sleeve on the main spindle of the attachment. Different sizes of bushings can be furnished to accommodate different sizes of nuts, there being a capacity for nuts measuring from 9/16 inch across flats and 3/8 inch thick, to those measuring 7/8 inch across flats and 5/8 inch thick. There are six bushings in the plate.

The operation of the attachment is as follows: As the nut is cut from the bar, the transferring arm *A* takes it and swings back to a position opposite a bushing in the magazine plate *B*. When the arm swings back, or into position facing the plate, a flat spring *C* rotates the nut so that its position is correct relative to the hole in the bushing of the plate. The arm then moves forward until the small pin that extends radially from the stud upon which the nut is carried, comes in contact with its stop. The arrangement for carrying the nut consists of a stud that is inserted in a bushing and is forced forward by a spiral spring. As the pin referred to reaches its stop, the bushing is forced further forward by the arm, with the result that the nut carried on the end of the stud is pushed off and into the hexagonal hole in the bushing in the plate. At the same time, a nut that has been castellated is pushed out at the back of the plate bushing by the entering nut. As soon as the nut has been inserted, the mechanism indexes and the plate is moved one-sixth of a revolution; then it is in a position to be slotted by the first cutter. While it is being slotted, another nut is being inserted by the transferring arm. When the mechanism indexes again, the first nut is moved to a position midway between the first and second cutters. At the next indexing, the plate has moved one-sixth of a revolution further, or one-third of a revolution from the first cutter, bringing the first nut in a position to be cut across by the second cutter. Two more indexings bring the nut into position to be operated on by the third cutter and at the end of the following indexing, the finished nut is ejected from the plate at the starting point by a new nut that is being inserted.

The sprockets and chain that drive the indexing and feeding mechanism are shown in the front view Fig. 1. The indexing mechanism consists of a segment of a gear mounted upon the shaft driven by the sprocket chain. Each time this segment revolves, its teeth engage with a gear fastened to the main spindle sleeve of the attachment and move the plate holding the nuts one-sixth of a revolution. When this movement has been made, the cylindrical cam *D* on the sprocket wheel shaft, proceeds to feed the geared head carrying the cutters forward. As it does so, the plate holding the nuts is positively locked in position. A pressure plate *E*, is mounted on the geared head to securely hold the nuts in the plate while they are being slotted. It has three slight projections which bear upon the nuts as they are operated upon by the cutters. The cutters extend through slots in this plate, and the plate is held firmly against the nuts by springs. This plate automatically compensates for any variation in the nut due to the amount of burr left from cutting off.

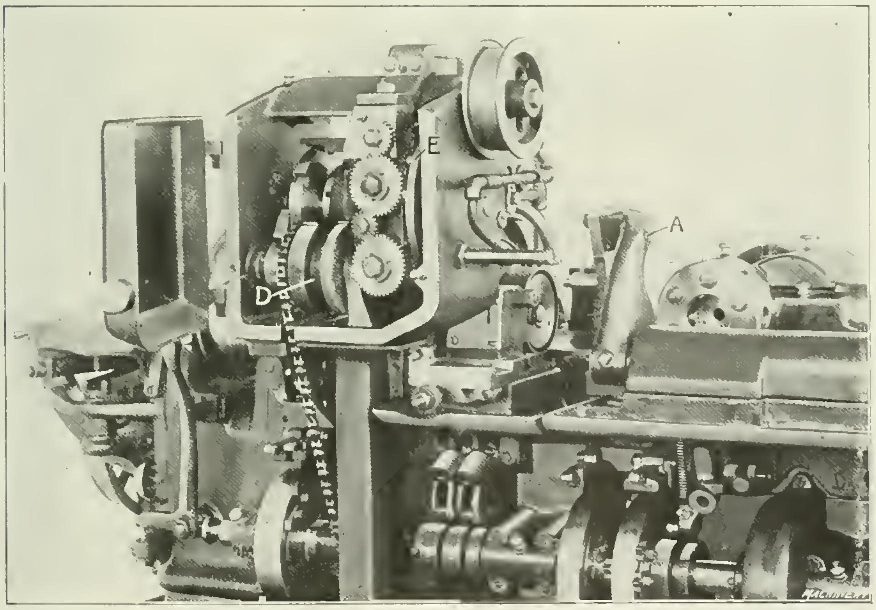


Fig. 1. Castellating Attachment applied to Brown & Sharpe Automatic Screw Machine

From the foregoing, it is seen that the operation of castellating a nut consumes the time of milling one slot and indexing the disk one-sixth of a revolution. It has been found that the time required for making the nut in the machine itself gives ample time for this sawing and indexing. With this attachment, the Brown & Sharpe Mfg. Co. has produced as many as a thousand nuts a day and the saws have been run for ten days without grinding.

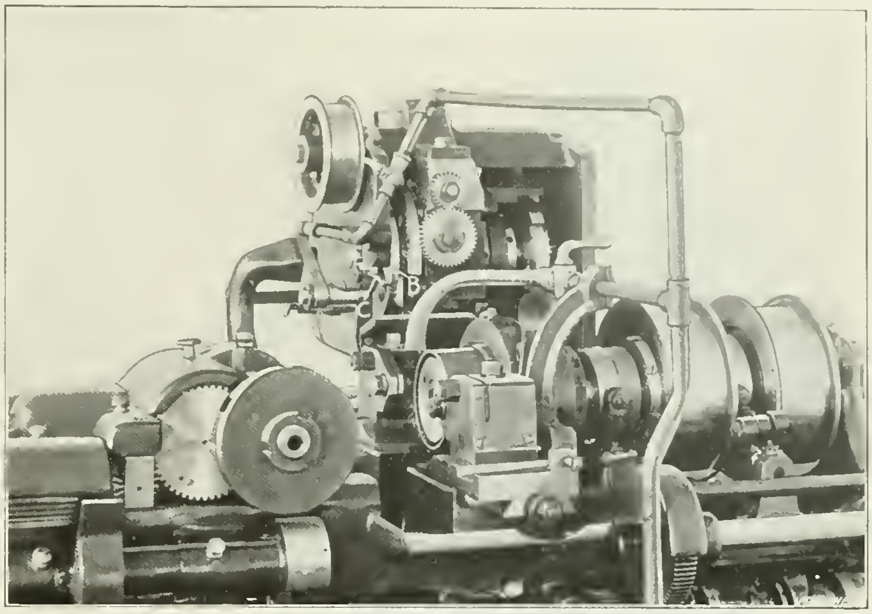


Fig. 2. Rear View of the Brown & Sharpe Castellating Attachment

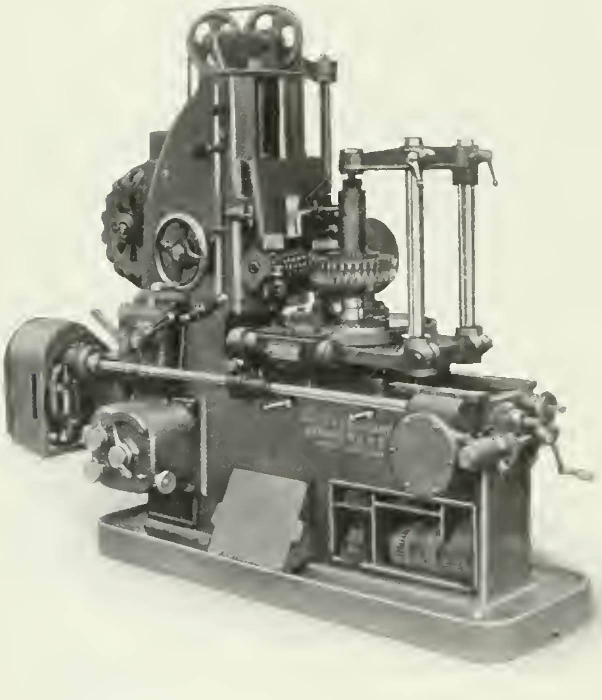
GOULD & EBERHARDT WORM-WHEEL HOBBING ATTACHMENT

The accompanying illustration shows a 24- by 8-inch spur and bevel gear cutting machine arranged with an automatic worm-wheel hobbing attachment and constant-speed motor drive, as designed and manufactured by Gould & Eberhardt, Newark, N. J.

The design of the vertical cutting machine is well adapted for the hobbing attachment, and. as arranged, the attachment does not interfere with the regular operations of the machine. The hob is mounted on the vertical cutter slide, and the latter is adjusted so that the center of the cutter arbor is in line with the center of the worm blank to be cut, and it is securely locked in this position. In order to insure that the cutter slide feed or return clutch does not engage and move the hob out of position, thus spoiling the blank, a safety pin has been provided to hold the trip lever and clutch in the proper position. The direct-reading cutter-slide feed dial can also be placed at zero, at which point the cutter-slide feed gears are disengaged which doubly prevents the cutter slide from feeding.

A chart is furnished for gearing the index mechanism, the same as for spur gears, according to the number of teeth in the worm-wheel, for maintaining the proper relation between the hob and the work. The feeding in of the blank is automatically taken care of by means of a feed lever and pawl which derives its motion from the worm-shaft through a worm and worm-wheel. The amount of feed per revolution of the blank may be changed by means of a cam and dial graduated in thousandths. The blank is then fed in to the proper depth of tooth. A dial, graduated in thousandths, is provided on the table feed-screw, and a scale and vernier are also furnished on the side of the machine, which allows the operator to ascertain at any time the exact center distance between the cutter spindle and the work mandrel. The machine is shown in the illustration cutting a steel worm-wheel having thirty-six teeth of ¾-inch circular pitch and a 2½-inch face width.

When the hobbing attachment is not needed, the worm on the worm-shaft, that imparts motion to the in-feed mechanism, may easily be disengaged, so that these parts do not rotate and become worn when the machine is being used for cutting spur and bevel gears. There is an adjustable safety guard over the driving pulley, and all running gears are enclosed with guards.



Gould & Eberhardt Automatic Gear-cutting Machine with a Constant-speed Motor Drive and Worm-wheel Hobbing Attachment

PRATT & WHITNEY QUICK-ACTION MANUFACTURERS' VISE

A new type of vise that is particularly adapted to milling machine work, has recently been placed on the market by the Pratt & Whitney Co., Hartford, Conn. This type of vise has been used extensively and with unusual success by this company in connection with milling operations and especially for gun work. The design of the vise is very compact, and in operation it has practically the rigidity of a solid casting.

The operation of the vise is exactly opposite to the ordinary screw vise in that the inner or central jaw, against which practically all of the working strains come, is bolted stationary and the outer jaw is movable. The outer jaw-holder, which is made from a steel forging, passes underneath and is supported by the stationary jaw, and it is actuated by a hardened cam which is forged integral with the operating lever. The form of the cam is such as to give a very rapid and efficient binding action and at the same time a wide opening to the jaws. The construction is such as to easily permit the removal and insertion of special jaws.

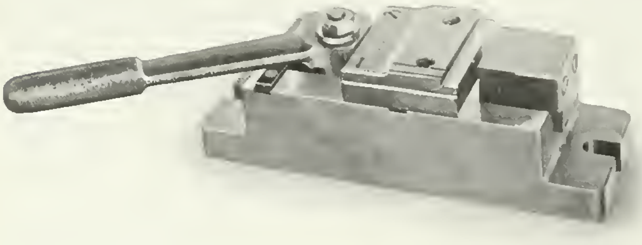


Fig. 1. Pratt & Whitney Quick-action Manufacturers' Vise

The vise is made in either single or double sizes, as shown in Figs. 1 and 2, respectively, and it is suitable for the Pratt & Whitney hand, No. 2 column power, and Lincoln milling machines. When made double, one set of jaws is supported by a wedge, as shown, by means of which a vertical adjustment is obtained to compensate for any variation of milling cutters due to uneven wear. The vise may readily be arranged to accommodate a large variety of work by means of special jaws. These vises are regularly furnished without jaws.

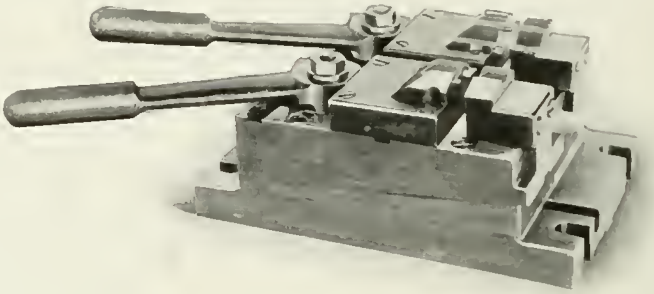
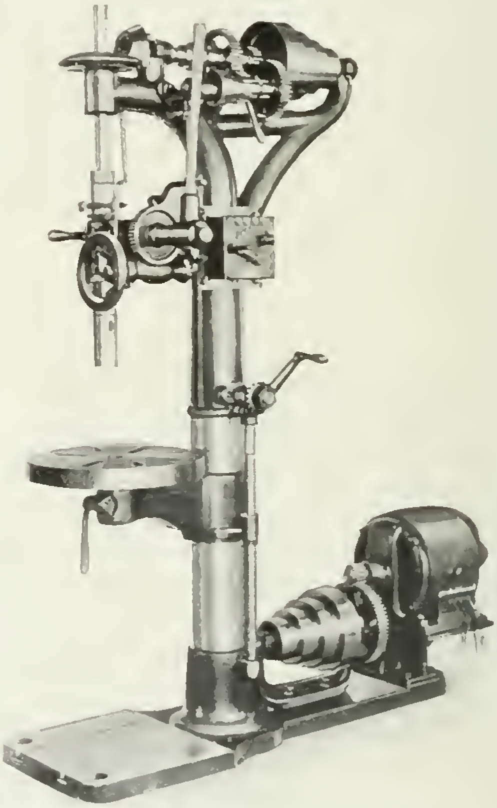


Fig 2. A Double Vise with Vertical Adjustment for One Set of Jaws

SIBLEY MOTOR-DRIVEN DRILLING MACHINE

A recent addition to the line of drilling machines manufactured by the Sibley Machine Tool Co., No. 8 Tutt St., South Bend, Ind., is illustrated herewith. This is a new design of 20-inch motor-driven upright press. The motor is mounted on the base at the rear and drives direct through gearing to the lower cone pulley as the engraving shows. This arrangement brings the weight down low and adds to the stability of the machine.



Sibley 20-inch Motor-driven Drilling Machine

All the working parts are generously proportioned and there is practically no spring between the head and table arm, as both of these parts have been made strong enough for much heavier work than the capacity of the press. The back-gears have a ratio of about 4 to 1, which, in conjunction with 2 to 1 driving gears and large cones, delivers ample power to the spindle.

The feed worm-gear is driven by a steel worm running in an oil bath which insures constant and thorough lubrication.

A steel feed lever is provided which is light enough for sensitive work and at the same time strong enough for heavy drilling operations. The change from lever to wheel feed is effected by a slight twist of the lever, and both feeds are independent of each other. An adjustable automatic stop collar on the spindle sleeve trips the latch which releases the worm-box lever and the entire mechanism swings away from the worm-gear on a hinge-pin, thus disengaging the feed. This worm-box lever also provides means for taking up any wear of the worm or worm-gear which may occur. The vertical feed shaft is driven by a worm-gear and worm running in oil, and the worm derives its power from the top shaft through a cone pulley.

Particular care has been given to the finish of this machine, the spindle and sleeve bring ground and other parts polished. All rough surfaces are painted with egg-shell enamel. This design is made with or without back-gears or power feed, and it may have either a geared or belted motor drive, reversing countershaft, or a geared tapping attachment. The 20-inch machine drills to the center of a 20¼-inch circle. The feed of the spindle is 8 inches; the maximum distance from the spindle to the base, 41½ inches; and the maximum distance to the table, 24 inches. The hole in the spindle is a No. 3 Morse taper. The diameter of the table is 16½ inches; diameter of the spindle 1¼ inch; and the diameter of the column, 5¼ inches. The shipping weight is 650 pounds.

INGERSOLL CUTTER GRINDER

An improved type of cutter grinder, designed to sharpen the large inserted-tooth milling cutters now used so extensively, with the same degree of accuracy as the smallest size within its range, is now being built by the Ingersoll Milling Machine Co., Rockford, Ill. This machine embodies several interesting and original features, and it has a capacity for grinding face milling cutters ranging from 4½ to 24 inches in diameter and with widths varying from ⅛ to 4 inches. In addition, it will grind either the face, side, or corner of any milling cutter within the range given, at one setting of the cutter, thus saving the time that would otherwise be required for the re-setting operation. The corner of the cutter may be ground either round or angular in shape, and cutters of any angle can also be sharpened on this machine at one setting. Provision is made for wet grinding, and the arrangement is such that the cooling fluid is not thrown about the floor.

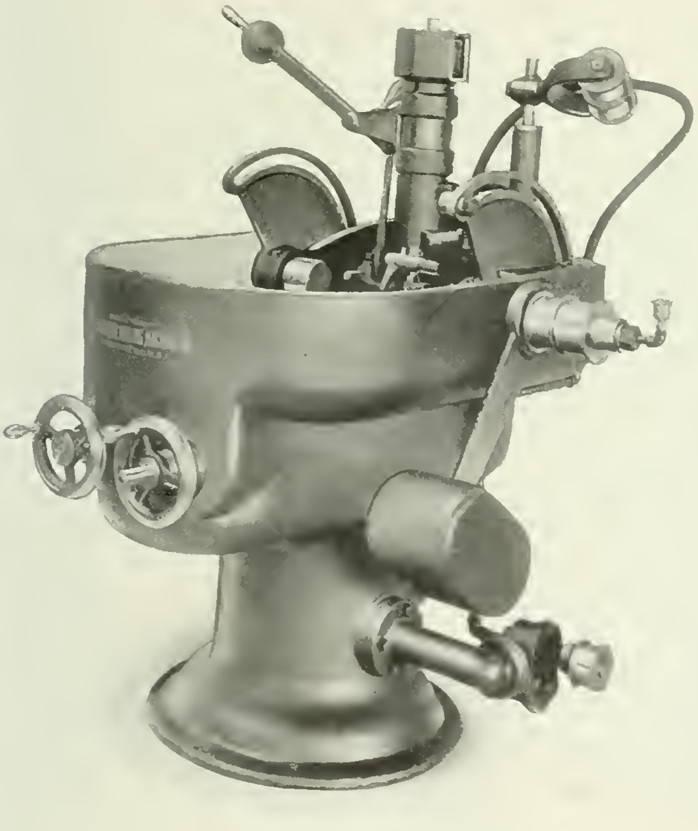


Fig. 1. Twenty-four inch Cutter Grinder built by the Ingersoll Milling Machine Co.

The construction of this grinder and its operation will be explained in connection with Figs. 1, 2 and 3. The cutter to be ground is mounted on an arbor *A* which is carried in spindle *B*. As this spindle revolves on a ball bearing, it has a sensitive movement so that the cutter tooth being ground is easily guided against finger *H*. The work-spindle is mounted in a quill *D* which may be adjusted vertically by pinion *E*, and the work with its spindle and quill is carried by a saddle *F*. This saddle has a horizontal adjustment along slide *G*, and the handwheels for both the vertical adjustment of the quill and the horizontal movement of the saddle, are graduated to thousandths of an inch. This horizontal and vertical movement is all that is necessary to place the cutter in the proper position for grinding. The emery wheel *I* is mounted on a spindle *J* which revolves in bronze bushings *K*, having a taper cone *L* to take up lost motion, if necessary. The spindle is carried in a sleeve *M* which has a vertical movement of 5 inches effected by means of the counterweighted lever shown in Fig. 1. The sleeve carrying the spindle is, in turn, mounted in a saddle *N* having a hand adjustment of 1½ inch operated by handwheel *O* which is also graduated to thousandths of an inch. This saddle, with the grinding head, is carried by a counterweighted yoke *P* mounted in roller bearings. This yoke, the counterweight for which may be seen at the side of the machine in Fig. 1, can be swung through an arc of 90 degrees from the horizontal to a vertical, and its angular position at any point is shown by quadrant *R*, which is graduated in degrees. This angular adjustment of the grinding head makes possible the sharpening of the cutter at one setting. Two stop or guide-fingers *H* are furnished for grinding either right- or left-hand cutters, and by means of a center gage, these fingers are set for grinding the proper degree of clearance. There are also four radius gages furnished, three of which are for grinding corners to a radius of ⅛, ¼, or ⅜ inch, and the fourth is for grinding a square corner. The method of setting the center and radius gages will be described later on.

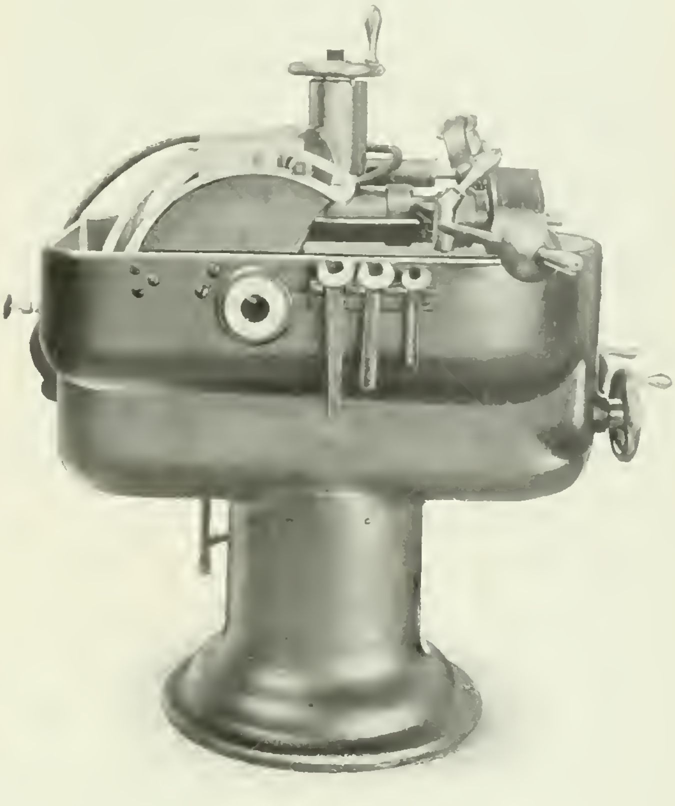


Fig. 2. Cutter Grinder in Position for Grinding Side of Cutter

When the cutter has been set and the finger adjusted, the operation of grinding consists in holding the tooth against the finger stop with one hand and feeding the grinding wheel across the face of the tooth with the other. This operation is repeated for each successive tooth until all are ground on the face; the yoke or grinding head is then swung over 90 degrees, or to whatever angle is desired, and the side of the tooth is ground in the same manner. Fig. 2 shows the position of the grinding head when the yoke is in the 90-degree position. For grinding angular cutters, the yoke is simply set to the desired angle, as shown by the quadrant, and the operation as described for grinding the sides and faces of the teeth is followed. When "round corners" are to be ground, the spindle sleeve is locked by a stop on the yoke, and the radius gage to which the cutter is set determines the radius of the corner of the tooth. This corner is then ground by swinging the counterbalanced yoke over each tooth. When the teeth are being ground, a flow of cutting fluid, regulated by valve *S*, is directed on the cutter through nozzle *T;* the fluid then drains to tank *U* from which it is again pumped to the work.

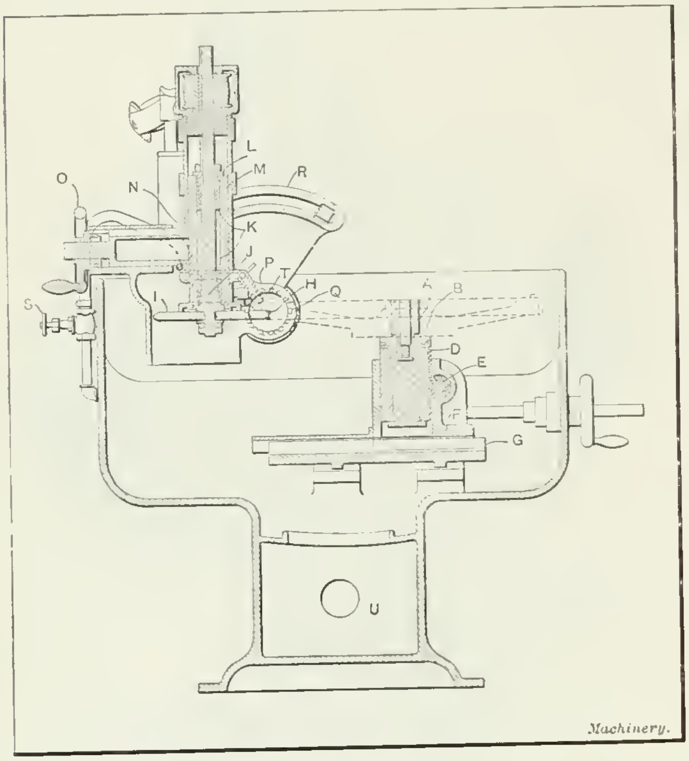


Fig. 3. Sectional View of Ingersoll Cutter Grinder

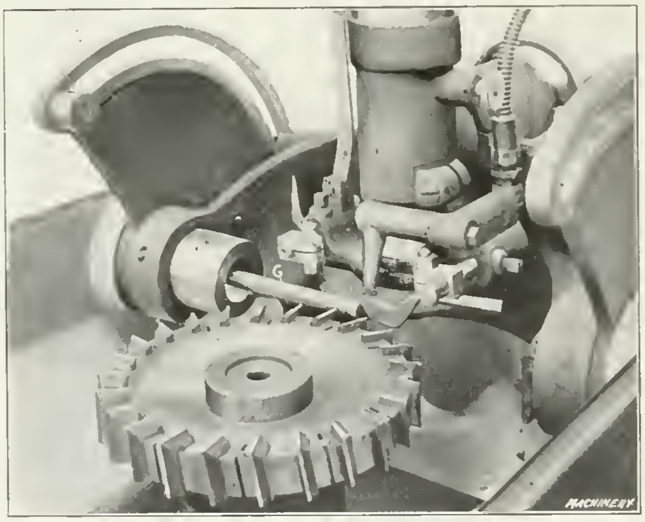


Fig. 4. Method of Setting Guide Finger for Clearance

The method of using the center gage, previously referred to, for setting the guide finger to obtain the proper degree of clearance is illustrated in Fig. 4. This gage *G* is inserted through a hollow bearing supporting the yoke, and its end lies in a vertical plane passing through the centers of the spindles which carry the grinding wheel and the cutter being ground. The distance that the index finger is set from the end of this gage determines the angular clearance of the tooth, and this distance, for cutters of different diameters and for various angles of clearance, may be ascertained by referring to a suitable table.

The method of setting cutters by means of radius gages for rounding the teeth, and also a quick method of grinding square corners, is illustrated in Fig. 5. Right-angle sections that are 1/8, 1/4, and 3/8 inch off center (depending on the radius) are milled from the ends of these radius gages, and when a corner of 1/4-inch radius is desired, for example, the gage *R* having a right-angle section 1/4 inch off center, is inserted through the hollow bearing of the yoke, as shown. By means of the horizontal and vertical adjustment provided, the tooth of the cutter is set into this milled section of the gage; the latter is then withdrawn and the cutter is ready for grinding. This operation, as previously stated, is performed by swinging the entire yoke and grinding wheel over each tooth. A quick setting for grinding a square corner is obtained by using a gage, from the end of which a quarter-section is milled, the method of adjusting the cutter being the same as for round corners.

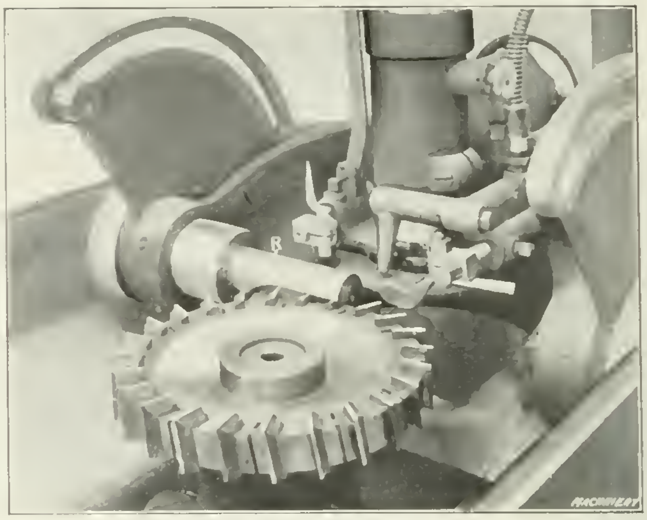


Fig. 5. Setting Cutter by Radius Gage for Rounding Corners of Teeth

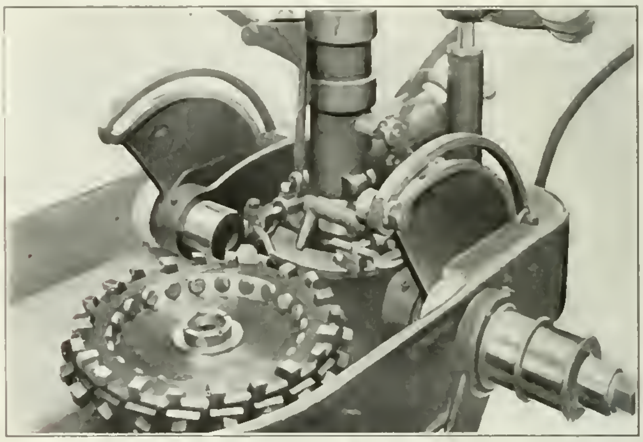


Fig. 6. Machine set for Grinding a Heavy Inserted-tooth Cutter

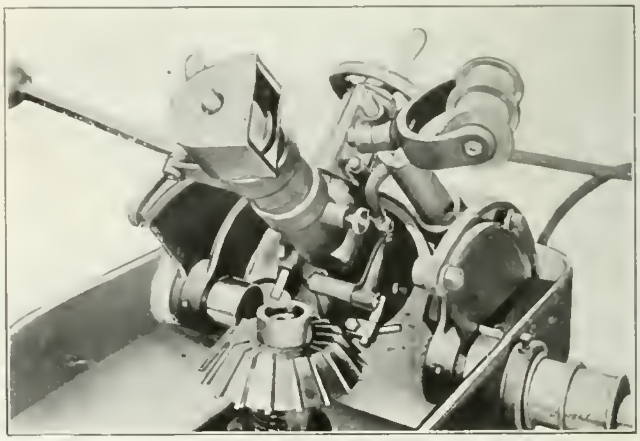


Fig. 7. Machine set for Grinding an Angular Cutter

Fig. 6 shows the machine set for grinding an 18-inch inserted-tooth heavy-type face mill. It is when grinding such large and heavy cutters as this, that the sensitiveness of movement resulting from the ball bearing mounting of the work-spindle, is particularly advantageous. In Fig. 7 the machine is shown set for grinding an angular cutter. The operation of setting consists in adjusting the yoke to the angle of the cutter by means of the graduated quadrant. The method of grinding is the same as for grinding any other type of cutter.

Particular attention has been given in the design of this machine to the convenience of operation, all controlling attachments being within easy reach of the operator's working position. The construction is also very rigid as the engraving indicates, the entire grinding mechanism being carried in a heavy base casting. The saddle on which the cutter is mounted has a horizontal adjustment of 10 inches and a vertical movement of 3 inches, to accommodate any size cutter within the machine's capacity. The grinding spindle has a 5-inch stroke and also a 1½-inch adjustment at right angles to the stroke, in order to compensate for the wear of the grinding wheel. The machine can be arranged for either belt or motor drive.

DAVIS-BOURNONVILLE OXY-ACETYLENE WELDING AND CUTTING MACHINE

The hand-operated oxy-acetylene blow-pipe, the use of which in connection with the cutting and welding of metals is familiar to most mechanics, has been supplemented by a machine designed for doing certain classes of work better and more efficiently than would be possible with a hand torch. This development is known as an acetylene welding and cutting machine, and it is a recent addition to the line of autogenous welding and cutting apparatus built by the Davis-Bournonville Co., 97 West St., New York. For that class of work on which the welding or cutting is done in straight lines, the machine can be used with economical results, as it provides means for mechanically moving the torch in the desired direction. The machine is also especially adapted to repetition work and for operating on very thin sheets, because of the certainty with which it can be regulated.

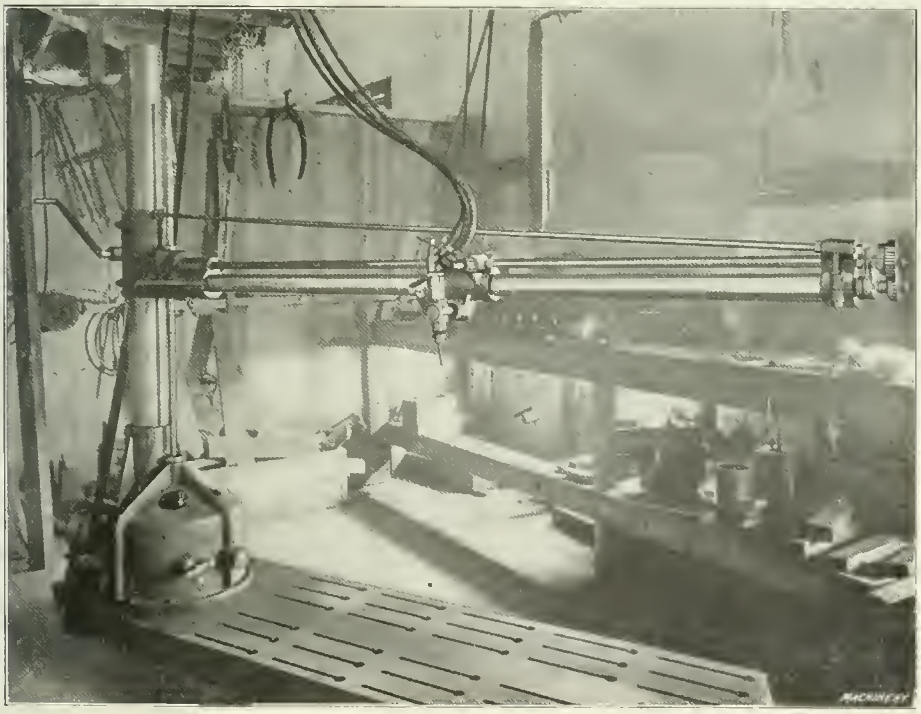


Fig. 1. Davis-Bournonville Oxy-acetylene Welding and Cutting Machine

A general view of this new welding machine is shown in Fig. 1. It consists, principally, of a cylindrical upright which carries a long hollow arm projecting 6 or 7 feet on one side. By means of a rack and pinion, this arm may be adjusted vertically on the column to any height desired. At the base of the upright, tight-and-loose pulleys are mounted on a short horizontal shaft and these are driven from an ordinary countershaft above. The horizontal shaft is connected through an adjustable friction disk drive to a vertical shaft, which, in turn, drives, through bevel gears, a shaft which passes through the hollow arm. At the outer end of the arm an arrangement of gears enables the enclosed shaft to transmit its movement to a horizontal screw mounted above the arm. The rotation of this screw, which might be called a feed-screw, operates the carriage upon which the torch and its controlling fixtures are mounted, back and forth when welding or cutting. The oxygen and acetylene gases are supplied to the torch through the flexible tubes shown.

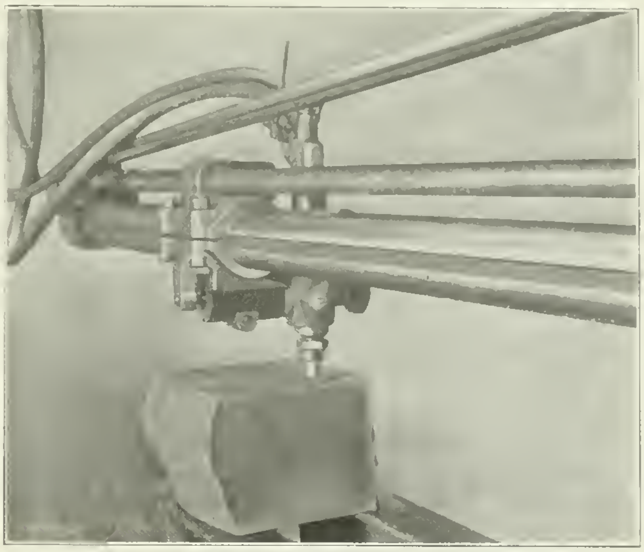


Fig. 2. Machine arranged for Heavy Cutting Operation

The tip used for welding is similar to the ordinary form, and the torch, which has an angular adjustment, is set at an angle of about 40 or 45 degrees to the horizontal, the inclination being to the rear of the welding movement. For many classes of work, the method of welding is quite simple. For example, if the weld is to be a flat one, the two pieces are simply clamped in the correct relative positions they are to occupy and the operation of welding is performed by the torch as it moves across the work at the proper rate of speed. Changes in speed may be obtained both by the adjustable friction drive in the base and also by the change gears at the end of the arm. In fact, a wide range of speeds is available, as the movement of the carriage may be varied from 3 to 24 inches per minute. The maximum travel of the carriage on the arm is 5 feet 5 inches, which means that a weld of approximately that length may be made. If an angular weld is desired, the only change to be made is in the arrangement of the work.

This machine, in addition to performing welding operations, can readily be used for cutting metals; in fact, the mechanical means of moving the torch in a straight line makes the machine especially adapted to this purpose. When metals are to be cut, the ordinary welding tip is replaced by one having three jets which are in line with the direction of movement. The torch is placed in a vertical position so that the flame is forced directly downward on the work. The first of these three flames is a heating jet of oxygen and acetylene, and at the rear there is another, but smaller, heating jet of the same kind. Between these two flames there is a cutting jet of pure oxygen, which is supplied from an independent tank because, ordinarily, the pressure back of the cutting jet is higher, and sometimes much higher, than is the case with the oxygen for the heating jet. By arranging the jets in the manner described, a strong heat is supplied just ahead of the oxygen and a moderate one just behind. The first jet is to raise the steel being cut to the temperature of combustion; a pure oxygen flame then comes into action and the metal is "cut." It has been found, however, that by providing an auxiliary heater in the rear, the work of cutting is facilitated. The operation is probably as follows: The front jet heats the metal to a certain temperature, which is doubtless somewhat diminished by the time the pure oxygen jet comes along, for while the oxygen jet is only 3/8 inch back of the first one, no doubt there is some heat lost through conduction before the cutting jet reaches a given spot, especially if the movement is slow, as would be the case with very thick material. The rear jet, however, provides additional heat in order to reduce this dissipation of heat by conduction. When thin plates are being cut, the rear jet is not necessary and can be shut off. This machine can be used advantageously for cutting either thin or thick material. The illustration Fig. 2 shows the machine arranged for a heavy cutting operation.

For certain classes of work, pre-heating prior to the use of the machine, could doubtless be employed to advantage in connection with welding operations or, in other words, it is not necessary to do all of the heating with the oxygen and acetylene gases. The saving, however, that can be effected by pre-heating, where the form and character of the work are favorable to it, does not result alone from a reduction in the consumption of gases, as time can also be saved. For example, certain pieces of work requiring a long seam and having sheets varying from 0.10 to 0.12 inch thick, were welded on a European machine at the rate of about 12 inches per minute without pre-heating, but when the same class of work was preheated before welding, a speed of from 26 to 28 inches per minute is said to have resulted. The methods of pre-heating would, of course, be varied somewhat with different classes of work. For small repetition work, pre-heating might in some cases be done subsequent to clamping, but prior to putting the work on the table, whereas other parts would require preheating with the work in the welding position. One desirable feature of pre-heating is that it diminishes the effects of expansion and contraction, in addition to effecting an economy in the use of gas and a saving in time.

HOLDER FOR BLUEPRINTS

The blueprint holder shown in Fig. 1 is designed to keep a drawing in plain sight and eliminate the time often lost by workmen while looking for prints that are not kept in any particular place. This holder also prevents drawings from being soiled or damaged. The device is very simple and there are no springs nor clips to get out of order.

The holder proper is composed of a vertical rod *A* on which are mounted two parts *B* and *C*. The upper member *B* is free to slide on the vertical rod and its weight holds the mounted print *D* in place. If the print is unmounted it is held near the upper edge between the inclined surfaces *a* and a_1 of the parts *B* and *C*. Provision is made for adjusting part *C* vertically to locate the print at the proper height. Rod *A* can be attached by a bracket to the machine or, if the holder is intended for bench use, a round base is provided. Fig. 2 shows this holder with a mounted print in place attached to a lathe.

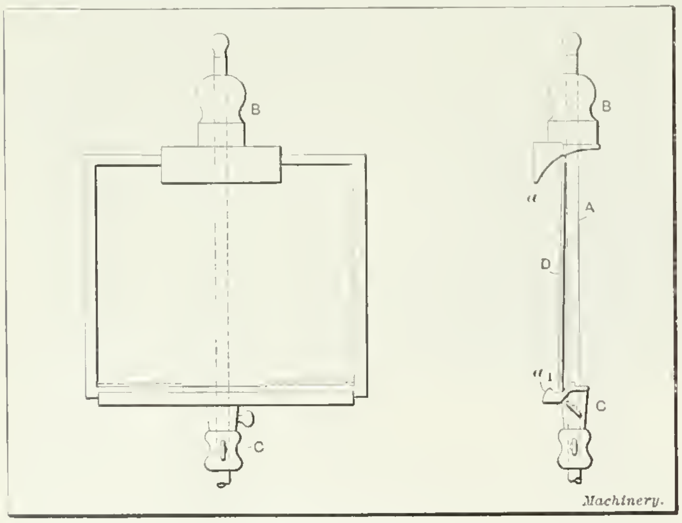


Fig. 1. Smith Blueprint Holder adapted for Holding Mounted or Unmounted Prints

A holder for text-books that has been devised for use in schools or laboratories, can also be applied to the same vertical rod used for the blueprint holder. Both of these holders have been put on the market by the Industrial Education Book Co., Boston, Mass.

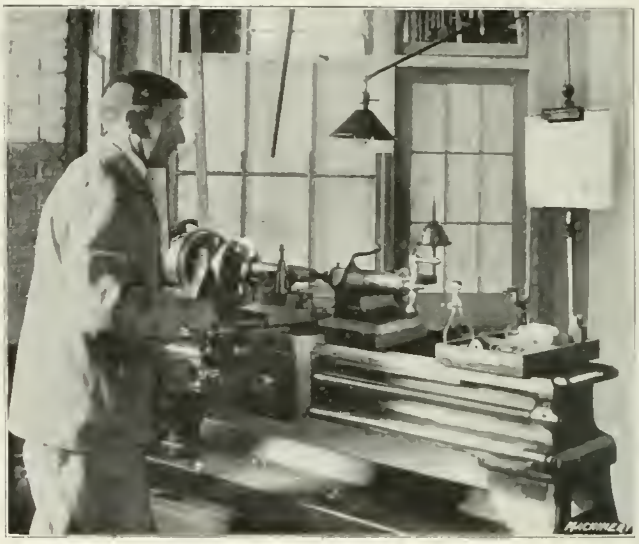
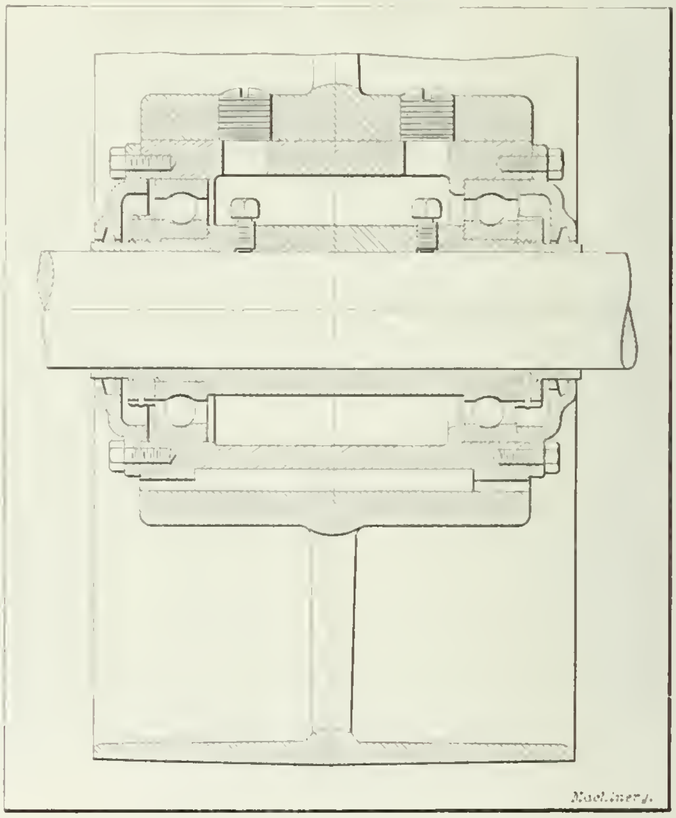


Fig. 2. Blueprint Holder applied to a Lathe

HESS-BRIGHT INTERCHANGEABLE BALL BEARING

A form of loose-pulley mounting has been brought out by the Hess-Bright Mfg. Co., 2111 Fairmount Ave., Philadelphia, Pa., to enable pulleys of any diameter, but of approximately equal belt width, to be mounted interchangeably on standard hubs containing Hess-Bright ball bearings. This bearing is shown applied to a pulley in the accompanying sectional view. The inner races of the ball bearings are a light press fit on a steel sleeve, and they are clamped by the nuts and wire locking rings shown. One outer race has a slight endwise freedom between the shoulders, and the other is entirely free; both are "sucking" fits, thus permitting a slow creep



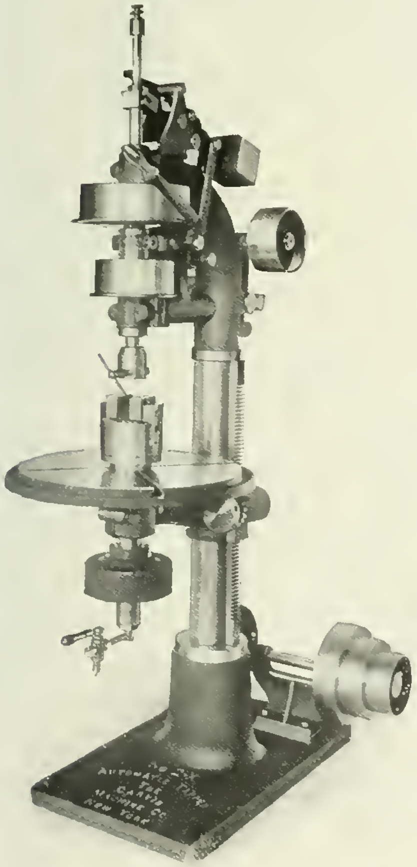
Interchangeable Ball-bearing Mounting for Loose Pulleys in order to distribute wear. The oil-retaining and dust-excluding closures at the end are very important. These closures have lips at least 3/32 inch wide, with sharp edges bored 1/64 inch larger than the ends of the sleeve. The inner race at each end has a return oil hole, and a single filling of oil or grease will last many months with these closures. The sleeve is secured to the shaft by set-screws, and for further convenience of access, there are corresponding holes through the pulley hub, which are closed by the screw plugs shown.

GARVIN AUTOMATIC TAPPING MACHINES

The Garvin Machine Co., Spring and Varick Sts., New York, has added two automatic tapping machines to its extensive line of tapping machinery. One of these machines, known as the No. 2, is shown herewith. This design will tap from ¼-inch to ⅞-inch holes in cast iron, and from ¼ inch to ¾ inch in steel. It will also drive ½-inch pipe taps in cast iron and ⅜-inch pipe taps in steel. The other machine is a No. 2 back-geared type, having a capacity varying from ½ inch to 1¼ inch in cast iron, and from ½ inch to 1 inch in steel. It will drive ¾-inch pipe taps in cast iron and ½-inch pipe taps in steel.

The machine shown in the illustration is equipped with a special chucking arrangement mounted on the table, consisting of a Garvin wrenchless two-jaw chuck operated by compressed air. This feature adds greatly to the productive capacity of the machine, as there is no time lost in clamping and unclamping the parts operated upon. The chuck jaws are opened instantly or closed for gripping the work by simply turning an air-valve. The work is then ready for the tap, which is started, for a couple of threads, by the hand lever shown, after which no further attention is required. When the tap reaches the bottom of the hole it is tripped and returned automatically.

The spindle is fitted with two friction pulleys, driven in opposite directions by one continuous belt, and between these pulleys there is a friction clutch keyed to the spindle. This friction clutch is connected with a lever at the right, by a toggle arrangement, which is adjustable for the desired tension, so that any extra safety device to prevent the breaking of taps is unnecessary. The tap is started by the lever at the right, and is tripped and reversed automatically at any point by an adjustable screw stop on the upper end of the spindle, which strikes the tripping lever on top of the machine.



Garvin Automatic Tapping Machine with Pneumatic Chuck

The spindle is balanced and fitted with a positive drive chuck for holding the taps. The table is surrounded by an oil groove and is adjustable up and down on the column to suit the work. This tool will operate satisfactorily at high speeds and will trip and reverse after being set, even though the operator should continue to press down on the starting lever.

GREAVES-KLUSMAN QUICK-CHANGE 15-INCH LATHE

In the November, 1910, number of MACHINERY (department of New Machinery and Tools) we illustrated a 15-inch lathe built by Greaves, Klusman & Co., Cincinnati, O. This company is now manufacturing another 15-inch size that differs somewhat from the machine previously described. One of the noteworthy features of this latest design is the new quick-change gear-box which is compact and simple in construction. This gear-box gives a change of feeds varying from 6 to 168 and a range of threads varying from 2 to 56 per inch, including 11½ pipe thread. This entire range of threads and feeds is obtained by operating the two handles shown. The one to the left controls the fine changes, and the segment handle or lever to the right compounds these changes. An index plate attached to the gear-box shows clearly the position of the two handles for any thread or feed. If it is desired to cut a special thread, this can be done by substituting change gears at the head end of the lathe.

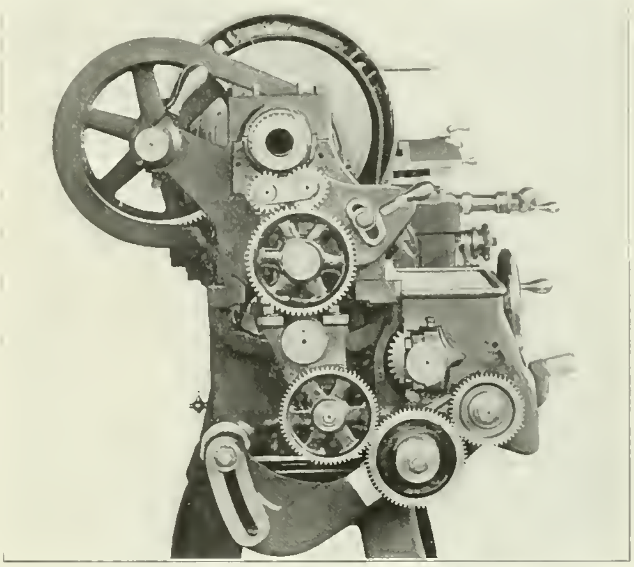


Fig. 1. End View of the Greaves-Klusmen Lathe

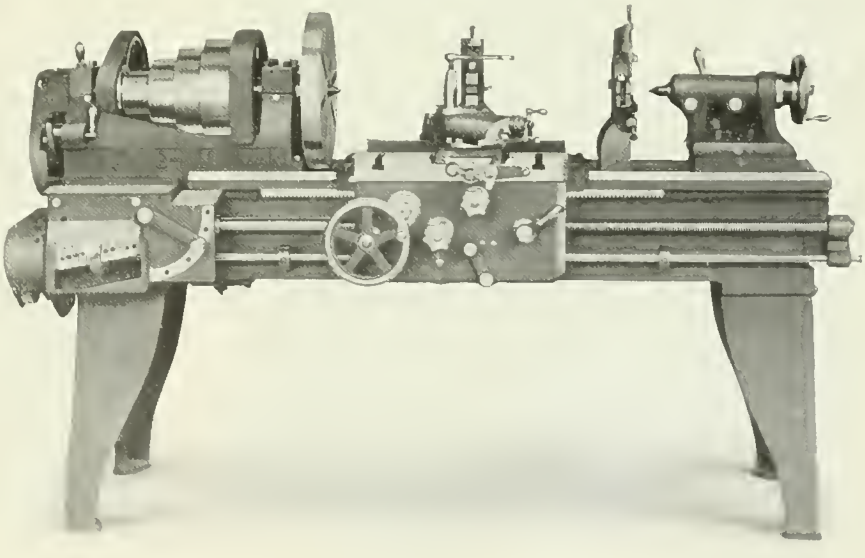


Fig. 2. Greaves, Klusman Heavy, Quick-change 15-inch Lathe

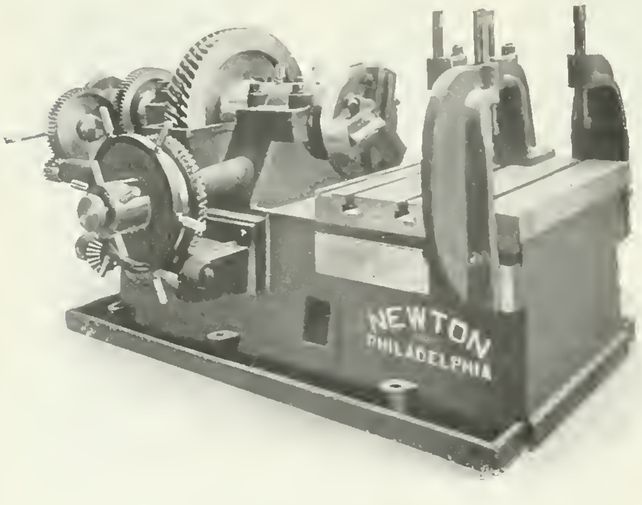
All gears are made from solid steel and the compounding gears run in an oil bath. Longitudinal feeds can be automatically stopped in either direction, and the feed-rod is supported at each end of the apron, which maintains its alignment for all positions. The carriage is fitted with a chasing dial for thread cutting, which enables the thread to be "caught" at any point without reversing the lead-screw. Both countershaft pulleys are thus allowed to run forward, providing a wide range of speeds.

The headstock is webbed its entire length, and the center line of both headstock and tailstock is placed back of the center of the bed to eliminate any overhang of the tool when turning large diameters. The spindle is of high-carbon steel, accurately ground, and runs in self-oiling phosphor-bronze bearings. The tailstock spindle is one-third longer than the usual form, and telescopes through a thimble at the rear. It has a full-length bearing in the barrel at the forward limit of travel, and is gripped by two sets of double-plug clamps at both ends of the barrel. An illustration showing the construction of this clamping device appeared in connection with the previous description referred to. The tailstock permits the compound rest to be swung around to an angle of 90 degrees and there is a graduated index provided for taper work.

The carriage has a full length bearing on each vee, and a wide flat bearing inside the front vee, which gives a support directly under the tool-rest and shortens the bridge of the carriage. The apron is of the double-plate box form. The gears are cut from solid steel and run on hardened and ground studs having bearings at each end. Both longitudinal and cross feeds are operated through frictions and are reversed in the apron. An interlocking arrangement prevents the feed-rod and lead-screw from being engaged simultaneously. As the illustration shows all gearing is carefully guarded. The regular equipment includes a compound rest, large and small face-plates, steady- and follow-rests, countershaft and wrenches. The maximum swing over the bed is 16⅜ inches and over the carriage 11¼ inches. The greatest distance between the centers, with a 6-foot bed, is 36 inches. There are sixteen spindle speeds, with a two-speed countershaft, varying from 5 to 475 revolutions per minute with the countershaft operating at the specified speed. The back-gear ratio is 12¼ to 1.

NEWTON RAIL-ENDING MACHINE

The machine shown in the accompanying view is a special design intended for taking short cuts on the ends of railroad rails or girder rails for street railways, and it is particularly adapted for squaring ends from which sufficient stock cannot be removed to support a saw-blade rigidly enough to give a square cut. This machine has a large spindle on which is mounted a head carrying three tools. This head is caused to revolve through large worm-gearing which enables heavy cuts to be taken. Feed variations are obtained by change gears, and there is a fast hand traverse to bring the cutters quickly up to the work.

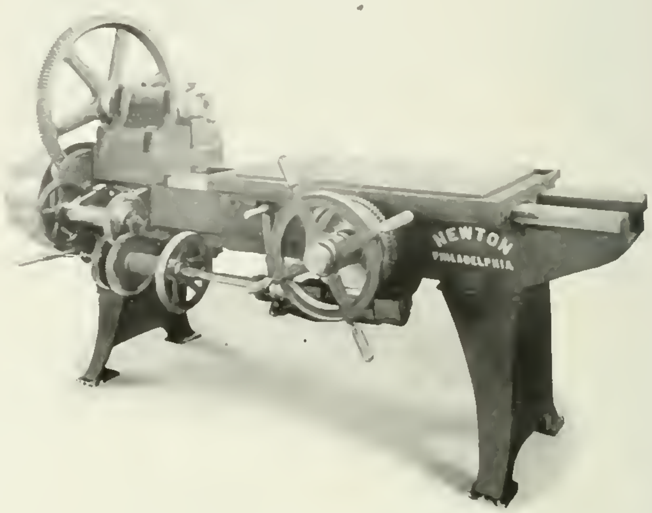


Special Machine for Squaring the Ends of Rails

The work-table is 31 inches long and 40 inches wide and has T-slots at the sides and top. There are also removable clamps for securely holding (in this case) built-up switches. The base of the machine is cored, as shown, to permit the escape of chips, and an oil pan is cast solid with it. A pump with piping and the necessary attachments is furnished for lubrication. The cutter head is 16 inches in diameter and the tools are 1¼ inch thick. The spindle is 8 inches in diameter and has an over-all bearing length of 41 inches. The bearings are bronze-bushed, and the driving worm-wheel, which is also bronze, is 33 inches in diameter. The worm is of hardened steel and is fitted with roller thrust bearings. This worm gearing is encased for continuous lubrication. The machine is driven by a 15-horsepower Westinghouse motor. The Newton Machine Tool Works, Inc., Philadelphia, Pa., is the manufacturer.

NEWTON SINGLE-SPINDLE BORING MACHINE

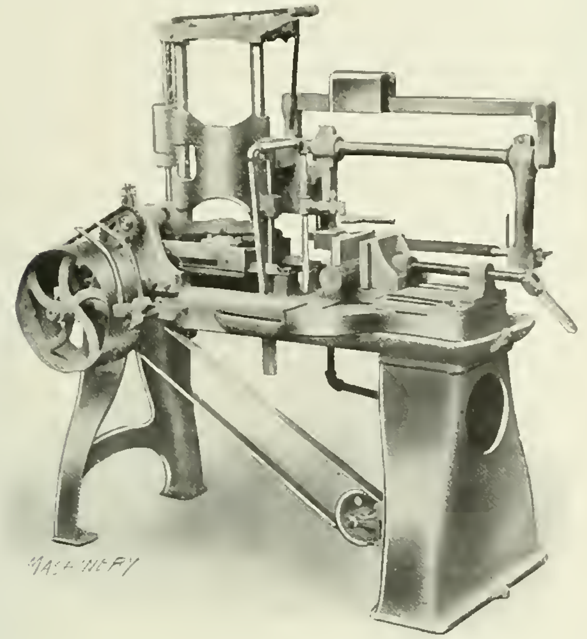
A machine designed particularly for boring the cylinders of air compressors, small pumps, automobile cylinders, crank and transmission cases, etc., is illustrated herewith. The drive to the spindle is by means of a large spur gear operated by a three-step cone, giving three speed changes varying approximately from seventeen to thirty revolutions per minute. The work-table is fed along the bed by means of a rack and spiral gear, and it has three changes of geared feed, ranging from 0.010 to 0.050 inch per revolution of the spindle; the maximum length of the feed is 32 inches. There is an automatic release to the feed, and the table can be operated by hand. The work-table is 21 inches wide and 36 inches long over the working surface, and it is entirely surrounded by an oil channel. The work-table has square locked bearings on the base, and side adjustment can be made by means of a taper shoe. The distance from the center of the spindle to the top of the table is 8¼ inches. The spindle is 3½ inches in diameter; it has a broad driving slot and a through retaining bolt for holding the boring-bars. The hole in the spindle is a No. 11 Brown & Sharpe taper. The equipment includes a pump with piping and attachments and a countershaft. This machine is built by the Newton Machine Tool Works, Inc., Philadelphia, Pa.



Newton Boring Machine

STERLING NO. 2½ HACKSAW MACHINE

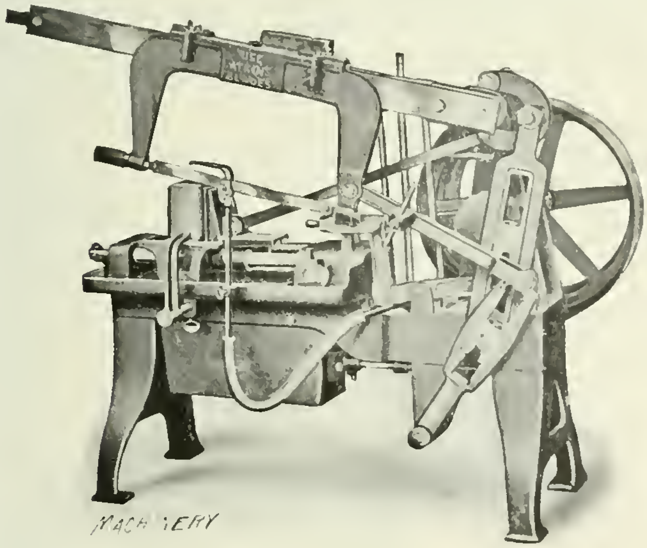
The Diamond Saw & Stamping Works, Buffalo, N. Y., has placed on the market a new high-speed power hacksaw machine which is known as the No. 2½. This machine is equipped with an automatic lifting device for raising the blade on the return stroke to eliminate unnecessary wear, and there is also an adjustable vise so that the full length of the saw can be used. The machine has a cutting capacity up to 7 inches for either round or square stock, and any length of blade from 10 to 15 inches, inclusive, can be used. The stroke of the saw is 6 inches. The drive is through milled gears of wide face. The bearings are large, and the gear bearings are adjustable so that lost motion can be taken up if necessary. The bearings for the main shaft are bushed, and wear can be eliminated by driving out the old bushings and replacing them. The vise can be swiveled for cutting any angle up to 45 degrees, and it is interchangeable so that it can be removed and replaced if necessary. The vise jaws are 3⅝ inches high, 5¾ inches wide, and the maximum opening is 7 inches. The feed of the saw is by gravity, and there is an automatic shut-off. The front cabinet leg forms a tank to which a pump is attached for supplying soda water or other lubricant to keep the blade cool when running at high speed. This machine is designed to operate at one hundred strokes per minute with lubrication. It weighs 380 pounds.



Sterling No. 2 1/2 Hacksaw Machine

ATKINS NO. 7 HACKSAW MACHINE

E. C. Atkins & Co., Indianapolis, Ind., are now building an improved design of power hacksaw machine. This latest design has the automatic stroke adjustment and the quick return common to the machine previously built, and, in addition, a raising device to avoid unnecessary wear of the teeth, a two-speed pulley, a depth gage and a lubricating system. The machine also operates with a draw cut, the cutting stroke being effected with a pulling instead of a pushing motion.



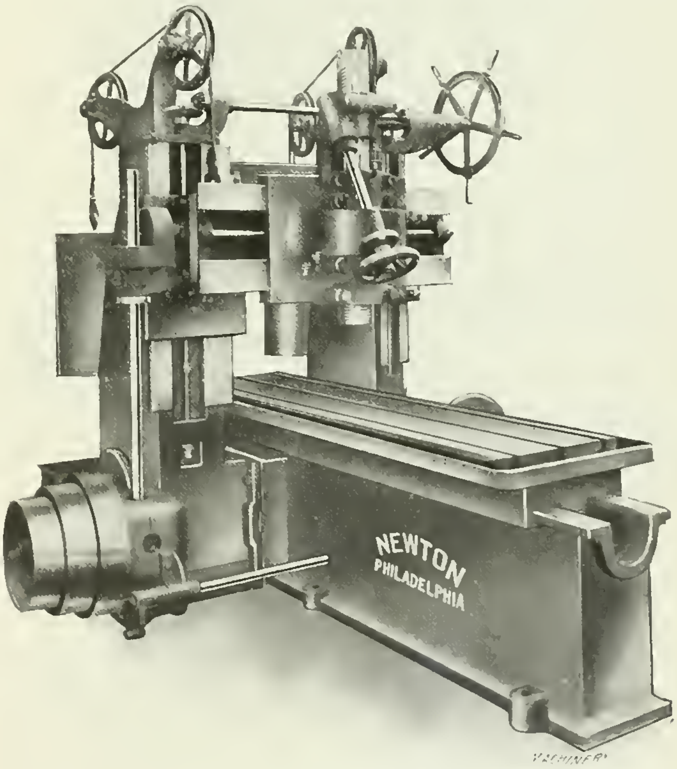
Atkins No. 7 Hacksaw Machine

The reciprocating mechanism for the saw is so arranged that the stroke is automatically adjusted to the size of the material being cut, which enables the full length of the saw-blade to be used. The way this automatic adjustment is effected on this latest design is as follows: The crankpin block operates in a slotted link, which is pivoted at its lower end to another block mounted in a lower slotted link as shown. This lower link swings about a pivot and is connected at its upper end with the saw frame by a connecting arm. The rear jaw of the work vise is connected by a steel rod with the hanger which holds the upper slotted link so that the position of the rear jaw determines the position of the link. When a large piece of stock is clamped in the vise, the connection with the rear jaw causes the upper link to be raised, which decreases the stroke of the saw frame to compensate for the increase in the size of the stock, and, inversely, the stroke is automatically lengthened for small diameters. In this way the entire blade is utilized.

In order to secure the full efficiency of the machine when cutting different sizes and kinds of material, it has been equipped with a two-speed pulley which enables the speed of the saw to be changed as required. A variation of thirty strokes per minute is possible. By means of a special adjustment, the saw can be stopped automatically at any desired depth of cut. There is a complete lubricating system, so arranged that the cooling compound is returned to the tank, where it is filtered before again being used. The saw frame has a long compensating bearing which insures an accurate cut, and the machine is rigidly built throughout.

NEWTON VERTICAL SLAB MILLING MACHINE

The Newton Machine Tool Works Inc., Philadelphia, Pa., has added to its line of milling machines a design especially adapted to machining broad surfaces on light castings, such as are used in the manufacture of textile and printing-press machinery. The general construction of this miller and the driving mechanism is quite plainly indicated in the illustration.



Newton Vertical Slab Milling Machine

The spindle, which has a diameter of 5 inches, is driven through worm-gearing connecting with the driving pulley by the horizontal and vertical shafts shown. The worm-wheel is 13 inches in diameter and both worm and wheel are encased for continual lubrication. The worm-wheel is made with a bronze ring and the worm is of hardened steel and has roller thrust bearings. The spindle is counterweighted and has 6 inches of independent vertical adjustment by the angular handwheel shown. The sleeve revolves in bronze-bushed capped bearings, and the spindle saddle has a square locked bearing on the rail. The spindle saddle has a hand adjustment only on the cross-rail, and the latter is counterweighted and is adjusted vertically by hand.

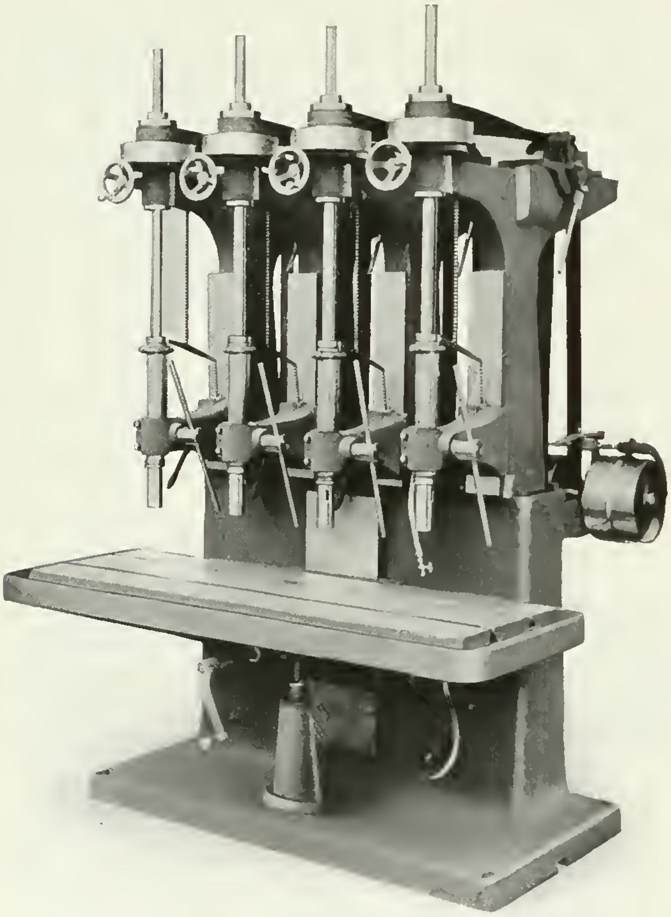
The work-table has square locked bearings on the bed, and it is driven through an angular rack and spiral gear. There are nine changes of geared feed, ranging from ½ inch to 8 inches per minute, and a power fast traverse, both of which are available in either direction, in addition to the hand adjustment. The working surface of the table is 20 inches wide and 6 feet 8 inches long, and it is surrounded by an oil channel as shown.

The distance between the uprights is 29¼ inches and work 27 inches in width can be admitted. The spindle saddle has a cross adjustment of 20 inches, and the maximum height from the end of the spindle to the surface of the work-table is 20 inches. The spindle has a No. 6 Morse taper and an external thread with a through bolt. The vertical adjustment of the spindle is measured by a micrometer gage.

This machine is of heavy construction, the design being based on the principle that weight is necessary to insure the required rigidity for producing accurate work.

HIGH-SPEED BALL-BEARING DRILL PRESS

The Cincinnati Pulley Machinery Co., Cincinnati, O., is now manufacturing the new design of No. 3 "Avey" high-speed ball-bearing drill press, which is illustrated herewith. This machine is built in either the single or multiple spindle type, and it has a capacity for drills up to the limit of No. 3 Morse taper shanks, or for diameters up to and including 1¼ inch.



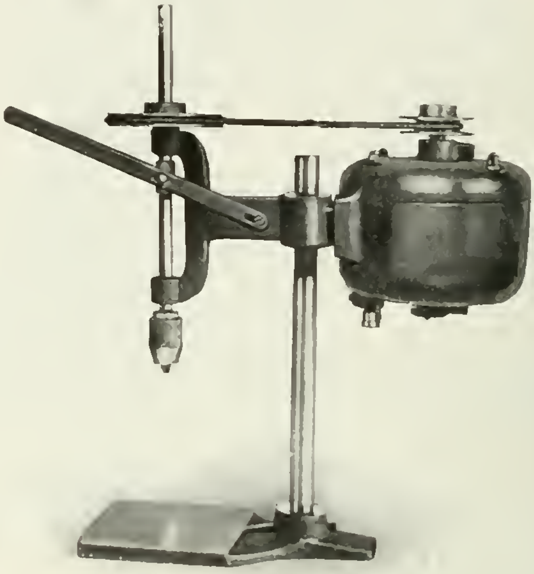
No. 3 Avey High-speed Drill Press, built by the Cincinnati Pulley Machinery Co.

The distance from the spindle center to the column face is 12 inches, and the spindle sleeve has a feed of 8 inches without resetting the head. The spindle sleeve is graduated and has a stop collar or depth gage mounted on it so that any predetermined depth of hole can be drilled without the use of a measuring scale. Four changes of speed are available for each spindle, and the driving belts pass over an adjustable idler carriage at the rear, which enables the belt tension to be varied as required. These idler carriages are controlled from the front of the machine by the handwheels shown, and a screw feed.

The spindles are 1 3/16 inch in diameter and have a No. 3 Morse taper. The driving pulleys are arranged for a 2-inch belt. The machine can be equipped with a lubricating outfit and the lower part of the column forms the tank. The table can be supplied with T-slots or be left plain, if desired. The working surface is surrounded by a large oil channel, as shown, to catch the lubricant, which is returned to the tank through a flexible pipe. The weight of the four-spindle machine illustrated, is approximately 4000 pounds.

SMALL MOTOR-DRIVEN DRILL PRESS

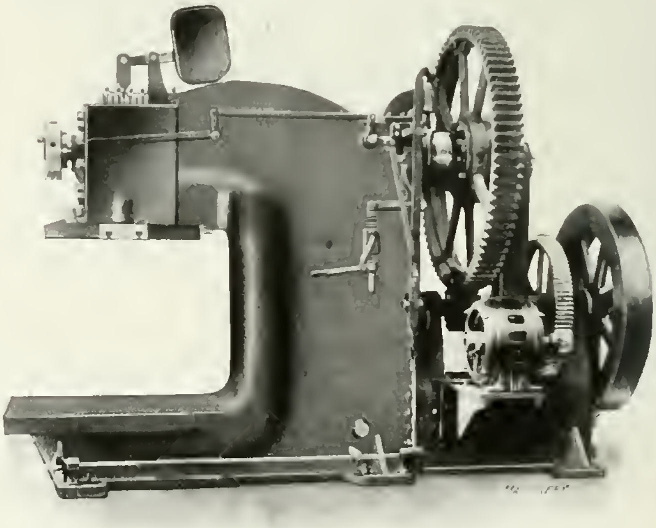
The motor-driven drilling machine shown in the illustration was designed by the Willey Machine Co., Jeffersonville, Ind., to meet the demand from the hardware trade, model makers, amateurs, etc., for a light bench drill of simple design. This machine has a capacity for drilling small holes up to about ¼ inch in diameter. The maximum travel of the spindle is 3 inches, and the sliding head has a movement of 7 inches on the column. The spindle is driven at a speed of 1000 revolutions per minute, by a 1/20 horsepower motor which can be furnished for either direct or alternating current. The weight of the machine is thirty pounds, and its general construction is clearly indicated by the illustration.



Small Motor-driven Drill Press, built by Willey Machine Co.

LARGE COPING AND PUNCHING MACHINE

The accompanying illustration shows a large coping and multiple punching machine especially designed and built by the Queen City Punch & Shear Co., Cincinnati, O., for the pur-

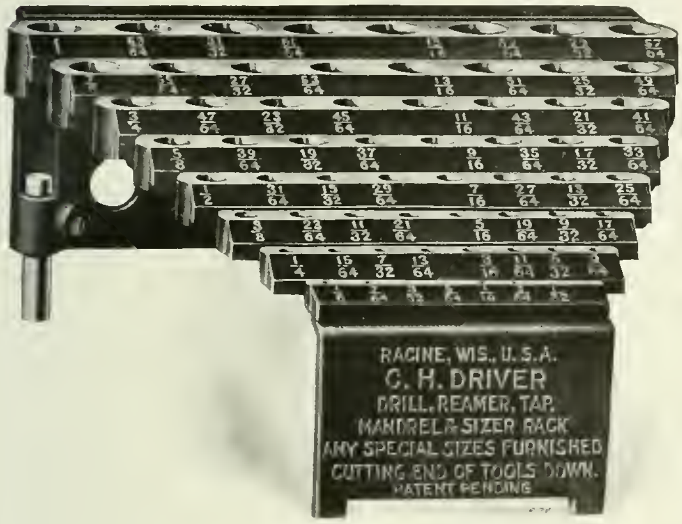


Queen City Coping and Punching Machine

pose of coping and punching sections from Bethlehem I-beams. This is said to be the first machine ever built solely for this purpose. It has a very large range beneath the ram or plunger, which is a solid steel casting, 42 inches long and 14 inches wide on its lower end. The die bed is 62 inches long from front to back and 32 inches wide, and has T-slots for fastening the various tools and appliances. The drive is by a motor attached to the side of the bed as shown. The clutches are of steel castings and of the type recently brought out by this company. This machine weighs about 63,000 pounds.

DRILL AND REAMER RACK

The rack or holder illustrated herewith is designed to keep such tools as drills, reamers, taps or mandrels in a regular place so that they will be available when wanted, and it also forms a convenient gage for determining the different sizes. The tools are held vertically in the holes shown which, in the particular rack illustrated, vary in diameter by 64ths of an inch, and when tools are being put away, they can be inserted in the rack without referring to any size marks by simply choosing the proper size hole in each case. From this it will be seen that the rack is practically a limit gage, as a tool cannot be put in a larger or smaller hole than the one representing its size, because it will not enter if too large and will drop through if too small. When a tool is taken from the rack, its size is shown by the figures opposite the hole, and this size cannot be wrong, as a tool either larger or smaller could not be retained in that particular hole. The rack has been arranged in this way to eliminate calipering and the use of drill gages.



Rack for Holding Drills, Reamers, Mandrels, etc.

This rack is made in sections and all parts are interchangeable, so that its size can be varied to meet individual requirements and special sections can be added if necessary. While the holes in the rack illustrated vary by 64ths, they are also made in sizes varying by 32nds, 16ths or 8ths of an inch. This rack is manufactured by C. H. Driver, 1419 16th St., Racine, Wis.

BAIRD SPRING-MAKING MACHINES

Several designs of spring-making machines built by the Baird Machine Co., Oakville, Conn., are illustrated in Figs. 1 to 4, inclusive. This company has made, heretofore, special spring-making machinery for concerns manufacturing parts requiring one or two forms of springs in such large quantities that a machine specially designed for that particular form was desirable. In order to meet the demand from spring manufacturers for spring-making machines having a comparatively wide range, the standard designs illustrated herewith were brought out.

These machines are divided into three different types. Fig. 1 illustrates a coiling and cutting machine. This design can be equipped with either die or roll tools to suit the form of spring required. The die tools are more easily changed from one size to another, but their initial cost is greater, as a separate set of tools is necessary for practically each size of spring; therefore the kind of tools to use depends somewhat on the conditions. The roller tools are better for jobbing manufacturers, as the same rolls can be used with a given diameter of wire, for making any spring within the capacity of the machine, by simply making the necessary adjustment.

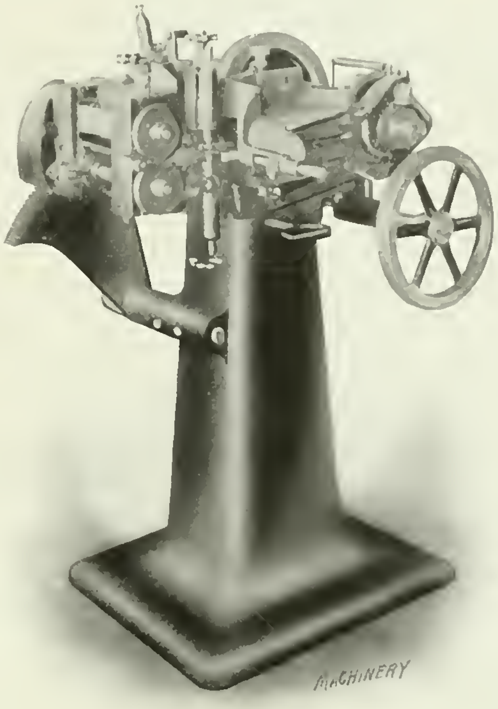


Fig. 1. Baird Spring Coiling and Cutting Machine

This type of machine automatically takes the wire from the coil, feeds it a predetermined length and coils either a right- or left-hand, open or closed spring and cuts it off. Attachments may be applied to the machine for varying the pitch or distance between the coils of the spring so that a spring of either the open or closed type can be formed. A diameter-changing attachment can also be applied for making either cone- or barrel-shaped springs, and attachments can be arranged to make cone- or barrel-shaped springs with squared ends or other combinations of form. A setting attachment can also be applied to "set" the spring or take out the initial tension. This machine is made in sizes taking wire up to about 3/16 inch in diameter and for making springs up to about 2 inches in diameter. Each machine also has quite a wide range of adjustment.

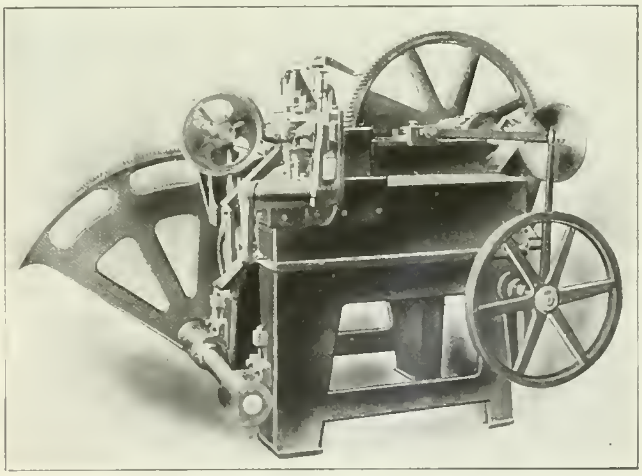


Fig. 2. Large Spring Winding and Cutting Machine

Figs. 2 and 3 illustrate what are known as spring winding and cutting machines. The springs are formed in these machines on an entirely different principle from the coiling type. They will also make either open, closed, right- or left-hand, and some types of cone springs, but all of these have straight projecting ends, such as are often necessary for springs that are subjected to a twisting action instead of an endwise movement. The lengths of these ends can be varied within certain limits to meet different conditions.

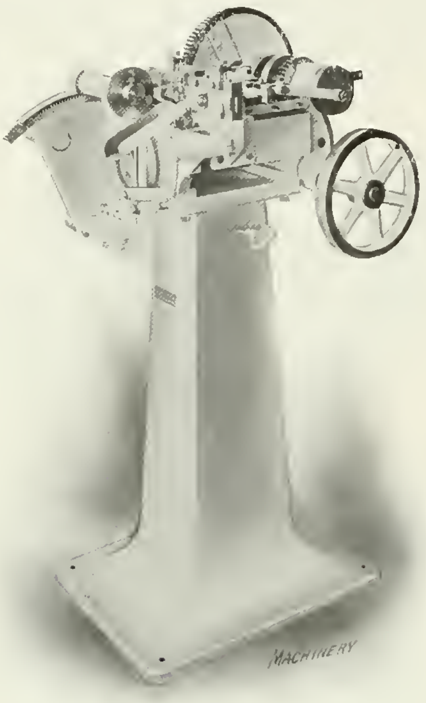


Fig 3. Winding and Cutting Type of Spring Machine

The continuous spring-coiling machine shown in Fig. 4 is similar in many respects to the spring coiling and cutting machines, except that the springs are not cut off. This type of machine is used for making long springs which contain so much wire that it is impracticable to feed to such a length.

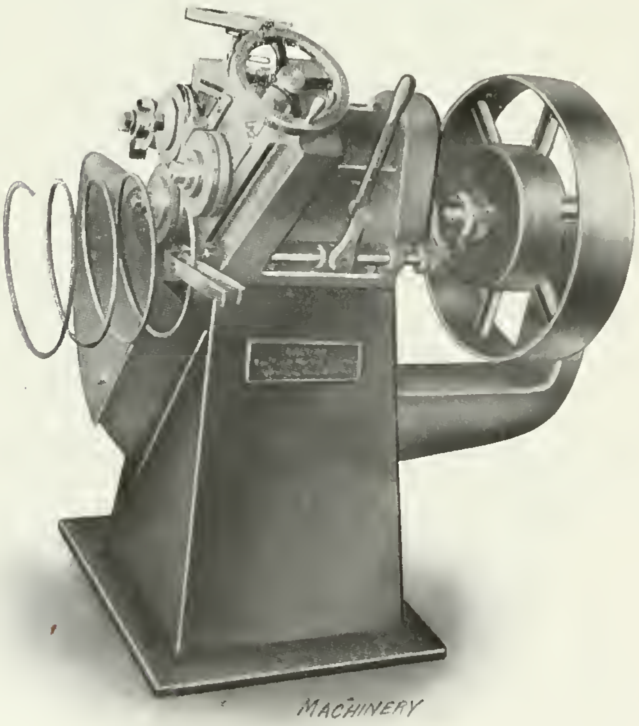


Fig. 4. Continuous Spring Coiling Machine

The attachments applied to the coiling and cutting machines for varying the pitch and diameter can also be applied to this machine so that a long length of spring, varying in pitch and diameter, for making such things as poker handles, etc., can be made and then cut into a number of shorter springs by a subsequent operation. The illustration shows the coiling machine making a spring of large diameter.

NEW MACHINERY AND TOOLS NOTES

Jig Clamp: St. Louis Sales Co., St. Louis, Mo. Quick-acting jig clamp adapted for use in connection with various types of machine tools, such as drilling machines, grinders, etc. The work is clamped by the movement of a lever.

Caster Drilling Machine: Hoefer Mfg. Co., 120 Jackson St., Freeport, Ill. Special seven-spindle machine for drilling the shaft holes in caster wheels. The machine is of the horizontal type and has a capacity for drilling from twenty to thirty castings per minute.

Keyseat Miller: Newton Machine Tool Wks., Inc., Philadelphia, Pa. Improved design of keyseat milling machine having a horizontal work-table and a vertical spindle. There is a wide range of spindle speeds and nine changes of geared feed. This machine is also adapted for milling elongated slots in piston-rods and for similar work.

Three-spindle Rail Drill: Niles-Bement Pond Co., New York. Three-spindle machine especially adapted to drilling railroad rails. The spindles are adjustable for different center distances, and they are contained in a counterweighted head having power down feed, friction release, and quick hand adjustment. The driving power is transmitted from a 15-horsepower motor at the rear, through a geared shaft.

Polishing and Buffing Machine: Hisey-Wolf Machine Co., Cincinnati, O. Portable electric polishing and buffing machine built in two sizes, having disks 6 and 12 inches in diameter, respectively, and weighing 95 and 140 pounds each. The machine is mounted on an arm having universal adjustment, and its weight is counterbalanced by a spiral spring. Pressure on the wheel is varied by a lever, and the machine can easily be swung to any desired position.

Clamp: George H. Wrigley, 447 N. 61st St., Philadelphia, Pa. Quick-acting C-clamp for structural work and general machine shop use. The adjusting screw is similar to that of an ordinary clamp except that it is provided with a lock-nut which retains it in any set position. The clamp is quickly applied or released by means of a lever which operates a lower swing jaw, the movement being through a toggle, thus giving a strong grip. The clamp is made of cast crucible steel in various sizes up to 7½ inches.

Belt Shifter: Diamond Iron Works, Minneapolis, Minn. Belt shifter for varying the speed of machine tools, consisting of a steel tube extending vertically from the machine to the countershaft. Attached to the upper end there is a short arm or loop through which the belt runs, and when a change of speed is desired the belt is shifted by turning the vertical shaft which has a lever attached to the lower end. In this way the speed can be increased or decreased quickly and the time that is often lost by the "shifting pole" method is eliminated.

Valve Grinder: R. K. LeBlond Machine Tool Co., Cincinnati, O. Special machine for grinding the angular seats on gas engine valves. The work is held close to the surface being ground by means of a draw-in attachment and collet. The chucking mechanism is free to swivel and has a micrometer adjustment which insures an accurate angular setting. The grinding head has an 8-inch wheel and there are two rates of speed. The cross-feed for the saddle has a graduated dial, and the table movement is equipped with adjustable stops.

Spline Miller: Berghausen Machine Co., Cincinnati, O. Splining machine with a capacity for cutting keyways of standard depth up to ½ inch, and with lengths up to 12 inches, in shafting varying from ½ inch to 3 inches in diameter. The two V-shaped work-holding jaws have independent adjustment so that work that is not uniform in diameter can be held. The cutter head has micrometer adjustment for depth, and the length of the cut is controlled by an automatic stop mechanism. In addition to the regular keyway cutter, there is another for Woodruff keys.

Brace Milling Machine: Newton Machine Tool Wks., Inc., Philadelphia, Pa. Brace milling machine having a capacity for milling the ends and chamfering one edge of two 8- by 8-inch angles, simultaneously. The cutter spindle is carried in a counterweighted saddle fitted to the upright with square locked bearings, and there are four changes of vertical feed, reversing and fast power traverse, and hand adjustment. The vise for holding the angles is removable, thus enabling the machine to be used for finishing the ends of columns. The machine is driven by a 10-horsepower motor.

Boring and Turning Mill: Niles-Bement Pond Co., New York. Special vertical boring and turning mill for boring and turning large gas and gasoline engine cylinders. The actual swing of the mill is 102 inches and it has a maximum height under the tool-holders of 10 feet, 6 inches. Cylinders 10 feet, 2 inches in length can be bored. The machine is equipped with a vertical boring bar, 12 inches in diameter, which has a traveling head that is raised and lowered by a feed-screw in the bar. On both sides of this central bar there are vertical boring heads for turning operations.

POINT AND RIDGE METHOD OF ELECTRIC WELDING

RESULTS OBTAINED BY UNIVERSAL WELDING CO.

The electric welding process, which from a commercial standpoint is comparatively new, has revolutionized many manufacturing methods, owing to its efficiency, particularly on that class of work which must be produced in large quantities and at a minimum cost. The extent, however, to which this method of welding metals is now employed, is no doubt very limited, in comparison with the number of manufacturing operations which could advantageously be performed by the electric process of welding. This is largely due to the fact that the art is little understood, particularly as regards the variety or range of work which can be efficiently welded electrically.

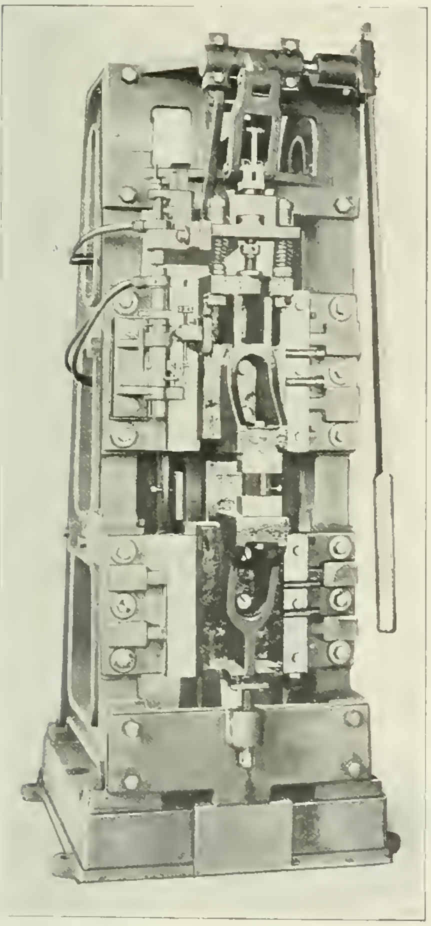


Fig. 1. Standard Type of Electric Welding Machine intended for General Work

Various types of electric welding machines have been placed on the market by the Universal Electric Welding Co., 227 Borden Ave., Long Island City. One of the machines handled by this company is made to be fastened on a bench and operated by a hand lever. This same machine can be fitted to a stand and operated either by hand or by foot power, and can also be belt-driven and made to work automatically. It is particularly adapted for "electrode" welding, commonly called "spot welding." It is constructed with long projecting horns made as deep as three feet and with varying capacities to weld from the lightest gages up to 1/4-inch sheets. The generally accepted idea that spot welding is practical to only as high as 1/8-inch thickness of sheet is fully disproved in the case of this machine. Pipe from 6 inches in diameter and up to 6 feet long can also be welded in machines of this type.

Methods of Welding

For a number of years electric welding was confined to the butt welding of rods, tubes, etc., and later the "spot" welding of flat stock by means of isolated welds of a limited area was developed. The spot method opened up an entirely new field, which, as the result of still later improvements, has been extended until, at the present time, the electric welding method of uniting metals is adapted to a great variety of manufacturing operations. One method of making a "spot" weld is to use pointed copper dies or electrodes, which are brought into contact with the work which is welded by the passage of a large volume of low-voltage current. Another method is to raise projections above the plane surface of the parts to be welded, which serve to concentrate or localize the current in order to heat the metal to the welding point; and a still further development consists in raising ridges above the plane surfaces, which, when crossed by corresponding ridges, give the same practical results as the raised points, with the additional advantage of ease in assembling the parts prior to welding. This idea of using points or ridges in connection with electric welding has made it possible to weld, commercially, an almost unlimited variety of work, as is indicated by the accompanying illustrations which show some interesting results achieved by the Universal Electric Welding Co. In the spot electrode welding of light-gage metals, a slight indentation is usually left in the surface at the weld, but by a method developed by this company, this condition is overcome, and the sheet can be left the full thickness and finished off. By using this method there is practically no limit to the thickness which can be spot welded. This is indicated in Fig. 8, where two bars each 7/8 inch thick have been spot welded together. The operation took about one minute.

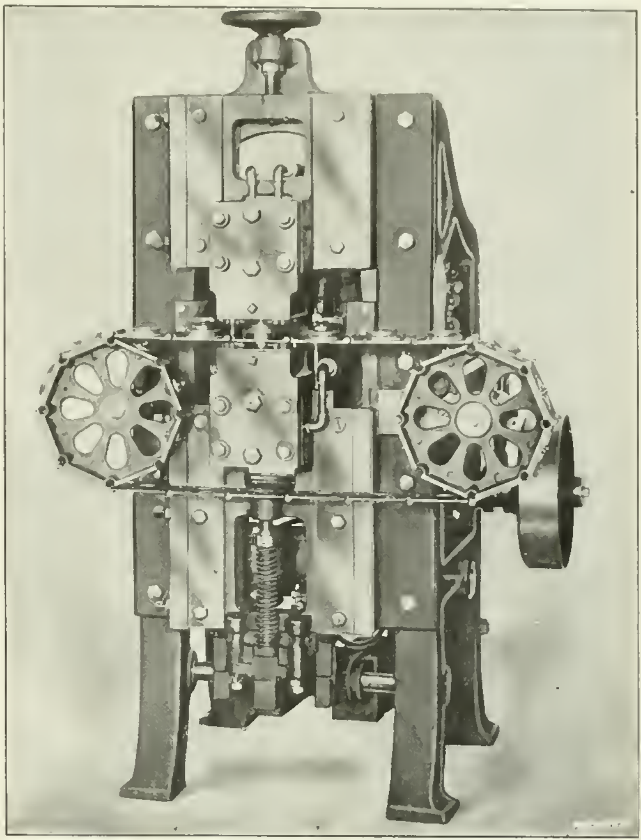


Fig. 2. Automatic Electric Sheave Welder

Point or Projection Welding

As mentioned, the welding of sheet metal is not restricted to one spot at a time, for any reasonable number of welds can be made at one operation by the method known as "point" or "projection" welding. In such welding, used, for example, for cooking utensils, sash pulleys, etc., the parts when stamped have small projections raised above the plane surface of the metal, the height of the projection varying according to the gage of the material. This is done during the operation of stamping. When welding such parts, properly shaped coppers are fitted to them. Each point acts as a resistance to the pas-

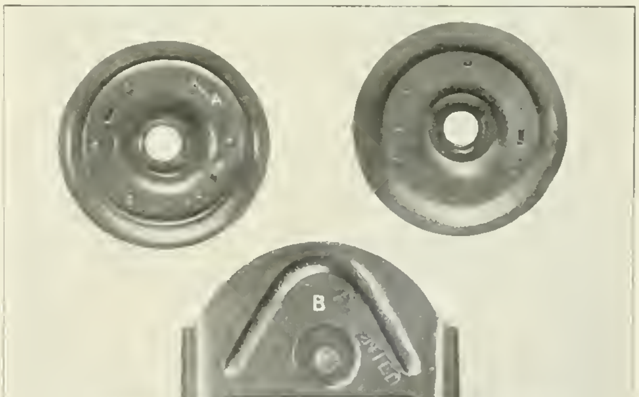


Fig. 3. Sash Pulley and Housing welded by the Point Method

sage of the welding current. The current divides itself among these points and by their resistance to its passage, each becomes a heated welding point. Pressure applied to the softening metal completes all the welds simultaneously. Fig. 4 shows a spout welded to a coffee pot at twenty-three distinct points.

A marked distinction exists between the two methods of "spot" and "point" welding, as many cases occur when the spot method cannot be used, but the point method proves perfectly successful and commercial. Fig. 4 illustrates an anti-skid chain which is an excellent example. In making this chain the electrode method was just tried by the manufacturer. The point method was then applied, raising points on both the body and the strap, and resulting in a perfect weld. The output by the spot method was 600 per day of unsatisfactory welds; by the point method 3000 per day of good welds.

Another excellent example is that of the door knob shown in Fig. 4. The shank is welded to the hollow knob by six distinct points. It is impossible to weld this except by the point method.

Ridge Welding

To facilitate the assembling of parts, a further improvement was made by the introduction of so-called "ridge" welding. The result of two ridges crossing is the same as of two points, and the operation of making the weld is identically the same. Both point and ridge welding permit the use of large flat blocks of copper for electrodes, the heat being localized by the points or ridges forming the welding spot. In both these methods the coppers require very little attention except an occasional touch with a file over the surface, as against continual shaping of small pointed electrodes.

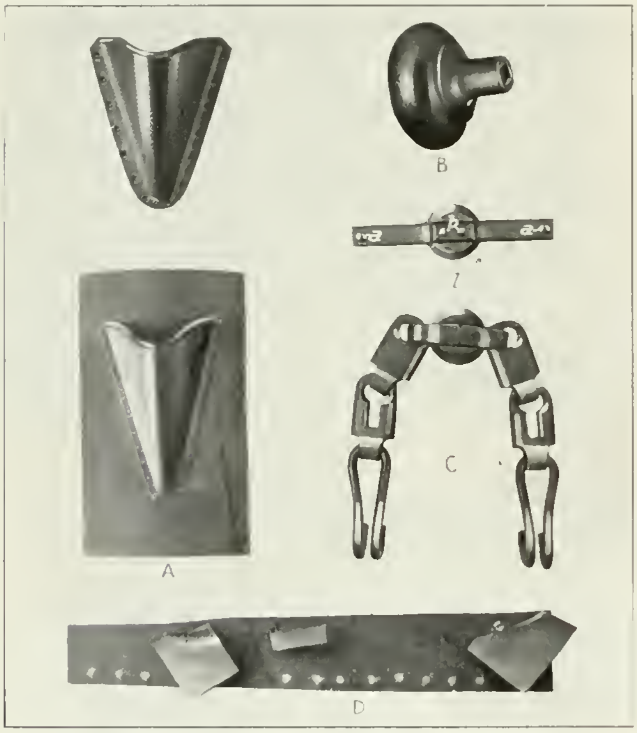


Fig. 4. Illustration of the Application of the Point Method of Electric Welding

Types of Welding Machines

The machine used for point and ridge welding is equipped with large copper electrodes instead of the pointed type, and the current is concentrated at the points to be welded by the small raised projections, as mentioned, instead of by reducing the area of the electrodes. With the large electrodes, sufficient current for welding heavy stock can be conducted without excessive heating and deterioration. A welding machine having these large electrodes is illustrated in Fig. 1, which shows a standard type intended for general work. This machine may be either hand-operated, as shown, or may be made semi-automatic, belt-driven. When a great quantity of similar articles is to be made special machines are usually built. The automatic sheave welder shown in Fig. 2 is used by the American Pulley Co.; it welds 15,000 pulleys in ten hours.

Examples of Electric Welding

Fig. 3 shows a sash pulley and housing which is an example of point welding. The pulley is made in halves, one half having an annular ridge and the other, six projections or raised points *A*. When the points of one half are brought into contact with the ridge on the other, the electric current, being concentrated, fuses the metal instantly, and six homogeneous point or spot welds are produced. These pulleys are welded on the automatic machine shown in Fig. 2. The housing *B* is also made in two parts, each of which is joined to the base-plate by four point welds as shown.

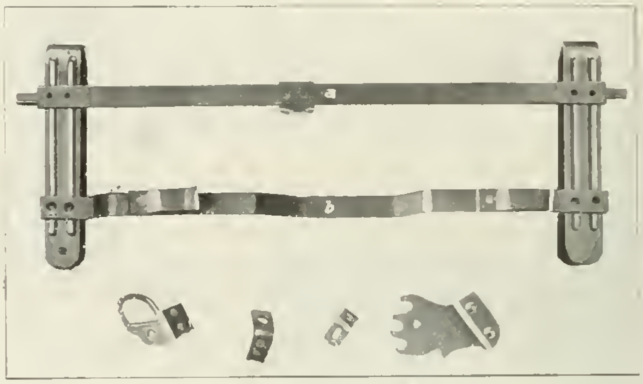


Fig. 5. Example of Ridge Welding

Another example of point welding is shown at *A* in Fig. 4, indicating how a spout is welded to a coffee pot, as already referred to. The "anti-skid" chain for automobiles shown at *C*, and also previously mentioned, has the central link *l* welded as indicated. The link is drop-forged with raised points at *a* and *b* which form the welds after the wings are bent over onto the central part. The strength of the point weld is indicated by the sample shown at *D*. An attempt to tear the small pieces from the steel strip, resulted in shearing the metal around the weld, but in no case did the weld prove defective.

Fig. 5 shows an example of ridge welding. This is part of a go-cart frame. The stock from which the end pieces are made has ridges rolled in it as shown. The cross-bar *a* is provided with two raised points at each end that come directly over the ridges, and the bar *b* has concave ends thus giving contact points where the curved edges rest on the ridges. Beneath this frame a number of small parts are shown that are prepared with projections ready for welding. The ridge method of welding is also used for welding reinforced concrete frames, the ridges which form the points of contact being originally rolled in the stock. Generally speaking, the ridge method is preferable, where practicable, owing to the greater facility in assembling parts prior to welding; the ridges also stiffen and strengthen the material. The results obtained by the ridge method are, as far as the quality of the weld is

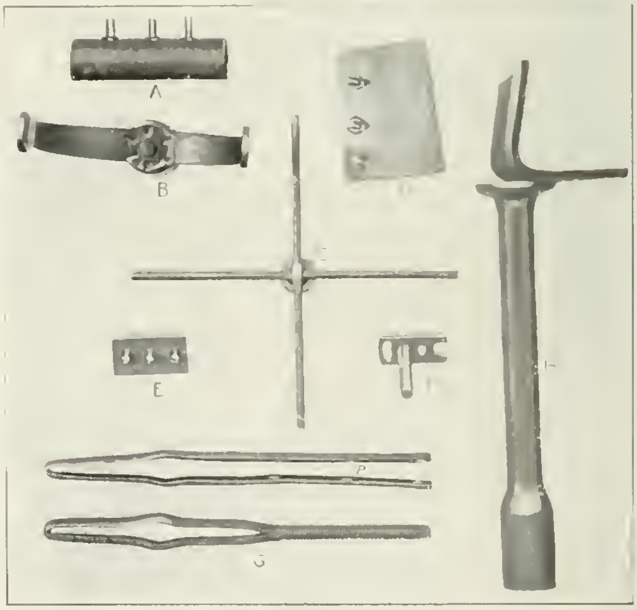


Fig. 6. Further Examples of Point and Ridge Welding

concerned, practically the same as when projections or points are used.

A number of examples including both ridge and point welding are shown in Fig. 6. A piece of tubing is shown at *A* to one side of which rivets have been welded. Part *B* is a D-top spade handle, the strap of which is welded to the cup. Six ridges are raised on the strap as shown, which make contact with an annular ridge on the cup, and the six points thus formed are welded in one operation. A sample of fencing, the cross wires of which are rigidly held by an electrically welded button, is shown at *C*. The button has an annular ridge which comes in contact with each wire at two points thus forming four welds. A piece of sheet brass to which steel rivets and screws have been welded, is shown at *D* to illustrate the possibilities of uniting different metals. By the point method, it is also possible to weld copper to copper, for notwithstanding the high conductivity of copper, the use of raised points concentrates the current and fuses the metal. The plates shown at *E* and *F* have posts welded to them at right angles as shown. The ends of these posts are cupped out, so as to form a projecting center surrounded by an annular groove. This formation serves two purposes: The projecting point concentrates the current, and as the parts are pressed together, the metal that naturally flows outward, fills the groove instead of forming an unsightly "flash" outside the post.

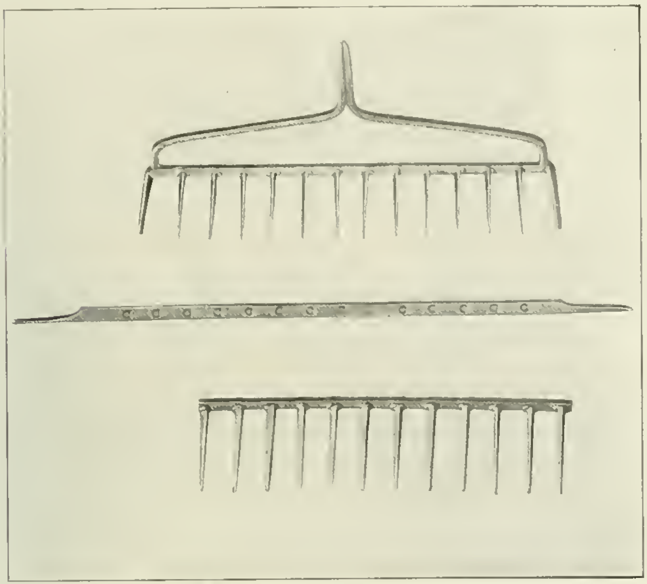


Fig. 7. Garden Rakes with Electrically Welded Teeth

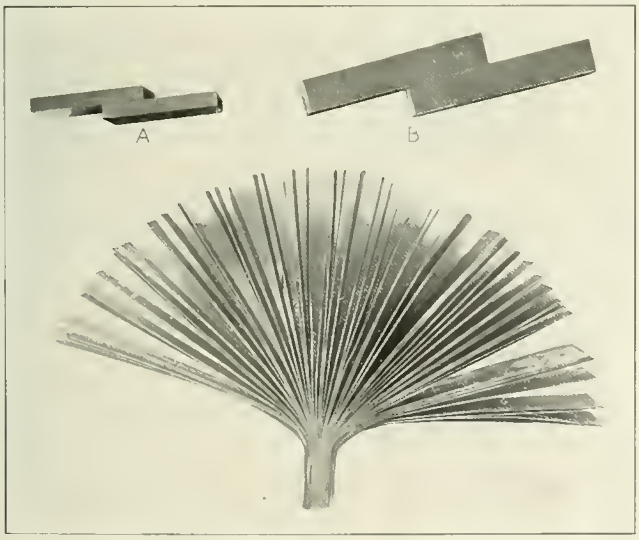


Fig 8. Examples showing Possibilities of Welding Thick Materials

A unique method of making a saw bolt for the handle of a logging saw is shown at *G*. Three projections *P* are formed on the half-round stock which is then bent over as shown in the upper view. The end which is afterward threaded is then welded at the three points simultaneously. Illustration *H* shows a method of welding a spoke to the rim of a line-shaft pulley. The end of the spoke has a projection which passes through a hole in the rim, and the latter is solidly welded to a round area in the center of the spoke.

The application of electric welding to the manufacture of garden rakes is shown in Fig. 7. The teeth of the rake in the lower view are welded to one corner of a square back. The back piece in the upper view has isolated spots formed on it (as shown in the center) to which the teeth are welded. What can be done in the welding of thick material by spot welding is illustrated by the samples in Fig. 8. Two flat pieces 3/8 inch thick are shown welded at *A*, and at *B*, two 7/8-inch square bars are welded together, this having already been referred to. The fan-shaped sample below contains 61 steel sheets of No. 26 gage that have been welded simultaneously in one minute.

The Universal Electric Welding Co. recently constructed a trolley car, 40 feet long, in four sections. The parts were all electrically welded and a saving of nearly one-half of the metal ordinarily required in the construction of such a car was thereby effected.

The various manufactured articles that have been referred to in the foregoing, are parts that are now being electrically welded on a commercial basis, and while the samples illustrated represent a very small part of what is now being accomplished, the diversified character of the work, both as to form and thickness of material, indicates to some extent, at least, the possibilities of electric welding.

* * *

LONG ADDENDUM GEARS*

The bevel driving gears in the rear axle have probably given more trouble to automobile makers and users than any other two gears used on a car. For that reason any system of gear tooth design that tends to quieter running, greater strength or durability is deserving of consideration. The system described in the following is not new, although none of the authors of standard gear books have deemed it worthy of more than a passing comment. It is, of course, understood that the tooth is of true involute or of octoid form, depending upon whether it is produced for a spur or bevel gear. The special feature of it is the lengthening of the addendum of the pinion tooth, with a corresponding shortening of the addendum of the gear tooth—the whole depth remaining the same as in the standard tooth.

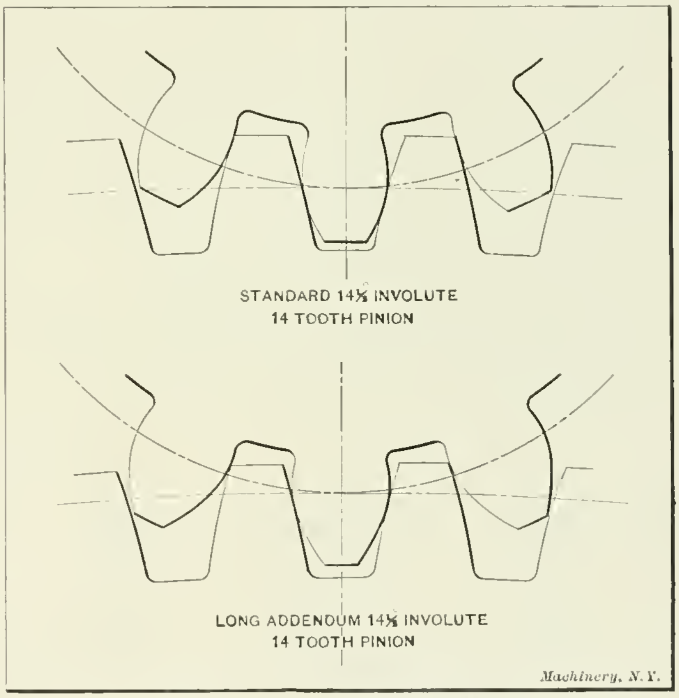


Fig. 1. Comparison between Standard and Long Addendum Gears

With the addendum or face of the driver lengthened, the arc of approach of the gear tooth action is lessened and the arc of recess is increased—becoming all recess and no approach when the driver has only faces and the driven only flanks. This gives particularly smooth running gears—almost equal, in fact, to spiral gears. As is well known, the friction of the arc of approach is much greater than that of the arc of recess—something on the principle of a man dragging a stick after him or pushing it ahead of him. This is very well explained in Grant's book on gearing under the heading of "The Friction of Approach."

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* Abstract of paper by Mr. E. W. Weaver, read before the Society of Automobile Engineers, at the Dayton, Ohio, meeting, June 15-17, 1911.

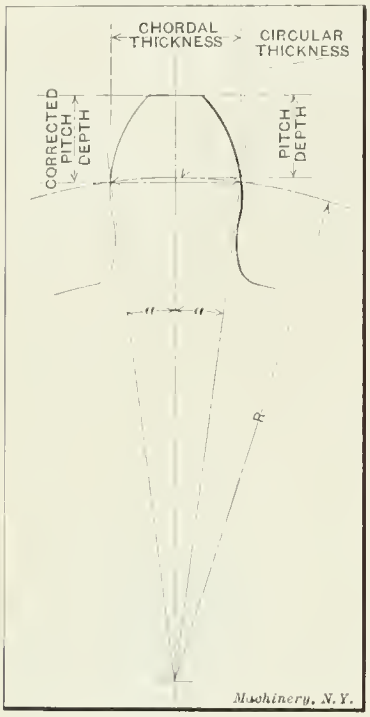


Fig. 2. Nomenclature of Gear Tooth

Pinions with Small Number of Teeth

Another advantage of this system is the very great improvement in the shape of the tooth when the pinion has a small number of teeth. It is readily seen in Fig. 1 that the pinion teeth with the long addendum are fully as strong as the gear teeth, while with the standard tooth they are not. This being the case, it is possible, in designing a rear axle drive, to select a smaller number of teeth for the pinion than one would otherwise wish to select—for instance, if the number of teeth previously used had been 17 and 54, the combination of 15 and 48 would give almost exactly the same ratio and would be fully as strong. With a $5\frac{1}{2}$-inch diameter pitch circle, the outside diameter of the large gear would be decreased somewhat over an inch, thereby making the case that much smaller and lighter with all its inherent advantages.

The disadvantage of using a small number of teeth in a pinion with the standard tooth, has been the small amount of stock left between the bore of the shaft and the bottom of the tooth spaces. This is eliminated to a large extent by the decrease of the dedendum of the pinion tooth.

TABLE I. CHORDAL THICKNESS OF TEETH FOR SPUR GEARS, 1 DIAMETRAL PITCH, SPECIAL PITCH DEPTH

To obtain chordal thickness of teeth and corrected pitch depth for any diametral pitch other than 1, divide figures in table by diametral pitch required

20 deg. Pressure Angle For Pinions, Addendum 0.7 Working Depth		
Number of Teeth	Chordal Thickness	Corrected Pitch Depth
12	1.8545	1.4720
13	1.8554	1.4665
14	1.8567	1.4618
15–16	1.8573	1.4559
17–18	1.8584	1.4495
19–20	1.8592	1.4442
21–22	1.8597	1.4402
23–25	1.8601	1.4361
26–29	1.8606	1.4316
30–34	1.8609	1.4272
For Gears, Addendum 0.3 Working Depth		
35–41	1.2792	0.6107
42–54	1.2793	0.6085
55–79	1.2794	0.6060
80–134	1.2795	0.6040
134	1.2795	0.6030

For bevel gears, find chordal thickness of tooth and corrected pitch depth of gear with the same number of teeth as a spur gear having a diameter equal to twice the back cone distance.

Field of Application

So much for its advantages. To look at the other side—its field of application is limited to gear sets having a large difference in the number of teeth in the gears and pinions, on account of the gear tooth becoming weaker as the number of teeth decreases. The gear having the lengthened addendum must at all times be the driver, as in reversing the application of power, the arc of recess becomes the arc of approach with its greater friction. This is of no account in the driving gears of a car, as in coasting no power is transmitted, except when there is a propeller-shaft brake.

Efficiency

One point which has not been touched on is the efficiency, and consequent life, of a gear of this system as compared with one of the ordinary or of the stub form of tooth. No exhaustive scientific tests to determine this have been made, to the author's knowledge, so it is a matter for further demonstration. For the remainder, the author is indebted to the Gleason Gear Works, of Rochester, N. Y., for supplying formulas, sketches, etc.

TABLE II. DIAMETRAL PITCH STANDARD TEETH

Diametral Pitch	Circular Pitch	Nearest Metric Pitch or "Module"	Diametral Equivalent of "Module"	Circular Pitch Corresponding to Module
$2\frac{1}{4}$	1.3962	11.0	2.309	1.3607
$2\frac{1}{2}$	1.2566	10.0	2.540	1.2370
$2\frac{3}{4}$	1.1424	9.0	2.822	1.1133
3	1.0472	8.0	3.175	0.9896
$3\frac{1}{2}$	0.8976	7.0	3.628	0.8659
4	0.7854	6.0	4.233	0.7422
$4\frac{1}{2}$	0.6981	5.5	4.618	0.6803
5	0.6283	5.0	5.080	0.6185
$5\frac{1}{2}$	0.5712	4.5	5.644	0.5566
6	0.5236	4.0	6.350	0.4948

Finding Circular Thickness of Tooth

The addendum of the pinion tooth as described is arbitrarily taken as 0.7 of its working depth, and 0.3 for the gear tooth for both $14\frac{1}{2}$ and 20 degrees pressure angles. To find the circular thickness of the tooth at the pitch line at these depths, multiply the circular pitch by 0.5659 for the pinion, and by 0.4341 for the gear for $14\frac{1}{2}$ degree pressure angle. For 20 degree pressure angle multiply the circular pitch by 0.5927 and 0.4037, respectively for the pinion and gear.

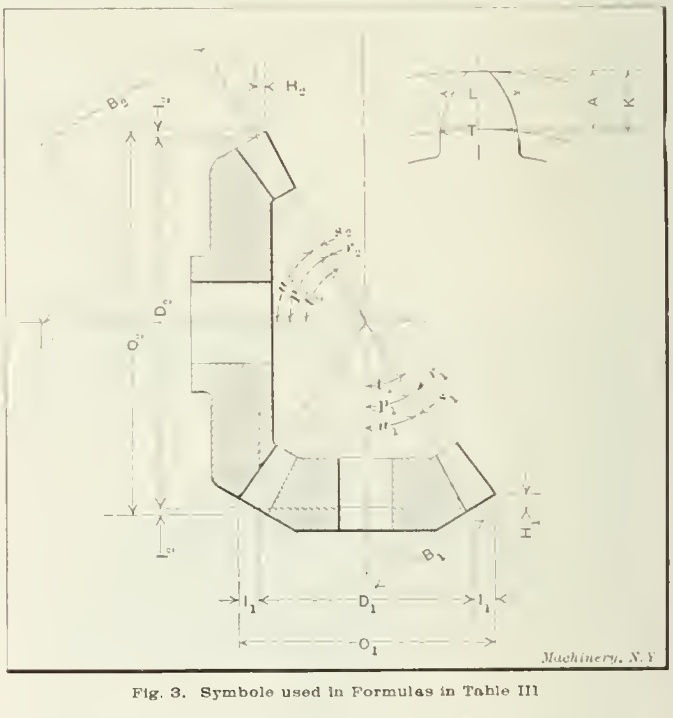


Fig. 3. Symbols used in Formulas in Table III

The impossibility of getting accurate circular measurements necessitates the calculation of the chordal thickness and corrected pitch depth. Referring to Fig. 2, let R equal the pitch radius for spur gear or the back cone distance for a bevel gear.

$$\text{Angle } a = \frac{1}{2} \times \frac{360 \text{ degrees}}{(2R \times 3.1416) \div \text{Circular Thickness}}$$

Chordal thickness $= 2 \times \sin a \times R$

Corrected pitch depth $=$ versed sin $a \times R +$ the given pitch depth.

These values have been tabulated for gears with as large a range of tooth numbers as the system is applicable to with advantage. The formulas required have also been arranged in the logical routine order for all necessary calculations for a pair of bevel gears of this system; symbols are as indicated in Fig. 3.

As some firms are using the metric pitch or "Module" system, Table II is given for their convenience.

* * *

SEVENTY-TWO HORSEPOWER ADAMS-FARWELL AVIATION MOTOR

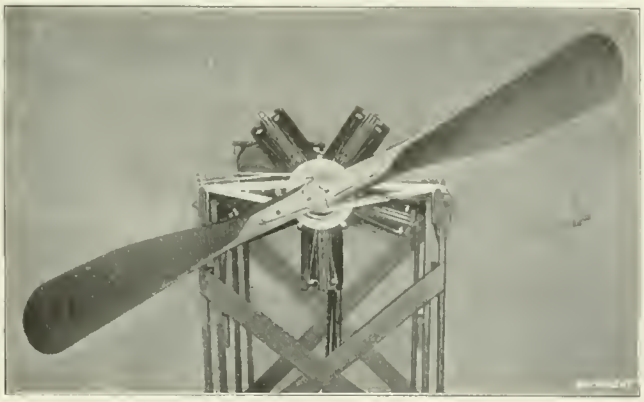
In the July, 1908, number of MACHINERY an article appeared on the Adams-Farwell aeronautic gasoline motor, describing the motors built by the Adams-Farwell Co., Dubuque, Iowa, for aviation purposes. In the January, 1911, issue, the same motor was referred to in an article entitled "Aeroplane and Airship Engines." The Adams-Farwell Co. has now brought out a 72-horsepower motor of the same type as those previously described, but revolving in a vertical plane as shown in the accompanying illustration. This motor, as described in the articles referred to, is in its principal aspects similar to the five-cylinder revolving motors used in the Adams-Farwell car, but it differs in some important features, having been designed from the ground up solely for aviation. By revolving in a vertical plane it can be direct-connected to the propeller shaft, or the propeller directly mounted on the motor shaft, as required.

The most interesting improvement found on this motor is the elimination of the carburetor and the employment of injection with a means for absolutely regulating the amount of gasoline injected into each cylinder, and insuring that all cylinders will receive exactly the same mixture. This also makes it possible to do away with the inlet valve, and employ one valve for both inlet and exhaust, as only air is drawn in by the suction stroke of the piston, while the gasoline is sprayed within the cylinder where it is mixed with the charge of air before compression. Having but one valve in the head of the cylinder, it can be made amply large to insure a full charge and a free exhaust.

TABLE III. FORMULAS FOR LONG ADDENDUM BEVEL GEARS

Name	Symbol		Formula	
	Pinion	Gear	Pinion	Gear
Number of Teeth.....	N_1	N_2	$N_1 = P_d \times D_1$	$N_2 = P_d \times D_2$
Diametral Pitch......	P_d	P_d	$P_d = \frac{N_1}{D_1} = \frac{N_2}{D_2}$	$P_d = \frac{N_1}{D_1} = \frac{N_2}{D_2}$
Circular Pitch........	P_c	P_c	Table II	Table II
Pitch Diameter in Inches	D_1	D_2	$D_1 = \frac{N_1}{P_d}$	$D_2 = \frac{N_2}{P_d}$
Pitch Angle..........	p_1	p_2	$\tan p_1 = \frac{N_1}{N_2}$	$\tan p_2 = \frac{N_2}{N_1}$
Working Depth	W	W	$\frac{2}{P_d}$	$\frac{2}{P_d}$
Addendum...........	A_1	A_2	$A_1 = 0.7 \times W$	$A_2 = 0.3 \times W$
Dedendum...........	E_1	E_2	$E_1 = A_2 + G$	$E_2 = A_1 + G$
Clearance...........	G	G	$G = P_c \times 0.05$	$G = P_c \times 0.05$
Full Depth	F	F	$F = W + G$	$F = W + G$
One-half Diameter Increment............	I_1	I_2	$I_1 = A_1 \times \cos p_1$	$I_2 = A_2 \times \cos p_2$
Outside Diameter.....	O_1	O_2	$O_1 = D_1 + 2\ I_1$	$O_2 = D_2 + 2\ I_2$
Circular Thickness ...	T_1	T_2	$T_1 = P_c \times 0.5927$	$T_2 = P_c - T_1$
Pitch Cone Distance..	C	C	$C = \frac{D_1}{2 \times \sin p_1}$	$C = \frac{D_1}{2 \times \sin p_1}$
Back Cone Distance ..	B_1	B_2	$B_1 = C \times \tan p_1$	$B_2 = C \times \tan p_2$
Addendum Angle	r_1	r_2	$\tan r_1 = \frac{A_1}{C}$	$\tan r_2 = \frac{A_2}{C}$
Dedendum Angle.....	s_1	s_2	$\tan s_1 = \frac{E_1}{C}$	$\tan s_2 = \frac{E_2}{C}$
Face Angle...........	t_1	t_2	$t_1 = p_1 + r_1$	$t_2 = p_2 + r_2$
Cutting Angle........	c_1	c_2	$c_1 = p_1 - s_1$	$c_2 = p_2 - s_2$
Distance from Crown to Pitch Line.......	H_1	H_2	$H_1 = A_1 \times \sin p_1$	$H_2 = A_2 \times \sin p_2$
No. Teeth in Spur Gear having Diameter equal to twice the Back Cone Distance.	S_1	S_2	$S_1 = 2 \times P_d \times B_1$	$S_2 = 2 \times P_d \times B_2$
Chordal Thickness....	L_1	L_2	Table I	Table I
Corrected Pitch Depth	K_1	K_2	Table I	Table I

In order to relieve the cam controlling the action of all five valves from the heavy load of opening a large valve against the high pressure at the time exhaust takes place, the cylinders are provided with auxiliary exhaust ports, which are uncovered by the piston on its downward stroke. No check valves are required over these auxiliary ports, as on the suction stroke, pure air, and not a mixture of gas, is drawn in, so that the air drawn in through the auxiliary ports on the suction stroke becomes a part of the explosive mixture.



Seventy-two Horsepower Aviation Motor

The control of the motor is entirely taken care of by regulating the amount of gasoline used, and the only adjustment that might be construed as belonging to the carburetting system, is the valve by means of which this control is accomplished. The speed may be regulated through quite a wide range by this simple means.

There are two spark plugs in each cylinder and two independent ignition systems, so that either set of plugs may be used, thus insuring against accidental stoppage of the motor from a broken wire. The motor has a bore of 6 inches and a stroke of the same length, and is therefore rated at 72 horsepower according to the A. L. A. M. formula. On actual propeller tests, even a greater power than this has been delivered. It will drive a 9-foot 6-inch propeller of 6-foot pitch at 900 to 1000 R. P. M., developing a thrust of from 440 to 460 pounds, which can be maintained indefinitely without overheating the motor.

* * *

CHROME-VANADIUM FORGINGS

In making chrome-vanadium steel forgings, the Erie Forge Co., of Erie, Pa., uses a steel having the following analysis:

Silicon, 0.131 per cent; sulphur, 0.017 per cent; phosphorus, 0.015 per cent; manganese, 0.60 per cent; carbon, 0.32 per cent; chromium, 0.87 per cent; vanadium, 0.18 per cent.

In the annealed state a steel of this composition shows a tensile strength of 134,000 pounds per square inch, with an elastic limit of 97,000 pounds per square inch. The elongation in 2 inches is 21.1 per cent, and the reduction in area, 57.3 per cent. After having been properly heat treated, quenched in oil, and annealed, the steel possesses an ultimate strength of 210,000 pounds per square inch; an elastic limit of 191,500 pounds per square inch; an elongation in 2 inches of 12 per cent, and a reduction in area of 45 per cent. A forging of a connecting-rod made from this steel was twisted through an angle of 270 degrees, giving it the appearance of a corkscrew, but showed no fracture or flaw of any kind.

* * *

The rapid industrial development of Canada is indicated by the fact that from January 1 to April 1, 1911, the amount of English capital invested in Canada aggregated $70,000,000

PERSONALS

Irving H. Page has resigned as president of the Stevens-Duryea Co., Chicopee Falls, Mass., but continues as treasurer and chairman of the board of directors.

O. C. Thompson, works manager of the National Wire Bound Box Co., South Bend Ind., has been made mechanical engineer with the Healy Box Corporation, New York.

George M. Hendee, president and manager of the Hendee Mfg. Co., Springfield, Mass., manufacturer of the Indian motorcycle, is on a business trip to Europe in the interest of his company.

D. W. Patten, for the past five years with Schuchardt & Schutte, New York, resigned July 1, and is now connected with Marshall & Huschart Machinery Co., Chicago, Ill., in the sales department.

Tracy W. Guthrie has been appointed secretary and general manager of the Standard Welding Co., Cleveland, Ohio, succeeding the late William S. Gorton who was killed by a railroad train April 17.

Col. Frank E. Cutting, for many years associated with the Hill Clarke & Co., Inc. interests has been elected president and general manager of the Lapointe Machine Tool Co., Hudson, Mass. The company was recently reorganized.

Ralph R. Lapointe has become the broach expert of the Lapointe Machine Tool Co., Hudson, Mass. This change came about through the reorganization of the company. Mr. Lapointe will also have charge of the reamer department.

Walter H. Whiteside has been elected president of the Stevens-Duryea Co., Chicopee Falls, Mass., to fill the vacancy caused by the resignation of Mr. Irving H. Page. Mr. Whiteside recently resigned the presidency of the Allis-Chalmers Co., and is an experienced manufacturer and organizer.

Harry P. Davis was elected vice-president of the Westinghouse Electric & Mfg. Co., Pittsburg, Pa. Mr. Davis has been in the employ of the Westinghouse Co. for twenty years. During the last few years he has been assistant to the first vice-president, and manager of engineering at the East Pittsburg Works.

Edwin M. Herr was elected president of the Westinghouse Electric & Mfg. Co., Pittsburg, Pa., at the meeting of the board of directors held in New York City, August 1. Mr. Herr has been first vice-president of the company since 1905. He succeeds Mr. Edwin F. Atkins who has been president of the company since June, 1910, and who declined re-election.

Ashley P. Peck, who for the past six years has been employed by the Allis-Chalmers Co., Milwaukee, Wis., as sales engineer, has recently been engaged by the Terry Steam Turbine Co., as district sales manager for the Middle West, with offices at 814 Peoples Gas Bldg., Chicago, Ill. Before engaging with the Allis-Chalmers Co., Mr. Peck was connected with the National Electric Co.

Malcolm R. Meldrum, formerly employed with the Baker Iron Works, Los Angeles, Cal., has been appointed chief engineer of the firm of W. D. Beath & Son, Ltd., Toronto, Canada. This company is re-designing its line of overhead cranes, and Mr. Meldrum's experience with Herbert Morris & Baskert, Ltd., the largest builders of cranes in England, makes him especially qualified for this work.

Information is wanted of the whereabouts of Albert Bettesworth, 418 Summerville Ave., Philadelphia, Pa., who has been missing since June 2. Mr. Betteswortb was employed in the armor shop of the Midvale Steel Works in Philadelphia, but left the city on account of irregularity of work there. Any information regarding him will be thankfully received by his cousin, Herbert Norton, at the above address.

Calvert Townley has been appointed assistant to the president of the Westinghouse Electric & Mfg. Co. Mr. Townley has for many years been connected with this company, first in Pittsburg and later as manager of the Boston office, and as special representative in New York City. For the past five years he has been closely identified with the electrification of the New York, New Haven & Hartford Railroad.

F. B. De Gress, who for the past ten years has been the New York district manager of the Crocker-Wheeler Co., Ampere, N. J., has resigned from this position and will become general sales manager of the Pulsometer Co., 17 Battery Place, New York. Besides looking after the commercial end of the business, Mr. De Gress will carry on a series of experiments with a view to improving certain features of the pulsometer in order to make it more suitable for general pumping work in power plants, industrial establishments, etc.

* * *

OBITUARIES

Edson J. Coon, master mechanic for the Waterbury Mfg. Co., Waterbury, Conn., died July 22 at Peale's Island, Portland, Me., at an age of sixty-two years. Mr. Coon was born in England, but lived in Waterbury the greater part of his life and for the last thirty years was in the employ of the Waterbury Mfg. Co.

Capt. Albert Gallatin Cummings, widely known in connection with steel works construction in Pennsylvania, and an inventor of switch and aeroplane devices, died at his home at Millersburg, Pa., July 31. Capt. Cummings, was born in New Hampshire in 1842 and served in the Fifth New Hampshire Regiment in the civil war.

Charles A. Palmer died at Pittsfield, Mass., on July 4, aged sixty-five years. Mr. Palmer was for many years in charge of the erecting at the E. D. Jones & Sons Machine Co., Pittsfield, Mass., builder of paper making machinery. Mr. Palmer's occupation took him, in the interest of the firm by whom he was employed, to all parts of the world where paper is manufactured.

G. W. S. Tham, president of the well-known Huskvarna Works in Sweden, died in Huskvarna, August 3. He was one of the most prominent men in the industries of his country, and it was largely through his efforts that the products of the Huskvarna Works—small arms, sewing machines, bicycles, etc.—became favorably known far beyond the boundaries of Sweden. He was born in 1839, and had been connected with the works mentioned since 1876.

* * *

TRAINING IN EFFICIENCY

Although scientific management has become almost a fad, the present industrial watchword of this country is efficiency, and men of notable ability are devoting their lives to devising ways and methods for increasing the efficiency of industrial workers.

In connection with this subject the investigation of Mr. Morris L. Cooke, published by the Carnegie Foundation for the advancement of teaching, and relating to the conditions of the universities and engineering schools of this country, becomes of special interest. Mr. Cooke points out that in a typical technical school the terms include only 223 working days; but of these, not less than 51 days are taken up by holidays and vacations; therefore only 172 days in the year remain for actual work in such institutions, which is but 77 per cent of the available working time during the school year, and 55 per cent of the calendar year. That the institutions which are training young men to be leaders in a field where efficiency is of the highest importance, are themselves conducted with such notorious inefficiency that nearly one-half of their working time is wasted, is certainly a most remarkable condition and one which the agitation for efficiency should remedy. It is probable that some of the dissatisfaction on the part of manufacturers with inexperienced college graduates is due to the habits of inefficiency acquired in the institutions where they were educated. If our educators are anxious to have the young engineers whom they are turning out received with greater appreciation, one of the first reforms they should institute is to inculcate habits of efficiency, responsibility and appreciation of the necessity of using every available moment to the best advantage.

* * *

In consequence of the success that has attended the use of heating value specifications in buying and selling coal, similar specifications have been issued by the Bureau of Mines to govern the purchase of fuel-oils and refined products of petroleum. A copy of these specifications can be obtained by addressing the director of the Bureau of Mines, Washington D. C.

* * *

The article entitled "Gas Engine Piston Rings," in another part of this number, should read instead, "Gas Engine Wrist pins."

* * *

COMING EVENTS

September 1-3.- First annual meeting of the Institute of Operating Engineers held at the Engineering Societies Building, 29 West 39th St., New York.

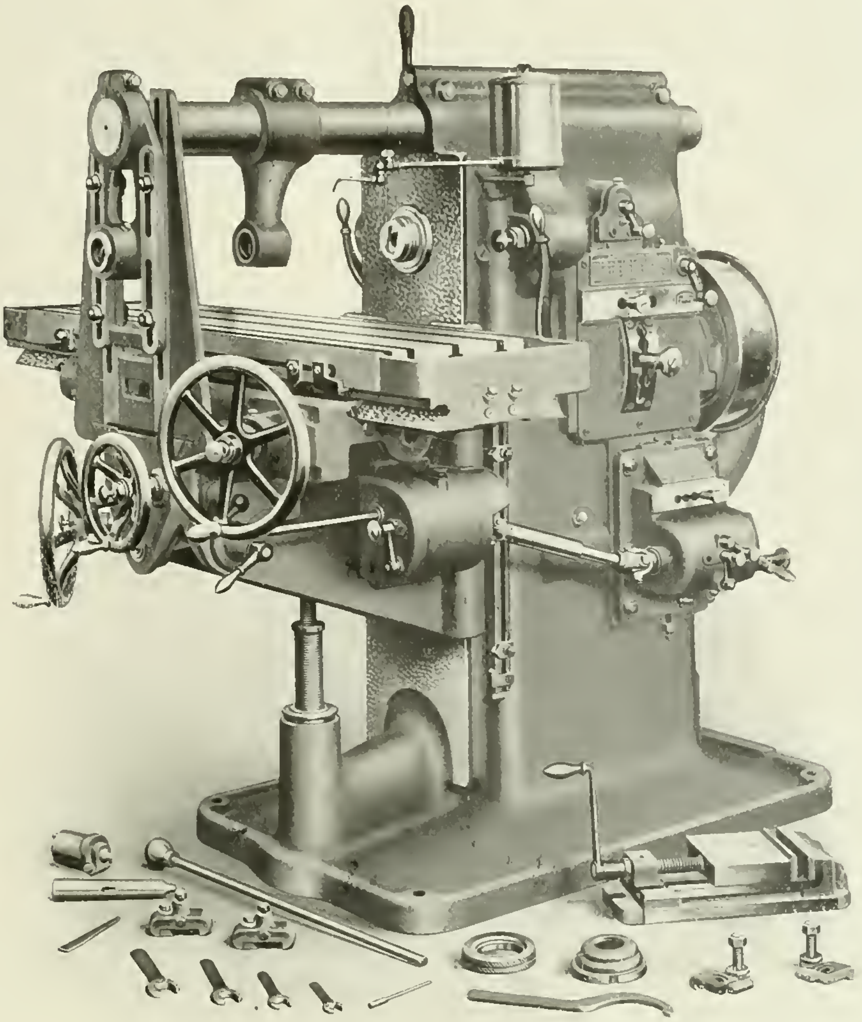
September 11-17. International Exposition of Inventions, held at St. Louis at the new Coliseum building. For further information apply to F. W. Payne, secretary and manager of the St. Louis Coliseum Co., St. Louis, Mo.

September 27-30.—Semi-annual meeting of the National Association of Cotton Manufacturers held at the Equinox House, Manchester, Vt. C. J. H. Woodbury, secretary and treasurer, P. O. Box 3672, Boston, Mass.

October 2-3.- Autumn meeting of the Iron & Steel Institute at Turin, Italy. G. C. Lloyd, secretary, 28 Victoria St., London, S. W., England.

October 2-28.—Industrial and educational exposition under the auspices of the Boston Chamber of Commerce, held in the Mechanics' Building at Boston, Mass. This exposition is devoted strictly to New England industries. No manufacturer outside of New England will be allowed to exhibit.

October 9-13. Convention of the American Electric Railway Asso-



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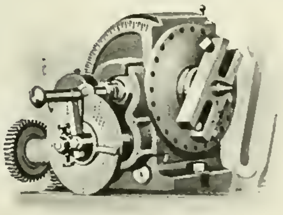

Write us for further particulars.

BROWN & SHARPE MFG. CO.

PROVIDENCE, R. I., U. S. A.

ciation, Young's New Pier, Atlantic City, N. J. H. C. Donecker, secretary-treasurer, 29 West 39th St., New York.

October 10. MACHINERY'S ninth annual entertainment, Hotel Astor, New York, Tuesday evening at 8 o'clock.

October 10-12.—Tenth annual convention of the National Machine Tool Builders' Association, in New York City. Charles E. Hildreth, 134 Gold St., Worcester, Mass., secretary.

November 2-4. Annual meeting of the International Society for the Promotion of Industrial Education, Cincinnati, Ohio. R. T. Davis, secretary, 18 W. 44th St., New York City.

SOCIETIES AND COLLEGES

University of Utah, Salt Lake City, Utah. Catalogue 1911-1912.

Upper Iowa University, Fayette, Ia. Catalogue 1910-1911; announcements 1911-1912.

Rose Polytechnic Institute, Terre Haute, Ind. Catalogue 1910-1911; calendar 1911-1912.

University of New Mexico, Albuquerque, N. M. Catalogue 1910-1911; announcements 1911-1912.

Michigan College of Mines, Houghton, Mich. Year Book 1910-1911; announcements, 1911-1912. Book of graduates of the Michigan College of Mines up to and including 1909. Book of views of the Michigan College of Mines.

Pratt Institute, Brooklyn, N. Y. Catalogue 1911-1912 containing an outline of the course of study in the institute, the entrance examinations and requirements, and some general information which is likely to be of value to prospective students.

Massachusetts Institute of Technology, Boston, Mass., announces that the proceedings of the Congress of Technology, held in Boston April 10-11, will be published. The single volume of about 500 pages, which will be sold at a moderate price, will contain the seventy-odd technical papers, relating to many fields of industry, which were read at the celebration of the fiftieth anniversary of the granting of the charter of the Massachusetts Institute of Technology.

NEW BOOKS AND PAMPHLETS

American Cement Directory, with Buyers' Index. 104 pages, 3 by 5 inches. Published by the Technical Press, Ford Bldg., Detroit, Mich. Price $1.00.

The Soil Solution—The Nutrient Medium for Plant Growth. By Frank K. Cameron. 136 pages, 6 by 9 inches. Published by the Chemical Publishing Co., Easton, Pa. Price $1.25.

The Revolution in Freight Claims. Bulletin No. 8 issued by the Railway Business Association. 30 pages, 6¾ by 10 inches. Published by the Railway Business Association, 2 Rector St., New York.

The Strength of Flat Plates. By Tandy A. Bryson. 15 pages, 6 by 9 inches. Published by the Department of Mechanical Engineering, Russell Sage Laboratory, Rensselaer Polytechnic Institute, Troy, N. Y.

The Conflict Between Federal and State Regulation of the Railways. Bulletin No. 15 of the Bureau of Railway Economics. 13 pages, 6 by 9 inches. Published by the Bureau of Railway Economics, Washington, D. C.

Report to the Legislature of the State of New York by the Commission Appointed to Inquire into the Question of Employers' Liability: Second Report—Causes and Prevention of Industrial Accidents; Third Report—Unemployment and Lack of Farm Labor; Fourth Report—Recommendation for a Constitutional Amendment.

Railway Shop Kinks. By Roy V. Wright. 290 pages, 9 by 12 inches. Published by the *Railway Age Gazette*, New York. Price $2.00.

The kinks contained in this book have been selected from the shop kinks published from time to time in the *Railway Age Gazette*. They have been classified, as far as possible, according to the different shops or departments in which they are used and are listed under the following heads: Machine Shop Kinks; Erecting Shop Kinks; Boiler Shop Kinks; Oxy-acetylene Welding and Cutting; Blacksmith Shop Kinks; Brass Foundry Kinks; Tin and Copper Shop Kinks; Engine House Kinks; Car Department Kinks; Steel Freight Car Kinks; Passenger Car Kinks; Planing Mill Kinks; Air-brake Kinks; Oil-house Kinks; Paint Shop Kinks, and Miscellaneous Kinks.

A Manual of Engineering Drawing. By Thomas E. French. 289 pages, 6 by 9 inches. Published by McGraw-Hill Book Co., New York. Price $2.00.

The author of this book, who is a professor of engineering drawing at the Ohio State University, has endeavored in the preparation of the volume to conform to modern engineering practice, and to present a book which would be of permanent value in the student's library. The book touches upon all the important phases of engineering drawing and comprises chapters on: the selection and use of instruments; applied geometry; lettering; orthographic projection; developed surfaces and intersections; working drawings; technical sketching; the elements of architectural drawing; and map and topographical drawing. The book is profusely illustrated, there being 452 illustrations in the text.

Hommes et Choses du P. L. M. 160 pages, 5½ by 8½ inches. Illustrated. Published by the Paris to Lyons and the Mediterranean Railway, Paris, France.

This interesting and instructive book, as the title implies, deals with the personnel and equipment of the Paris to Lyons and the Mediterranean Railway. It is a handsome book, beautifully illustrated with expensive engravings. Primarily, it is a history of the development of the company from its inception, leading on down to the present time. A description is given of the present rolling stock and personnel, and besides, a tour of the road, well illustrated, gives one a good impression of that portion of France traversed by the road. The book is enlivened throughout with caricatures depicting humorous incidents, past and present, on the road. The book shows careful preparation and is an exceptionally high-grade production.

Machine Shop Practice. By William J. Kaup. 227 pages, 5¼ by 8½ inches. Published by John Wiley & Sons, New York. Price $1.25.

In this book the author, who was formerly head of the department of machine construction at the Pratt Institute, and who is now connected with the Westinghouse Electric & Mfg. Co., Pittsburg, Pa., presents an elementary treatise on machine shop work, prepared especially for trade, industrial and technical schools, but also for young men directly engaged in practical machine shop work. It has not been the purpose of the author to present in this volume a comprehensive treatise on machine shop practice, but primarily to deal with those things, as stated in the preface, "which seemed too small to notice by those who have already written so ably on the subject." The book contains chapters on vise work, filing, scraping, hand tools, materials of construction, drill presses, planers and shapers, lathe practice, cutting tools, boring mills, milling machines, measuring instruments, gearing, grinding, tool steel and its treatment, toolmaking and shop systems.

Cost Keeping and Scientific Management. By Holden A. Evans. 252 pages, 6 by 9 inches. 44 illustrations. Published by the McGraw-Hill Book Co., New York. Price $3.00.

The need of accurate systems of keeping costs would appear to be so obvious that every manufacturing concern should provide the best means available for the purpose; but unfortunately many concerns, some of them large and apparently prosperous, have no accurate means of determining detailed costs. The result is that while a line of manufacture as a whole may show a fair profit, large losses may be incurred in the manufacture of certain parts that have not been properly costed. The work is written particularly to fit the needs of jobbing shops and small manufacturing plants where accurate cost keeping and the principles of good management have received but little attention, and is largely based on the principles of management advocated by Mr. Fred W. Taylor. The contents by chapter headings are as follows: The Importance of Accurate Costs; The Purposes of a Cost System; The Various Elements of Cost; Distribution of Indirect Costs; Production, Order, Shop Order and Cost Section Records; Indirect Charges; Supervision of the Expense Accounts; Methods Followed in the Payment of Labor; Management; Wasted Time Detected by Time Studies; The Principles of Scientific Management which can be followed By a Manager; Methods which lead towards Scientific Management; Machine Shop Methods; Organization of a Smith Shop, A Wood-Working Shop, and a Canvas and Flag Shop; and Reductions in Cost Due to Scientific Methods.

Centrifugal Pumps: Their Design and Construction. By Louis C. Loewenstein and Clarence P. Crissey, 435 pages, 6½ by 9½ inches, 317 illustrations. Published by D. Van Nostrand Co., New York. Price, $4.50.

The American engineering public has so long looked to the old world for guidance in the matter of centrifugal pump design, that it has been with difficulty that the ties seemingly formed by necessity have been largely thrown off. At present, however, much of the centrifugal pump business is supplied right here in America, the new designs being based on the manufacturer's own experience and data, in contradistinction to the past, when the construction, if carried on in this country, was from European designs or information. As indicative of the ability of this country to handle its own centrifugal pump design, several books have appeared written by authorities, one of the best of which is the book under discussion One can readily appreciate the difficulties to be encountered in preparing a treatise on such a subject, involving, as it does, so much mathematics in its theory, but this particular point seems to have been well taken care of, the mathematical consideration being materially simplified by the extensive use of simple velocity diagrams and of the graphic means of representing conditions. In addition to considering the theory and design, the book contains a large number of examples of typical installations of the best known types, and discussion of their qualifications and adaptability to the various conditions under which they are designed to operate. The extensive use of illustrations makes the book of more than ordinary interest to the average reader. There are in all seven chapters: Theory of Centrifugal Pumps; Consumption of Power and Efficiency; The Regulation and Classification of Centrifugal Pumps; The Calculation of Impeller and Guide Vanes; Design of Important Pump Parts; Types of Centrifugal Pumps; and Testing of Centrifugal Pumps.

CATALOGUES AND CIRCULARS

Skinner Chuck Co., New Britain, Conn. Circular illustrating and describing the Hopkinson drill vise and the No. 0 toolmakers' vise made by the company.

Schuchardt & Schutte, Cedar and West Sts., New York. Circular of the "Columbia" high-speed universal chucks, which were illustrated and described in the August number of Machinery.

General Electric Co., Schenectady, N. Y. Bulletin No. 4855 illustrating and describing gas-electric motor cars of the double truck type built by the company for regular railway service.

Cleveland Planer Works, 3148-3160 Superior Ave., Cleveland, Ohio. Bulletin illustrating and describing the Cleveland open-side planers, and calling attention to the advantages of this type of planer.

Modern Systems Correspondence School, 6 Beacon St., Boston, Mass. Circular describing the methods pursued by the Modern Systems Correspondence School of Boston, of which Oscar E. Perrigo is the director.

Warren Webster & Co., Camden, N. J. Pamphlets describing the modulation heating system as installed in office buildings, together with test results from an investigation made of a modulation steam heating system.

American Blower Co., Detroit, Mich. Bulletin No. 315, illustrating and describing "Ventura" disk ventilating fans. The bulletin contains a number of tables for ascertaining the capacities, speed, horsepower and sizes of fans.

Niles-Bement-Pond Co., 111 Broadway, New York. Catalogue illustrating and describing heavy-duty lathes. The lathes included are from 24- to 72-inch swing. Gun lathes of from 53- to 108-inch swing are also described.

Cutler-Hammer Mfg. Co., Milwaukee, Wis. Circular illustrating installations of the Thomas gas meter, illustrated and described in the March, 1911, number of Machinery. The circular also gives the results of tests made on the meter.

International Acheson Graphite Co., Niagara Falls, N. Y. Booklet entitled "Three Little Stories of Three Big Events and Three Winning Lubricants." The pamphlet refers to the use of oildag, gredag and aquadag as lubricants in gas engines.

Ph. Bonvillain & E. Ronceray, 9-11, Rue des Envierges, Paris, France. Catalogue No. 6, illustrating and describing a number of different sizes and types of molding machines built by the firm. The catalogue is published in the French language.

Frontier Iron Works, Cor. Grant & Letchworth Sts., Buffalo, N. Y. Blotter illustrating the large variety of gasoline motor cylinder castings which the company furnishes to builders of automobiles, aeroplanes and marine engines as a specialty.

Rockwell Furnace Co., 26 Cortlandt St., New York. Bulletin No. 29, describing the Lalor automatic stop-valve designed to automatically stop the supply of oil in case of breakage of the oil lines or abnormal flow of oil to the burners in oil furnaces.

Detroit Twist Drill Co., Detroit, Mich. Booklet No. 18 on Detroit carbon and high-speed drills, reamers, cutters, special drills, etc. The booklet contains lists and descriptions of a few of the standard types of tools, together with useful hints for operators.

Westinghouse Electric & Mfg. Co., Pittsburg, Pa. Catalogue of Westinghouse controllers for railway shops. This catalogue was especially arranged and prepared for distribution at the Master Mechanics' and Master Car Builders' convention at Atlantic City, N. J.

Hess-Bright Mfg. Co., 21st and Fairmount Ave., Philadelphia, Pa. In order to facilitate the references to the data sheets issued by the company, a classified index has been arranged for them, and index separating cards, printed for the several classes, have been provided.

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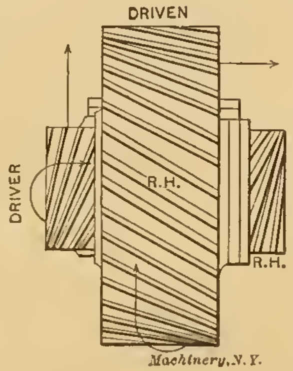
SPIRAL GEARS—V

Shafts at Right Angles, Ratio Equal, Center Distance Approximate



When the spiral angles are 45 degrees, the gears are exactly alike; when other than 45 degrees, their sum must equal 90 degrees.

Given or assumed:

1. Position of gear having right- or left-hand spiral depending on the rotation and direction in which thrust is to be received (see thrust diagram).
2. C_a = approximate center distance.
3. P_n = normal pitch (pitch of cutter).
4. N = number of teeth.
5. α = angle of spiral.

To find:

a. When spiral angles are 45 degrees.

1. D = pitch diameter = $\frac{N}{0.70711\,P_n}$ 2. O = outside diameter = $D + \frac{2}{P_n}$
3. T = number of teeth marked on cutter = $\frac{N}{0.353}$
4. L = lead of spiral = πD.   5. C = center distance = D.

b. When spiral angles are other than 45 degrees.

1. D = pitch diameter = $\frac{N}{P_n \cos \alpha}$
2. T = number of teeth marked on cutter = $\frac{N}{\cos^3 \alpha}$
3. C = center distance = sum of pitch radii.
4. L = lead of spiral = $\pi D \cot \alpha$.

Example

Given or assumed:

1. Fig. 10 (thrust diagram).   2. $C_a = 2.5$ inches.
3. $P_n = 10$.   4. $N = 18$ teeth.   5. $\alpha = 45$ degrees.

To find:

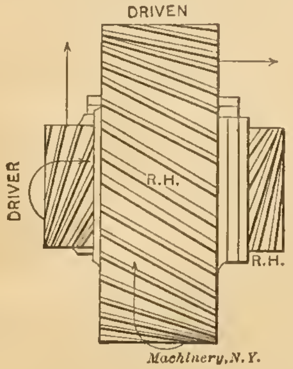
1. $D = \frac{N}{0.70711\,P_n} = \frac{18}{0.70711 \times 10} = 2.546$ inches.   2. $O = D + \frac{2}{P_n} = 2.546 + \frac{2}{10} = 2.746$ inches
3. $T = \frac{N}{\cos^3 \alpha} = \frac{18}{0.353} = 51$ teeth.   4. $L = \pi D \times 1 = 3.1416 \times 2.546 = 7.999$ inches.

Contributed by James H. Carver

No. 147, Data Sheet, MACHINERY, October, 1911

SPIRAL GEARS—VI

Shafts at Right Angles, Ratio Equal, Center Distance Exact



Gears have same direction of spiral but probably different pitch diameters, and spiral angles whose sum is 90 degrees.

Given or assumed:

1. Position of gear having right- or left-hand spiral depending on rotation and direction in which thrust is to be received (see thrust diagram).
2. P_n = normal pitch (pitch of cutter).
3. ϕ = approximate spiral angle of one gear.
4. C = center distance.
5. N = number of teeth nearest whole number to $C P_n \times \cos \phi$.

To find:

1. α = spiral angle of one gear

$$\sin 2\alpha = \frac{N^2}{2\,C^2 P^2_n} \pm \sqrt{\frac{N^2}{C^2\,P^2_n} + \left(\frac{N^2}{2\,C^2\,P^2_n}\right)^2}$$

2. β = spiral angle of other gear = $90° - \alpha$.   3. D = pitch diameter of one gear = $\frac{N}{P_n \cos \alpha}$
4. d = pitch diameter of other gear = $\frac{N}{P_n \cos \beta}$
5. O = outside diameter of one gear = $D + \frac{2}{P_n}$
6. o = outside diameter of other gear = $d + \frac{2}{P_n}$
7. T = number of teeth marked on cutter for one gear = $\frac{N}{\cos^3 \alpha}$
8. t = number of teeth marked on cutter for other gear = $\frac{N}{\cos^3 \beta}$
9. L = lead of spiral for one gear = $\pi D \cot \alpha$.
10. l = lead of spiral for other gear = $\pi d \cot \beta$.

Example

Given or assumed:

1. Fig. 10 (thrust diagram).   2. $P_n = 10$.   3. $\phi = 45$ degrees.   4. $C = 4$ inches.
5. $N = C P_n \cos \phi = 4 \times 10 \times 0.70711 = 28.28$, say 28 teeth.

To find:

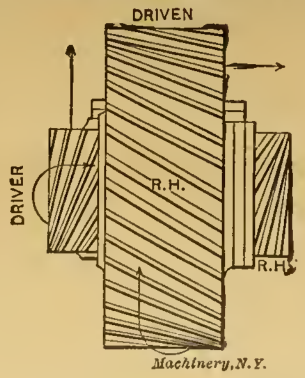
1. $\sin 2\alpha = 0.98664$ $\therefore \alpha = 40° 18' 42''$.   2. $\beta = 90° - \alpha = 49° 41' 18''$.
3. $D = \frac{N}{P_n \cos \alpha} = \frac{28}{10 \times 0.76254} = 3.672$ inches.   4. $d = \frac{N}{P_n \cos \beta} = \frac{28}{10 \times 0.6469} = 4.328$ inches.
5. $O = 3.672 + 0.2 = 3.872$ inches.   6. $o = 4.328 + 0.2 = 4.528$ inches.
7. $T = \frac{N}{\cos^3 \alpha} = \frac{28}{(0.762)^3} = 63.6$, say 64 teeth (No. 2 cutter).
8. $t = \frac{N}{\cos^3 \beta} = \frac{28}{(0.647)^3} = 103.8$, say 104 teeth.
9. $L = \pi D \cot \alpha = 3.1416 \times 3.672 \times 1.1787 = 13.597$ inches.
10. $l = \pi d \cot \beta = 3.1416 \times 4.328 \times 0.84841 = 11.536$ inches.

Contributed by James H. Carver

No. 147, Data Sheet, MACHINERY, October, 1911

SPIRAL GEARS—VII

Shafts at Right Angles, Ratio Unequal, C. D. Approximate



Sum of spiral angles of gear and pinion must equal 90 degrees.

Given or assumed:

1. Position of gear having right- or left-hand spiral depending on rotation and direction in which thrust is to be received.
2. C_a = approximate center distance.
3. P_n = normal pitch (pitch of cutter).
4. R = ratio of gear to pinion.
5. n = number of teeth in pinion $= \dfrac{1.41\,C_a\,P_n}{R+1}$ for 45 degrees $= \dfrac{2\,C_a\,P_n \cos\alpha \cos\beta}{R\cos\beta + \cos\alpha}$ for any angle.
6. N = number of teeth in gear $= n\,R$.
7. α = angle of spiral on gear.
8. β = angle of spiral on pinion.

To find:

a. When spiral angles are 45 degrees.

1. D = pitch diameter of gear $= \dfrac{N}{0.70711\,P_n}$ 2. d = pitch diameter of pinion $= \dfrac{n}{0.70711\,P_n}$
3. O = outside diameter of gear $= D + \dfrac{2}{P_n}$ 4. o = outside diameter of pinion $= d + \dfrac{2}{P_n}$
5. T = number of cutter (gear) $= \dfrac{N}{0.353}$ 6. t = number of cutter (pinion) $= \dfrac{n}{0.353}$
7. L = lead of spiral on gear $= \pi D$. 8. l = lead of spiral on pinion $= \pi d$.
9. C = center distance (exact) $= \dfrac{D+d}{2}$

b. When spiral angles are other than 45 degrees.

1. $D = \dfrac{N}{P_n \cos\alpha}$ 3. $T = \dfrac{N}{\cos^3\alpha}$ 5. $L = \pi D \cot\alpha$
2. $d = \dfrac{n}{P_n \cos\beta}$ 4. $t = \dfrac{n}{\cos^3\beta}$ 6. $l = \pi d \cot\beta$

Example

Given or assumed:

1. Fig. 10 (thrust diagram). 2. $C_a = 3.2$ inches. 3. $P_n = 10$. 4. $R = 1.5$.
5. $n = \dfrac{1.41\,C_a\,P_n}{R+1} = \dfrac{1.41 \times 3.2 \times 10}{1.5+1}$ = say 18 teeth. 6. $N = n\,R = 18 \times 1.5 = 27$ teeth.
7. α = 45 degrees. 8. β = 45 degrees.

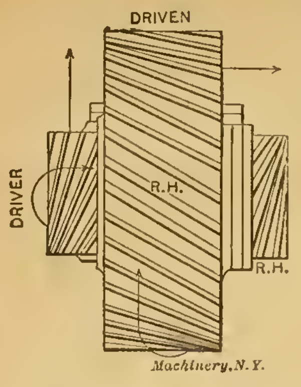
To find:

1. $D = \dfrac{N}{0.70711\,P_n} = \dfrac{27}{0.70711 \times 10} = 3.818$ ins. 2. $d = \dfrac{n}{0.70711\,P_n} = \dfrac{18}{0.70711 \times 10} = 2.545$ ins.
3. $O = D + \dfrac{2}{P_n} = 3.818 + \dfrac{2}{10} = 4.018$ inches. 4. $o = d + \dfrac{2}{P_n} = 2.545 + \dfrac{2}{10} = 2.745$ inches.
5. $T = \dfrac{N}{0.353} = \dfrac{27}{0.353} = 76.5$, say 76 teeth. 6. $t = \dfrac{n}{0.353} = \dfrac{18}{0.353} = 51$ teeth.
7. $L = \pi D = 3.1416 \times 3.818 = 12$ inches. 8. $l = \pi d = 3.1416 \times 2.545 = 8$ inches.
9. $C = \dfrac{D+d}{2} = \dfrac{3.818 + 2.545}{2} = 3.182$ inches.

Contributed by James H. Carver

SPIRAL GEARS—VIII

Shafts at Right Angles, Ratios Unequal, Center Distance Exact



Gears have same direction of spiral. The sum of spiral angles of both gears will equal 90 degrees.

Given or assumed:

1. Position of gear having right- or left-hand spiral depending on rotation and direction in which thrust is to be received. (See thrust diagram.)
2. P_n = normal pitch (pitch of cutter).
3. R = ratio of number of teeth in large gear to number of teeth in small gear.
4. α_a = approximate spiral angle of large gear.
5. C = exact center distance.

To find:

1. n = number of teeth in small gear nearest $\dfrac{2\,C\,P_n \sin\alpha_a}{1 + R\tan\alpha_a}$
2. N = number of teeth in large gear $= R\,n$.
3. α = exact spiral angle of large gear, found by trial from $R\sec\alpha + \operatorname{cosec}\alpha = \dfrac{2\,C\,P_n}{n}$
4. β = exact spiral angle of small gear $= 90° - \alpha$.
5. D = pitch diameter of large gear $= \dfrac{N}{P_n \cos\alpha}$ 6. d = pitch diameter of small gear $= \dfrac{n}{P_n \cos\beta}$
7. O = outside diameter large gear $= D + \dfrac{2}{P_n}$ 8. o = outside diameter small gear $= d + \dfrac{2}{P_n}$
9. T = number of teeth marked on cutter for large gear $= \dfrac{N}{\cos^3\alpha}$
10. t = number of teeth marked on cutter for small gear $= \dfrac{n}{\cos^3\beta}$
11. L = lead of spiral on large gear $= \pi D \cot\alpha$.
12. l = lead of spiral on small gear $= \pi d \cot\beta$.

Example

Given or assumed:

1. Fig. 10 (thrust diagram). 2. $P_n = 8$. 3. $R = 3$. 4. $\alpha_a = 45$ degrees. 5. $C = 10$ inches.

To find:

1. $n = \dfrac{2\,C\,P_n \sin\alpha_a}{1 + R\tan\alpha_a} = \dfrac{2 \times 10 \times 8 \times 0.70711}{1+3} = 28.25$, say 28 teeth.
2. $N = R\,n = 3 \times 28 = 84$ teeth.
3. $R\sec\alpha + \operatorname{cosec}\alpha = \dfrac{2\,C\,P_n}{n} = \dfrac{2 \times 10 \times 8}{28} = 5.714$. $\therefore \alpha = 46° 6'$.
4. $\beta = 90° - \alpha = 90° - 46° 6' = 43° 54'$. 5. $D = \dfrac{N}{P_n \cos\alpha} = \dfrac{84}{8 \times 0.6934} = 15.143$ inches.
6. $d = \dfrac{n}{P_n \cos\beta} = \dfrac{28}{8 \times 0.72055} = 4.857$ ins. 7. $O = D + \dfrac{2}{P_n} = 15.143 + 0.25 = 15.393$ ins.
8. $o = d + \dfrac{2}{P_n} = 4.857 + 0.25 = 5.107$ inches. 9. $T = \dfrac{N}{\cos^3\alpha} = \dfrac{84}{0.333}$, say 252 teeth.
10. $t = \dfrac{n}{\cos^3\beta} = \dfrac{28}{0.374}$ = say 75 teeth.
11. $L = \pi D \cot\alpha = 3.1416 \times 15.143 \times 0.96232 = 45.78$ inches.
12. $l = \pi d \cot\beta = 3.1416 \times 4.857 \times 1.0392 = 15.857$ inches.

Contributed by James H. Carver

MACHINERY
October, 1911

THE ROSS RIFLE AND ITS MANUFACTURE[*]—1

A RIFLE HAVING A STRAIGHT-PULL BOLT ACTION WHICH WILL RESIST 100,000 POUNDS BREECH PRESSURE

By DOUGLAS T. HAMILTON[†]

THE time is not yet at hand when the nations of this world "shall beat their swords into plowshares and their spears into pruning-hooks," but rather they are endeavoring to develop more wonderful and more powerful weapons than ever before. The ultimate outcome of this competitive endeavor is unknown to us, but laying aside the question of disarmament and considering the improvements in mechanical construction of the modern firearms, we will find much to interest us in regard to interchangeable manufacture.

Fig. 1. The Ross Rifle Factory, Quebec, Canada

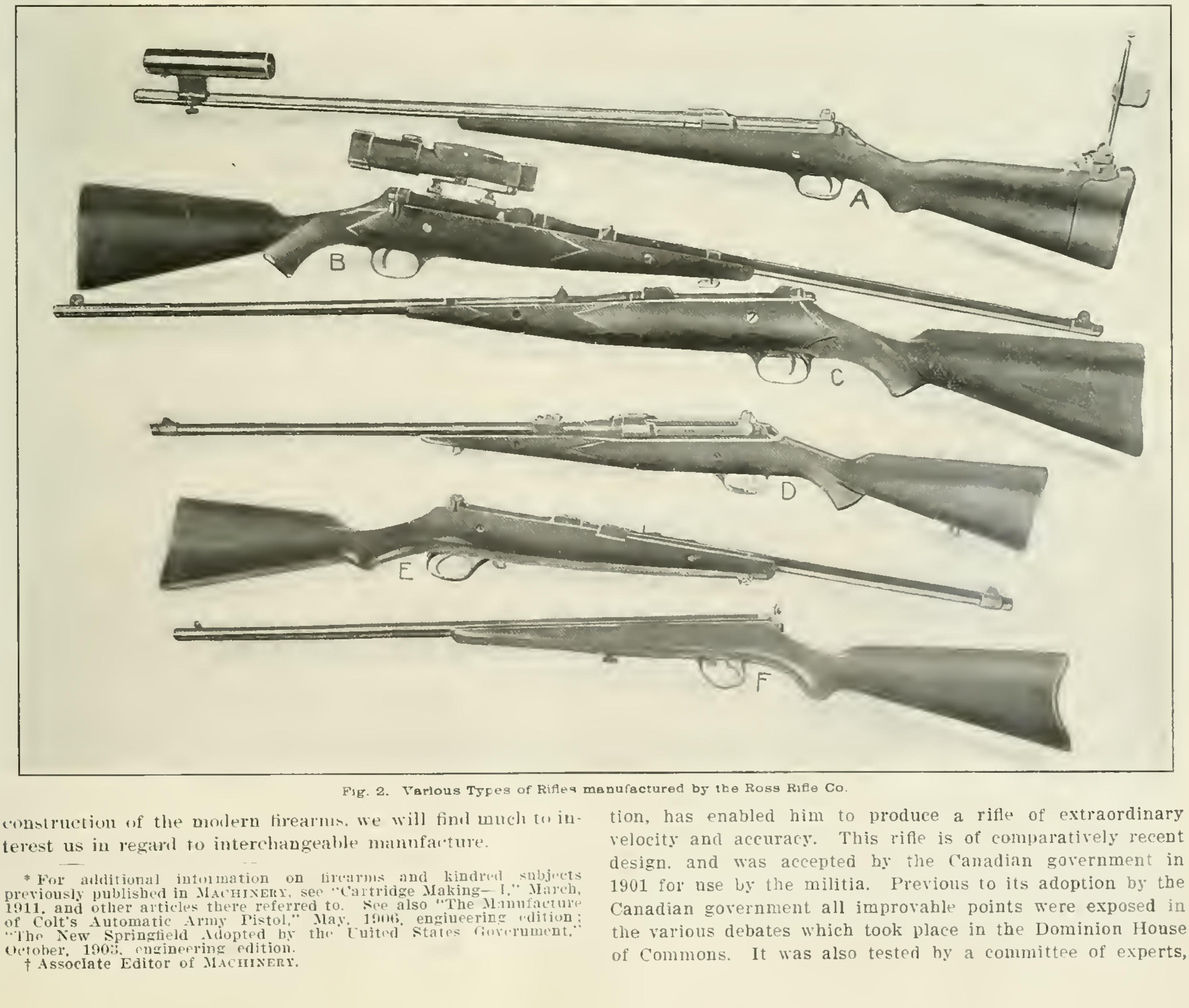


Fig. 2. Various Types of Rifles manufactured by the Ross Rifle Co.

The Ross rifle is a good example of the improvements made in the modern firearm. This rifle embodies much that is interesting in the way of mechanical movements. The designer and manufacturer—Sir Charles Ross, Bart.—as a large land owner in Scotland, has had ample opportunity of testing its capabilities. This, coupled with his experience in matters pertaining to the science of military rifle design and construction, has enabled him to produce a rifle of extraordinary velocity and accuracy. This rifle is of comparatively recent design, and was accepted by the Canadian government in 1901 for use by the militia. Previous to its adoption by the Canadian government all improvable points were exposed in the various debates which took place in the Dominion House of Commons. It was also tested by a committee of experts, the tests being similar to those of the U. S. Ordnance Board, with every additional rigor of detail that ingenuity could devise. The rifle passed every test satisfactorily, and it now stands on its merits alone. The careful attention given to details and the ability of the designer of this rifle to take advantage of the peculiarities of its construction will be clearly set forth in the articles which will follow, dealing with its manufacture.

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[*] For additional information on firearms and kindred subjects previously published in MACHINERY, see "Cartridge Making—I," March, 1911, and other articles there referred to. See also "The Manufacture of Colt's Automatic Army Pistol," May, 1906, engineering edition; "The New Springfield Adopted by the United States Government," October, 1903, engineering edition.

[†] Associate Editor of MACHINERY.

The Ross Rifle Factory

The Ross rifle is manufactured in the city of Quebec, the factory being located on the historic Plains of Abraham overlooking the St. Lawrence River. It is a three-story 200 by 45-foot brick building with two wings, each 60 by 45 feet. The boiler house is a separate building, 60 by 50 feet, and contains, besides the boiler for heating the plant, the case-hardening furnaces, hardening ovens and the blacksmith's forge. A 100,000-gallon water tank, erected on top of an old Martello tower, located at the rear of the factory, supplies water to the automatic fire sprinkler system located throughout the works. The various departments are run by separate motors, so that one department can be stopped independently of the others.

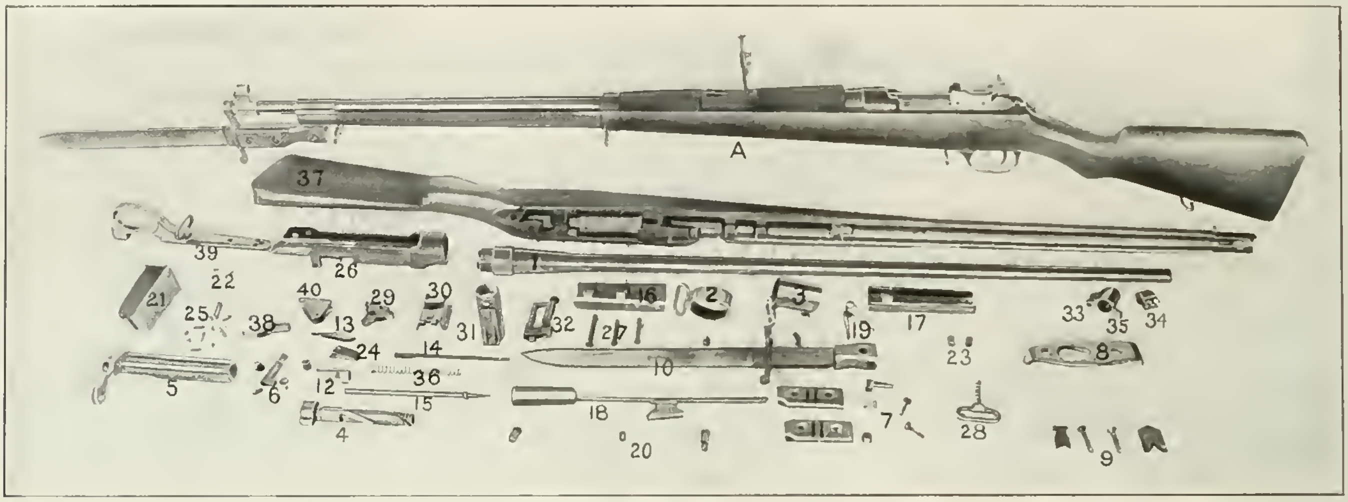


Fig. 3. The Mark II* Military Rifle and its Component Parts

As is the usual practice, this factory is divided into departments, each one being used for some series of operations on the rifle. The front wing of the building is used exclusively for offices, while the lower one-story building, shown in the immediate foreground to the right of Fig. 1, is used by the government for inspection purposes. All manufactured parts, as well as the completed rifles, are inspected here by government inspectors, so that any rifles or parts that pass inspection can be relied upon as complying with the specifications. The lower floor of the main building, to the right, is devoted to the manufacture of the barrel; here the barrel-turning drilling and rifling machines are located. The second floor is occupied by the tool-room where all special tools, jigs and fixtures used in the manufacture of the rifle are made. The top floor is equipped with woodworking machinery for the manufacture of the stock. The lower floor of the main building, to the left, is occupied by the milling and profiling machines. The second floor is the screw-machine department and the top floor the assembling department. The rear wing of the factory is given up to stores, experimental, repairing, burring, buffing and finishing departments, and is equipped with machinery suitable for the purpose. All raw material, as well as the tool equipment consisting of milling fixtures, punches and dies, cutters, etc., is kept in the store-room. In the saw-tooth roof building to the left are the Ross rifle inspection and barrel straightening departments.

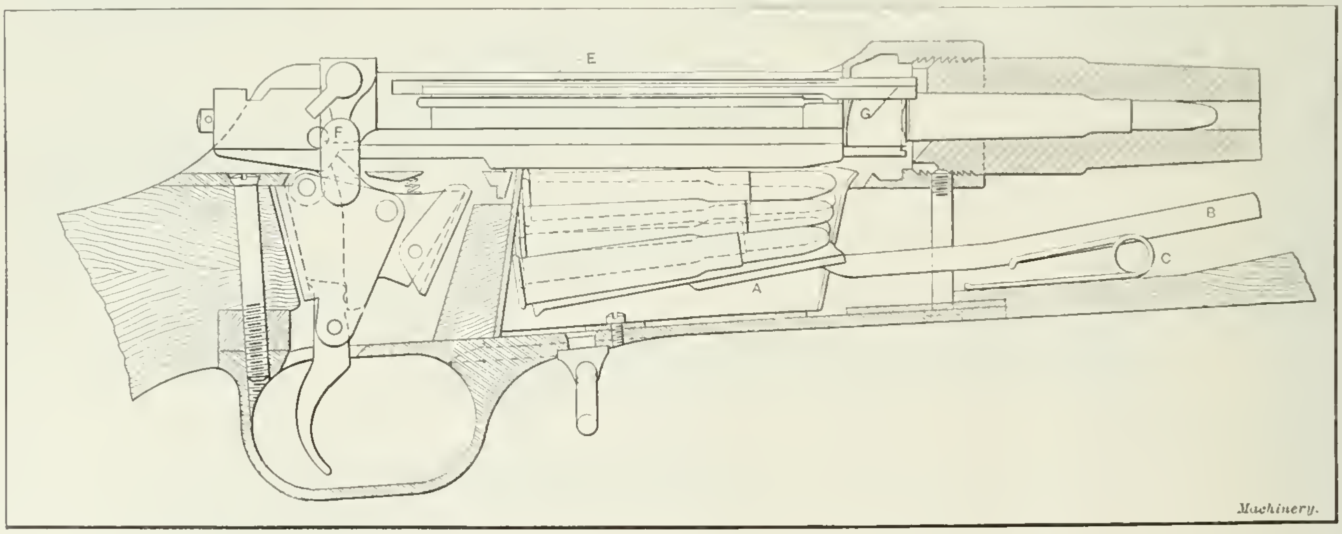


Fig. 4. Sectional View of Ross Rifle showing the Magazine, Bolt and Trigger Action

Types of Rifles Manufactured

The first rifle manufactured by the Ross Rifle Co. was the military rifle, shown in its improved form at A, in Fig. 3 where the various parts are also shown. This rifle is called the "Mark II**," and is that used by the Canadian militia. The component parts of this rifle are listed in the following:

1. Barrel. 2. Band, rear. 3. Band, front. 4. Bolt. 5. Bolt sleeve. 6. Bolt, parts. 7. Bolt, locking parts. 8. Butt plate. 9. Butt trap plate, parts. 10. Bayonet. 11. Bayonet handles. 12. Cocking piece. 13. Ejector. 14. Extractor. 15. Firing pin. 16. Guard, rear hand. 17. Guard, front hand. 18. Lifter. 19. Lifter spring. 20. Lifter screws. 21. Magazine box. 22. Magazine screws. 23. Nuts for band screws. 24. Pawl. 25. Pins and springs for trigger pull. 26. Receiver. 27. Receiver screws. 28. Strap link. 29. Sear. 30. Sight bridge and charger guide. 31. Sight sleeve and base, rear. 32. Sight, rear. 33. Sight base and sleeve, front. 34. Sight hood, front. 35. Sight, front. 36. Spring, main. 37. Stock. 38. Trigger. 39. Trigger guard. 40. Yoke.

In addition to the military rifle, the Ross Rifle Co. also manufactures the various types of rifles shown in Fig. 2. A is the 0.280 match rifle equipped with match sights and is built under N. R. A. regulations for use in match rifle competitions. It has a barrel 30½ inches long and is designed especially for match purposes. The rifle shown at *B* is a 0.280 sporting rifle equipped with the Ross telescope sight. *C* is this rifle equipped with plain sights, and is called the "Ross high-velocity rifle, Scotch deer-stalking pattern"—a rifle designed by Sir Charles Ross especially for deer-stalking purposes. The 0.280 Ross sporting rifle weighs—without telescope sight—seven pounds, three ounces, and has a muzzle velocity of 3100 feet per second, and a muzzle energy of over 3150 foot-pounds. It is not necessary to change the sights for 300 yards, as the trajectory of the bullet is practically flat for this distance.

The rifle shown at *D* is what is called the "Ross straight-pull Model E sporting rifle." This rifle weighs about seven pounds, two ounces, has a muzzle velocity of 2000 feet per second, and is bored to suit the 0.303 British service ammunition, W. M. C. Winchester, and English-made 0.303 soft-nose for sporting purposes. If so desired, it can be chambered to take 0.35 caliber Winchester cartridges. The rifle shown at *E* is the Ross straight-pull sporting rifle Model R. This rifle is not so expensive as Model E, not being made from select parts. It is chambered for 0.303 British cartridges, and has a muzzle velocity of 2000 feet per second.

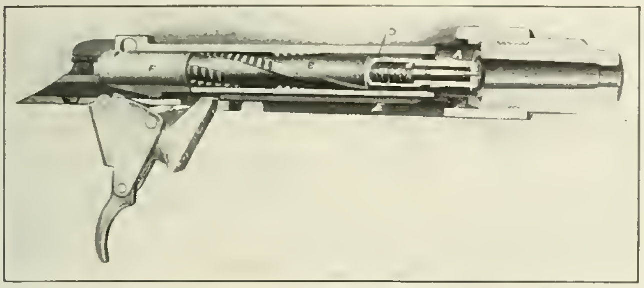


Fig. 5. Sectional View of the Receiver and Bolt Sleeve, with Bolt Seated at Instant of Discharge

To meet the demand for a small caliber target rifle for the militia, the Ross Rifle Co. has designed a 0.22 caliber rifle, as shown at *F*. This rifle embodies the main Ross feature—the straight-pull bolt action—and is of simple design, being composed of few parts. It is a single-shot rifle, the cartridge being inserted through a cut-out at the rear of the chamber on the right-hand side of the barrel. It is chambered to take both 0.22 short and long cartridges. This rifle is given the same care and attention as the regular rifles manufactured by this company. The location of the rear sight is a commendable feature for target practice; it is set on the rear of the straight-pull bolt, as shown in the illustration, thus bringing it close to the eye of the shooter.

Operation of the Ross Rifle

The Ross 0.303 military rifle as well as the 0.303 and 0.280 sporting rifles are equipped with a magazine which holds five cartridges, as shown in Fig. 4. This magazine is of such a width that two cartridges cannot be placed side by side, but overlap one another, as it were, so that they roll freely past each other and are, therefore, easily inserted into the chamber. The cartridges rest on a platform *A* attached to a lifter *B*, the latter being acted upon by a coil spring *C*. When the bolt and bolt sleeve *E* are drawn back by pulling on the handle *F*, the uppermost cartridge rises, and when the bolt is pushed forward it carries the cartridge ahead of it, locating it in the chamber in the barrel.

When the cartridge is forced into the chamber by the bolt, the extractor *G* slips over the head of the shell, a cut being provided in the rear end of the barrel for this purpose; then as the bolt is withdrawn after the cartridge has been discharged, the extractor pulls the empty shell out of the chamber until it comes in contact with an ejector which throws it out of the receiver. As one cartridge is fed into the chamber, the next one comes up flush with the base of the bolt sleeve, being retained in that position by a shoulder on the side of the magazine. So quickly can this bolt action be effected that it is possible to empty the magazine before the first cartridge touches the ground. All the cartridges in the magazine may be discharged without taking the rifle from the shoulder, it only requiring a simple back-and-forth movement of the right hand to eject the empty shell and reload.

A Straight-pull Bolt Action

A peculiar feature of the Ross rifle is its straight-pull bolt action. This rifle differs from others of its class in that it is only necessary to pull the bolt back and forth to open and lock it, extract the cartridge, compress the firing pin, seat another cartridge in the chamber, and then lock the bolt. The construction of the bolt and bolt sleeve are clearly shown in Fig. 5, where the bolt is shown seated at the instant of discharge.

The bolt is locked in its forward position behind two cam-faced projections in the receiver, two cam-faced lugs *A* being provided on the bolt for this purpose. So effective is this method of locking, that the bolt will resist, when locked, a breech pressure of 100,000 pounds. The bolt and bolt sleeve are the most interesting parts of this rifle, and work on the principle of the well-known spiral screw-driver. It is well known that if the pitch of a screw be increased sufficiently, a pressure on the nut in the direction of the axis will cause the screw to rotate, if the nut is prevented from turning. In this case, the bolt sleeve is the nut, which is prevented from rotating by guide slots cut in the sides of the receiver; and the spiral ribs on the bolt, which mesh with spiral grooves in the bolt sleeve, correspond to the screw.

The bolt is provided with two spiral ribs, extending to within 1 inch of the rear face of the lugs, and also two short threaded ribs, ½ inch long at the rear end. The ribs have a pitch of one turn in 6 inches and are 0.200 inch wide. The thread cut in the rear end of these spiral ribs is of the buttress form, ⅛ inch pitch. Four grooves are cut in the bolt sleeve to fit the spiral ribs on the bolt, and the ribs thus formed in the sleeve are threaded to suit the thread on the bolt. During the forward movement of the bolt, the threads are in mesh, and take all the thrust of forcing the cartridge into the chamber and cocking the action. At the end of the forward movement, when the lugs on the bolt-head strike the barrel, an ingenious arrangement of camming surfaces throws the threads out of mesh, bringing into play the spiral ribs, which revolve the bolt lugs into the locked position behind the cam-faced projections in the receiver. These operations are reversed on the backward stroke.

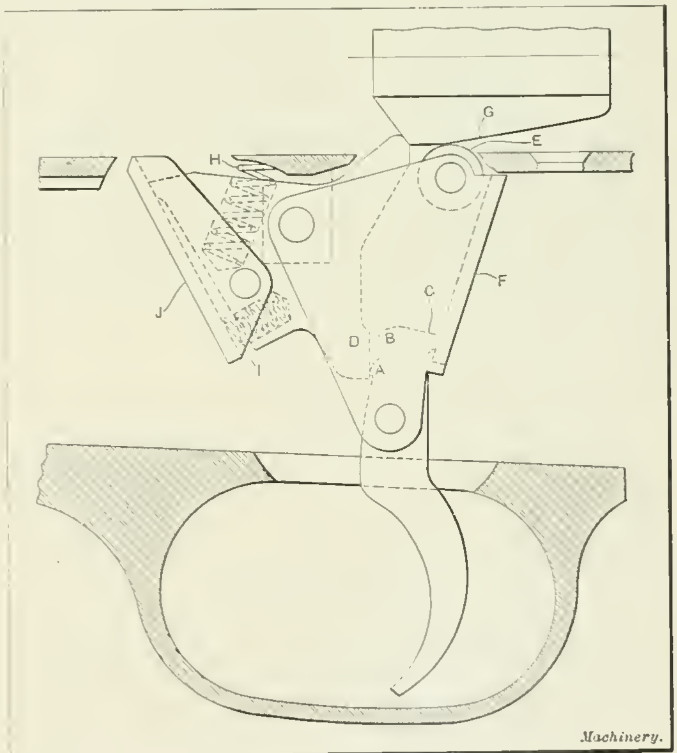


Fig. 6. Diagram illustrating Double-pull Trigger Action

As shown in Fig. 5, the firing pin *C* passes centrally through the bolt *D* and is surrounded by a coil spring *E*, to the compression of which it owes its propulsive force. This firing pin is controlled by a cocking piece *F*, which is held to it by a cone-shaped pin fitting in a groove cut in the firing pin, the cocking piece, in turn, being controlled by the sear *D* (see Fig. 6). When the trigger is pulled, the sear operates and thereby releases the cocking piece, with the result that the firing pin strikes the primer in the cartridge. These parts are so related to one another that the cartridge cannot be discharged without first seating and locking the bolt-head behind the locking projections in the receiver. If the bolt should not be pushed entirely home and the trigger should be pulled, either the cartridge would not explode or the bolt would seat and lock before the explosion could occur, thus eliminating any disastrous result and making the bolt absolutely safe and reliable.

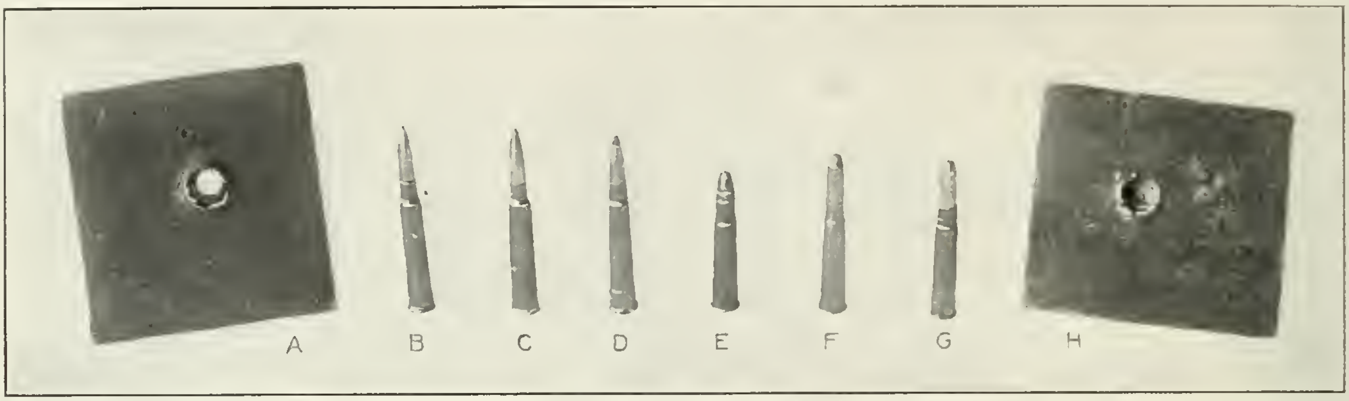


Fig. 7. The Ross Ammunition and Results obtained by it—Note Hole bored through 5/8-inch Machine-steel Plate with 0.280 180-grain Bullet

Double-pull Trigger Action

The military and sporting rifles now being manufactured by the Ross Rifle Co. are equipped with what is called a "double-pull trigger action." This consists mainly of a trigger, pawl, and sear, as shown in Fig. 6. The upper end of the trigger is provided with two rounded projections *A* and *B*, and a projecting lug *C*, the latter bearing against the bracket *F*, and assisting in cocking. The first part of the pull on the trigger brings the projections *B* in contact with the lower nose of the sear *D* and at the same time brings the roller *E*, held in frame *F*, in contact with the cocking piece *G;* this action also depresses the spring *H*. On a further pull of the trigger of 5½ pounds—on the military rifle—the sear is released from the cocking piece, and the spring in the bolt, against the tension of which the sear operates, draws in the cocking piece, this, in turn, carrying the firing pin that discharges the cartridge.

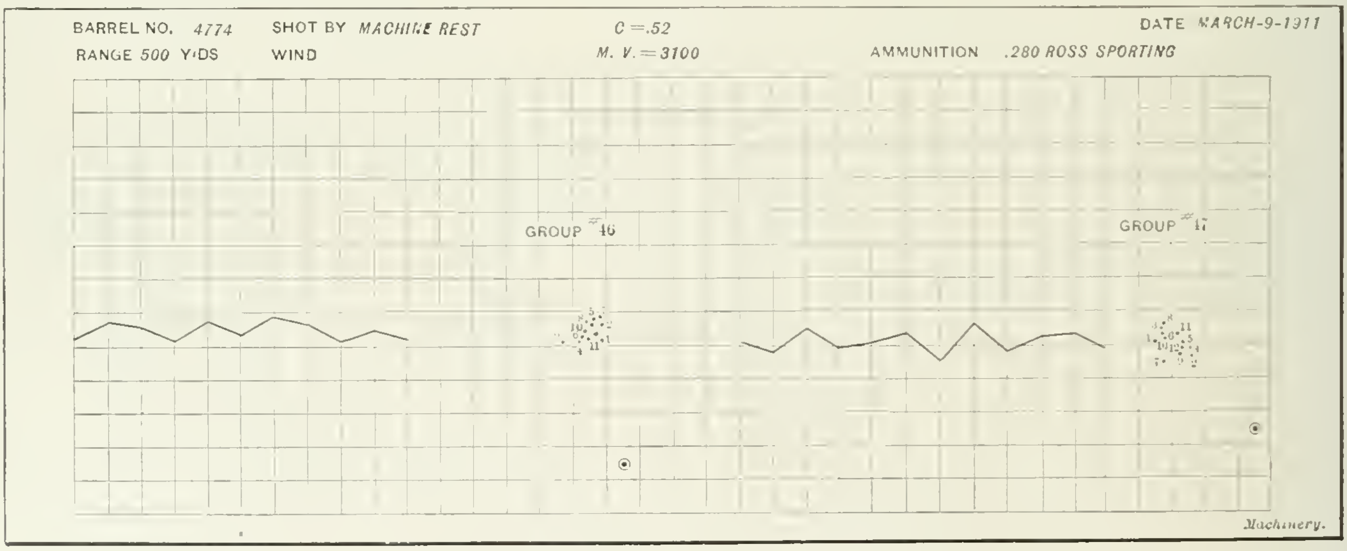


Fig. 8. Interesting Target Groups made by 0.280 Ross Sporting Rifle at 500 Yards

The spring *I* keeps the pawl *J* in contact with the forward nose of the sear, the pawl acting as a resistance member during the cocking operation.

In rifles equipped with the ordinary trigger action, the sportsman is not sure at just what point the firing pin will be released and, therefore, is not always prepared when the cartridge is discharged. With this double-pull trigger action, he knows exactly when the cocking piece will be released and is aware of the exact moment when the cartridge will be discharged. The resistance is always the same for the first part of the pull, so that one can tell when the fingers are cold and stiff just how much pressure is being applied and at what point the cocking piece will be released.

A Study in Speeds

The velocity of the 0.280 Ross sporting rifle is so remarkable that it may be interesting here to make a few comparisons. The muzzle velocity, or to be more correct, the initial velocity, at 90 feet from the muzzle, is 3100 feet per second, or about 35 miles per minute, developing a muzzle energy of over 3150 foot-pounds. The great linear velocity of this missile does not impress us so much as its rotative speed, because we have nothing with which to compare it. While traveling at this rapid rate of 35 miles per minute in a linear direction, the bullet also rotates on its axis at the rate of 257,736 revolutions per minute, the rifling in the barrel having a twist which gives one turn in 8.66 inches. The rotative speed is found by the following formula:

$$R = \frac{V \times 12 \times 60}{P}$$

in which

R = the rotative speed, or R. P. M.;

V = the muzzle velocity;

P = the pitch or twist of the rifling in the barrel.

The peripheral speed of this small missile would be:

$$\frac{0.280 \times 3.1416 \times 257{,}736}{12} = 18{,}893 \text{ feet per minute.}$$

This enormous rotative speed, 257,736 R. P. M., is more than eight and one-half times greater than the highest speed known at the present time, this being the speed of the rotor of a small De Laval turbine, which makes 30,000 R. P. M. When we consider the difficulty of making a rotor which will revolve at a speed of 30,000 R. P. M., we have an idea of some of the perplexing problems confronting the ballistic expert. Rotating the bullet at such an enormous speed, according to the Ross Rifle Co., does not have a deteriorating effect on the barrel, as it is claimed that the 0.280 barrel will last three times as long as the 0.303 barrel, under ordinary conditions.

Some Remarkable Results Attained with the Ross Rifle

After reading the foregoing description, the reader may be sufficiently interested to take note of some of the remarkable results attained with the 0.303 service and the 0.280 sporting rifles manufactured by the Ross Rifle Co. In the rifle competitions which took place at Bisley, England, in the present year, Private Clifford, of Canada, with the regular 0.303 Ross military rifle, won both the King's and Prince of Wales' trophies. This feat had never before been accomplished by any one man,—a most remarkable result. The Canadian team won the McKinnon cup and tied the English team for first place in the competition for the Kolapore cup. When we consider that all of the British Colonies were represented at this competition, the importance of winning such trophies seems the more remarkable. The 0.280 Ross rifle and ammunition also came in for a fair share of the "spoils", winning six matches, in which the ranges varied from 900 to 1100 yards, and tying for first place in two of the competitions.

The remarkable penetrating power of the 0.280 Ross rifle as compared with the ordinary 0.303 service rifle is clearly illustrated in Fig. 7. At *A* and *H* are shown two ⅝-inch machine-steel blocks. The block shown at *A* has a hole "drilled" clear through it; this was accomplished by the 0.280 Ross cartridge with the nickel jacket bullet shown at *B*. The plate shown at *H* was also placed at the same distance—100 feet—and the service cartridge shown at *G* was used in the ordinary Mark II** rifle. This bullet, which is also nickel-jacketed, made a depression only 3/16 inch deep, which is a fair comparison of the remarkable penetrating power of the 0.280 rifle and ammunition. The nickel-jacketed 180-grain bullet, fired from the 0.280 rifle, will penetrate eighty pine boards, ⅞ inch thick, placed at a distance of fifteen feet from the muzzle. Since the energy required to penetrate the fleshy part of a man's body is equal to that required to penetrate a one-inch pine board, this bullet, theoretically speaking, will mow down seventy men placed in a line at a distance of fifteen feet from the muzzle.

The cartridges shown at *C* and *D* are other types of ammunition used in the 0.280 Ross sporting rifle, the one shown at *D* being the regular copper tube bullet used especially for hunting purposes. The cartridges shown at *E*, *F* and *G* are representative of the ammunition used in the 0.303 service rifle.

Not only has the 0.280 Ross rifle extraordinary penetrating power, but it also shoots accurately, so much so that it carries off all the trophies; that is, of course, in the hands of experienced riflemen, and under ordinary conditions. Fig. 8 shows two representative groups made with a 0.280 Ross at 500 yards, the rifle being held in a machine rest when the two groups, numbers 46 and 47, were made. The target represented in the illustration is plotted off in six-inch squares, so that out of the eleven shots fired, not one of them was outside of an eight-inch circle. The zigzag lines to the right and left show the plotting of the various shots in the groups. When we consider that the regulation size of the bull's eye at 500 yards is 12 inches, the marvelous accuracy of this rifle will be fully realized.

* * *

The Bureau of Statistics, Department of Commerce and Labor, has undertaken to publish monthly the sailing dates of all vessels leaving the various ports of the United States to various ports in all countries of the world. A sailing list of this kind will undoubtedly prove useful to many exporting manufacturers and can be had upon application to the Bureau. It will be published each month in ample time to enable merchandise or passengers from interior parts to reach the seaboard in time for sailing dates.

* * *

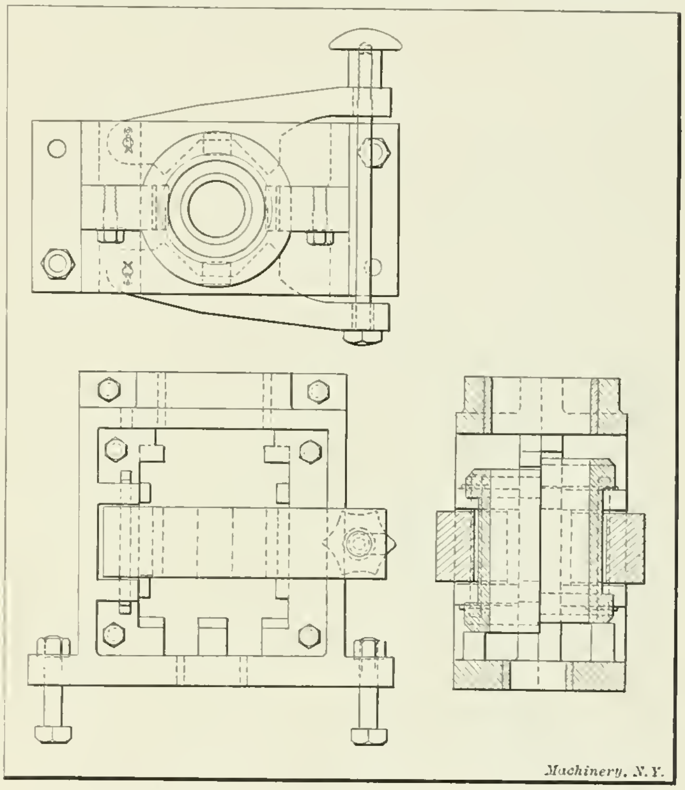
The consumption of aluminum throughout the world is increasing very rapidly according to a recent statement in the *Daily Consular and Trade Reports*. A German source is quoted as stating that in 1909 the amount consumed exceeded 34,000 tons—a marked increase over previous years.

JIG FOR BORING BRASSES

The accompanying illustration shows a jig used for boring brasses for lathe headstocks. This jig is in use in the shops of the Walcott & Wood Machine Co., Jackson, Mich. By its use, it is possible to obtain accurately bored brasses at a cost of only one-tenth of that at which they could be produced by previously used methods. Until the jig method referred to was adopted, the brasses were bored in the lathe; now they are bored by the use of an end mill in a drill press.

The first operation on the brasses is to plane the faces of the half circular parts; then they are rough-turned on the outside. After these operations are completed, the brasses are ready to be put into the jig shown in the illustration, for boring in the drill press. An end mill is first used for the roughing cut, after which the holes are finished by a reamer. The brasses are then put on a mandrel and the outside is finish turned. Finally they are finish reamed in place in the headstock.

The most interesting feature of the method is the construction of the jig used. This is made in two completely separate halves, which are screwed together. Locating points for the brasses are planed so that the brasses rest with their planed faces against the lugs in the jig at the exact center line of the device, as shown in the sectional view. The two halves of the brasses are offset as indicated in order to permit each half to get a bearing in the jig. In this way it is possible to bore all the brasses exactly alike and they do not have to be made in pairs, as before; any one half will properly fit any other half. The most valuable feature in addition to interchangeability is, of course, the rapidity with which the work can be performed in the drill press as compared with boring in the lathe.



Jig used for Boring Brasses in the Drill Press

* * *

Steel castings containing vanadium should never be used without annealing. In the unannealed state they are more brittle than plain carbon-steel castings. In annealing vanadium steel castings, it should be observed that a somewhat higher temperature is required than is used when annealing ordinary steel castings. A temperature of at least 1500 degrees F. is necessary, and it is preferable that a temperature of 1560 degrees F. be used. Rolling mill pinions made from vanadium steel castings have proved to have from two to three times the life of carbon-steel pinions and from one and a half to two and a half times the life of nickel-steel pinions.

SOLDERS, THEIR CHARACTERISTICS AND USES*

Solder, used for joining metallic surfaces or edges, is almost always composed of an alloy of two or more metals. The solder used must have a lower melting-point than the metals to be joined by it, but the fusing-point of the solder should approach as nearly as possible to that of the metals to be joined so that a more tenacious junction is effected. There is a great variety of solders, bearing the following names: hard, soft, brass, silver, gold, copper, tin, plumbers' and many others—the name designates in most cases their use. There are, however, broadly speaking, only two types of solder, that is, hard and soft. The former fuses at a red heat, while the latter melts at a comparatively low temperature.

Soft Solders

Soft solders consist chiefly of lead and tin although other metals are occasionally added to lower the melting-point. The fusibility of lead-tin alloys increases with the percentage of tin up to a certain point, but when the tin exceeds 67 per cent, the melting-point rises gradually to the melting-point of the tin. Soft solders are termed common, medium and fine according to the tin content, those containing the most lead being the cheapest and having the highest melting-points.

Fine or best solder is largely used for soldering Britannia metal, brass and tin-plate articles. The soft solder called "common" is used by plumbers for ordinary work, this solder containing two parts of lead to one part of tin. Fine solder is also used for soldering cast iron, steel, copper and many alloys. For iron and steel, rosin or sal ammoniac is used as a flux, but for copper and its alloys, chloride of zinc is usually employed. Solder composed of two parts of lead and one part tin is termed in England "plumbers'" sealed solder and is stamped by an officer of the "Plumbers' Company."

The best solders are made from pure lead and pure tin, but the use of scrap metal is very largely employed, and this is likely to contain impurities, such as antimony. Antimony improves the appearance of solder, and thus deceives the buyer, who is chiefly guided by the brightness of the surface. Antimony also renders the solder less fluid when melted and tends to prevent perfect adhesion of the surfaces. Moreover, the solder has a greater tendency to corrode, so that antimony can be called an objectionable impurity. Zinc, when present even in small quantities, has an injurious effect on soft solder, causing the solder to flow sluggishly. Aluminum acts in a similar way. Phosphorus when added in small amounts renders soft solder very "lively", that is, the solder has a tendency to form into small globules and run freely over the surface on which it is being applied. Too much phosphorus is injurious, and if it is added to thin the solder it should be in the form of phosphor-tin. One or two ounces of five per cent phosphor-tin to one hundred pounds of solder is generally sufficient.

In melting solder scrap, oxides are formed, and some of these are likely to become entangled in the molten metal, causing it to become thick. To obviate this, vigorous stirring with a stick is necessary in order to bring the dross to the surface. The tendency of lead-tin alloys to thicken depends upon the length of exposure to the atmosphere and the area exposed, more dross naturally forming on a large area than on a smaller one. For this reason, it is preferable when melting lead to use a deep narrow vessel.

Thick metal may be purified by reducing the oxide by means of charcoal, care being taken to prevent the metal from getting too hot, as the rapidity of oxidation increases with the temperature. Stirring the metal with a stick serves the same purpose; of course, the wood must be pushed to the bottom. Some use raw bone instead of wood, but the odor given off is objectionable. When dross in large quantities is to be treated, a reverberatory furnace is the most economical, but small quantities should be treated in a crucible furnace. The advantage of the reverberatory furnace is that the surface of the metal is not exposed to the air and therefore not oxidized. The melting-point of lead is 618.8 degrees F. An addition of tin lowers the melting-point. The melting-point of tin is 446 degrees F. An addition of lead to tin also lowers its melting-point. There is, however, a limiting point beyond which the temperature can not be lowered by either the addition of tin or lead.

The melting-point of lead-tin alloys, and the hardness test as obtained by the Brinell method, is as follows:

Percentages of		Melting Point (Degrees F.)	Hardness Test (Brinell Method)
Tin	Lead		
0	100	618.8	3.9
10	90	577.4	10.1
20	80	532.4	12.16
30	70	491.0	14.5
40	60	446.0	15.8
50	50	401.0	15.0
60	40	368.6	14.6
66	34	356.0	16.7
70	30	365.0	15.8
80	20	388.4	15.2
90	10	419.0	13.3
100	0	466.0	4.1

These results show that the hardest alloy is one that contains 66 per cent of tin, and 34 per cent lead, which is practically the eutectic alloy and therefore the one having the lowest melting-point of all the alloys. The results also show that tin is slightly harder than lead.

Soldering and Brazing

As two pieces to be soldered must be thoroughly alloyed with the material used as a solder, the temperature must be raised and maintained at such a point that inter-penetration can take place completely. For this reason it is necessary that the piece joined be perfectly clean, and means must be provided to prevent oxidation during soldering, oxides tending to prevent interfusion. This is accomplished by using a coating of some substance that melts at the fusing temperature of the solder, and thus excludes the air. The coating should have a solvent action on the oxide, thus keeping the metal clean and enabling the metal and solder to unite thoroughly. The fluxes generally used are rosin, sal ammoniac, zinc, chloride and borax. The flux is added first and the solder melted by means of a flame or soldering iron, the latter first being smoothed with a file and then properly tinned; otherwise no satisfactory soldering can be done. In all cases where zinc chloride is used as a flux the article should be cleaned after soldering to prevent subsequent corrosion of the metal.

A new soldering substance called "tinol," which has many advantages over the ordinary metal, especially for joining parts with a jet flame, can now be obtained. This solder differs materially from the solder hitherto produced being in the form of a paste, which contains both solder and a flux for dissolving the oxides. The solder is composed of tin and lead in suitable proportions. Six different alloys are made up in this form, ranging from twenty parts tin and eighty parts lead to pure tin. Another alloy is made of tin, lead and cadmium having a melting-point of 248 degrees F, which is especially useful for instrument work, as it can be applied without affecting the temper or color of steel springs.

Hard Soldering

Hard soldering or brazing is used for joining such metals as copper, silver and gold, and alloys such as brass, German silver, gun metal, etc., which require a strong joint and a solder approaching somewhat near in color to that of the metal to be joined. For hard soldering a red-heat is necessary, and borax is required as a flux to protect the metal from oxidation, and to dissolve the oxides formed. Heating for brazing cannot be accomplished with a soldering iron, but must be effected by a blowpipe.

Fusible Alloys

This is the name given to a series of alloys which can be melted at comparatively low melting temperatures, consisting of lead and tin to which bismuth, cadmium or mercury is added. Tin and bismuth both possess low melting-points and readily compound in all proportions when fused together. A small proportion of bismuth added to tin increases the hardness, and imparts greater luster and fusibility. The presence of bismuth in tin greatly increases the tendency to oxidation. An alloy of twenty parts tin to one part bismuth is but slightly ductile. Alloys composed of tin, bismuth and lead are valuable for making fusible solders, such as are used for safety pumps. The most fusible alloy of tin, bismuth and lead consists of equal parts of lead and tin and twice the quantity of bismuth. This composition melts below 212 degrees F. The addition of cadmium lowers the melting-point of many alloys, some of which are fusible in boiling water. The melting-points of these fusible alloys are as follows:

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* Abstracted from the Birmingham *Engineering and Mining Journal.*

Percentages of				Melting Point (Degrees F.)
Cadmium	Tin	Lead	Bismuth	
17.30	18.24	32.00	32.45	155.1
13.60	19.00	33.40	34.00	153.5
14.30	19.00	31.10	33.60	150.0
4.00	——	44.00	52.00	190.4
9.00	——	57.7	33.30	203.0

Brass Solders

Brass solders are composed of copper-zinc alloys, and are employed for joining brass parts and other copper alloys by fusion. The melting-point of copper-zinc alloys depends upon the percentage of zinc, and as the proportion of zinc increases the melting-point is lowered. The fusing-point of solders should be as close as possible to that of the article to be soldered, as a more tenacious joint is thereby secured. An easily fusible solder may be made from two parts of zinc to one part of copper, but the joint will be weaker than when a solder more difficult to fuse is employed. A readily fusible solder may be made with 44 per cent copper, 50 per cent zinc, 4 per cent tin and 2 per cent lead. Alloys containing much lead, however, should be avoided, since lead does not transfuse with brass and thus decreases the strength of the joint. A hard solder for the richer alloys of copper and zinc may be produced from 53 parts copper and 47 parts zinc. Brass solder is sometimes used for soldering copper and iron articles, and these metals have a much higher melting-point than brass, thus allowing the use of a richer copper alloy. In these cases tin is often added as one of the ingredients, but it should be sparingly used as it increases the brittleness of the solder. The addition of tin to brass lightens the color, giving it a gray tint. The melting-points of copper-zinc alloys in different proportions are as follows:

Percentages of		Melting Point (Degrees F.)
Copper	Zinc	
100	0	1980
96	4	1967
86	14	1890
80	20	1846
76	24	1796
72	28	1756
71	29	1746
66.4	33.6	1684
63	37	1666
60	40	1634
50	50	1616
48	52	1598
41	59	1544
35	65	1501
33	67	1477
29	71	1467
24	76	1364
20	80	1301

In making brazing solders it is important that the constituting metals should be commercially pure, as impurities interfere with the color, malleability and strength. These solders are only used in the crushed or granulated form, and are made by pouring the alloy into an iron mold and compounding it while in the highly heated state. Some manufacturers pour the molten metal into cold water, dropping it from a certain height, the metal in its descent passing through a wet broom or similar contrivance, thus dividing it into fragments. The granulated metal is afterwards put through sieves of different meshes, to bring together grains of uniform size. A fine and useful solder is obtained by arranging a horizontal pipe at some distance above the surface of a tank of water, and connecting this horizontal pipe with a water reservoir by means of which a jet of water is thrown horizontally over the lower vessel containing water. On this jet of water the molten metal is poured thus dividing it into grains of different sizes, the variation in size depending on the force or pressure of the water. A variety of different brazing solders which are widely used, with their characteristics, are as follows:

Percentages of				Characteristics	Color
Copper	Zinc	Tin	Lead		
58	42	—	—	very strong	reddish yellow
53	47	—	—	strong	reddish yellow
48	52	—	—	medium	reddish yellow
54.5	43.5	1.5	0.5	medium	reddish yellow
34	66	—	—	easily fusible	white
44	50	4	2	easily fusible	gray
57	28	15	4	white solder	white

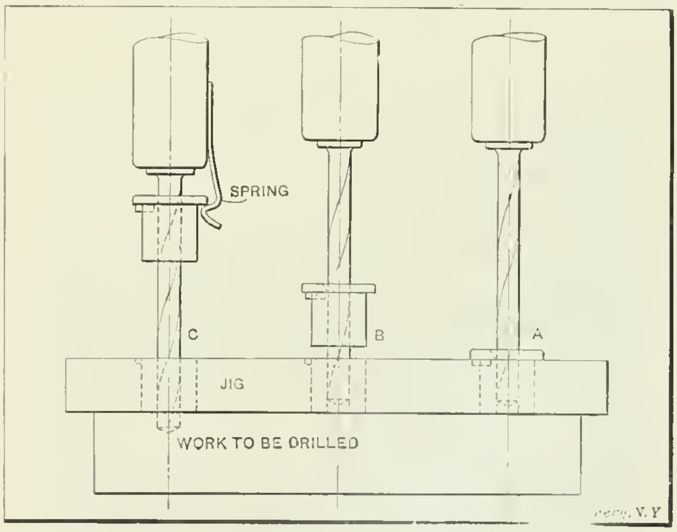
German Silver Solders

Solders for German silver are generally made of the same materials as those which compose the alloy to be soldered, but in such proportions that the melting point is lowered. In some cases silver solder is used for uniting German silver articles, and German silver solder is also used for soldering articles of iron and steel on account of its high melting-point and tenacity. German silver solder is known under different names, as argentan, arguzoid, etc. It is rendered moderately fusible by an addition of zinc to the copper and nickel. The ease with which it can be pulverized depends on the proportion of zinc. If the solder is too brittle it indicates too much zinc, which defect can be remedied by adding the requisite copper and nickel. For soldering alloys composed of from 16 to 22 per cent nickel, the following proportions may be used as a solder: Copper 47 per cent, nickel 11 per cent, and zinc 42 per cent; from experiments which have been conducted by the author, it has been found that 50 per cent of nickel may be used, but beyond that proportion the solder becomes very porous.

* * *

ALIGNING THE SPINDLES OF A MULTIPLE-SPINDLE DRILL PRESS

In a circular issued by the Baush Machine Tool Co., Springfield, Mass., is shown the method illustrated in the accompanying engraving for aligning the spindles of a multiple-spindle drill press with the bushings in the jig. Those familiar with this work know that when aligning the spindle, if the drill is small, it is difficult to see whether the drill deflects when entering the bushing or not, owing to the fact that the drill is pointed and the top of the bushing is bell-mouthed. This trouble can be overcome by using a removable bushing, and sliding it up on the drill as shown at *B*. Then when the spindle is brought down, as the bushing and the jig both have sharp corners, it can easily be seen whether the bushing is in line or not. The bushing is prevented from rotating in the jig, as shown at *A*, by a small key-pin fitting in a corresponding slot in the jig.



Method of Aligning the Spindles of a Multiple-spindle Drill Press

When deep holes are to be drilled, an auxiliary spring catch, shown at *C*, can be used to advantage. After the drill has started properly into the work, the bushing is removed from the jig and held by the spring. This allows the chips to escape, and also reduces the wear on the bushing.

MAKING MILLING MACHINE SPINDLES

By JOHN GOETZ*

On a high-grade milling machine, one of the parts which requires very careful attention in machining is the work-spindle. If care is not exercised in the machining and grinding operations, so that the spindle when finished will run perfectly true, poor work will be accomplished by the machine. The Kempsmith Mfg. Co., Milwaukee, Wis., employs some novel and interesting methods in the manufacture of the work-spindles for its milling machines, a description of which is given in the following article. The accompanying illustration Fig. 1 shows a work-spindle for a No. 3 Kempsmith plain and universal milling machine. This spindle is made from a drop-forging of special steel. It is received in the machining department in the condition shown at *A*, Fig. 2, a completed spindle being shown at *B* with the gear assembled on it.

The forgings for the spindles are carried from the stockroom to the lathe department on the special trucks shown in Fig. 3. The spindles, however, shown on the trucks have been machined and are ready for grinding. A tag is attached to one of the spindles on the truck, and a blueprint accompanies the lot on which the finished sizes are given, as shown in Fig. 1.

The Machining Operations

On the blueprint which accompanies the spindle forgings are given the machining operations in their correct order. They are as follows:

1. Measure, mark and cut off to length;
2. Straighten and center;

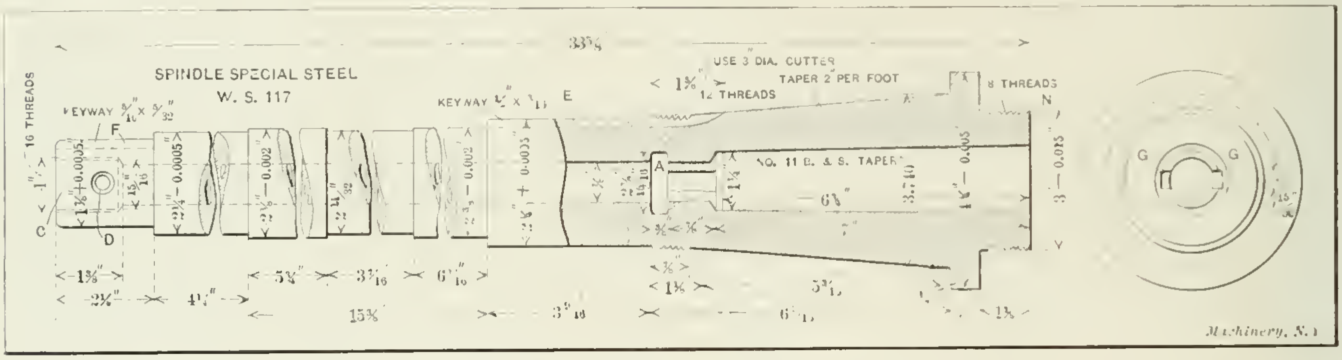


Fig. 1. Work-spindle for a No. 3 Kempsmith Plain and Universal Milling Machine

3. Rough turn nose of spindle to the following dimensions 3⅛, 4¾ and 3.740 inches, respectively, and face (see Fig. 1);
4. Rough turn on lathe with multiple-tool turning attachment;
5. Bore ⅞-inch hole through spindle;
6. Rough bore and ream tapered hole in nose of spindle;

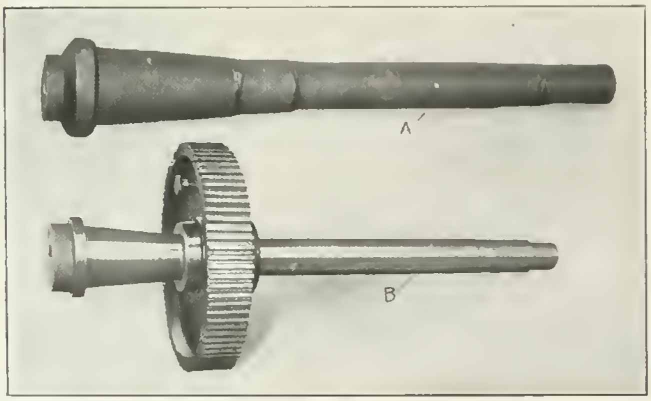


Fig. 2. The Work-spindle in the Rough and Finished Conditions

7. Finish bore tapered hole in engine lathe (for grinding), put in recess *A*, and face nose *N*; (see Fig. 1).
8. Broach tang slots in milling machine;
9. Finish turn nose end to 3 inches diameter;
10. Finish turn in lathe with multiple-tool turning attachment;
11. Bore and tap rear end of spindle;
12. Mill keyways *E* and *F* (see Fig. 1);
13. Mill all threads and put on nose guard, or knurled nut;
14. Grind external diameter;
15. Grind internal tapered hole.

Roughing-down a Milling Machine Work-spindle

After the forging has been straightened and centered, it is put into the lathe for which we have made a multiple-tool turning attachment, shown in Fig. 4. Here it is roughed down by four turning tools *A*, *B*, *C* and *D*, respectively. Turning tool *D* is held in a "floating" holder that is actuated by a cam *E*, this cam giving the correct movement to the holder, so that the part *F* of the spindle is turned tapered. The other tools *A*, *B* and *C* turn down the straight portions of the spindle, as shown in the illustration. This turning attachment may be removed by unscrewing the two nuts at the rear, when it can be lifted off the carriage. Lubricant is supplied to the turning tools by means of flexible steel tubes *G* which are connected to a general distributing tank. This means of lubricating has been adopted entirely throughout the Kempsmith shops, and has been found to be more satisfactory than individual pumps located at the machines. A general view of the lathe and the rough turning operation are shown in Fig. 5. Here the pipe *I* is shown, which supplies lubricant to the tubes *G*. The lubricant is drained away from the bed of the machine by a pipe *J*, which conducts it to a distant tank below the floor, equipped with a rotary pump for supplying the system with lubricant.

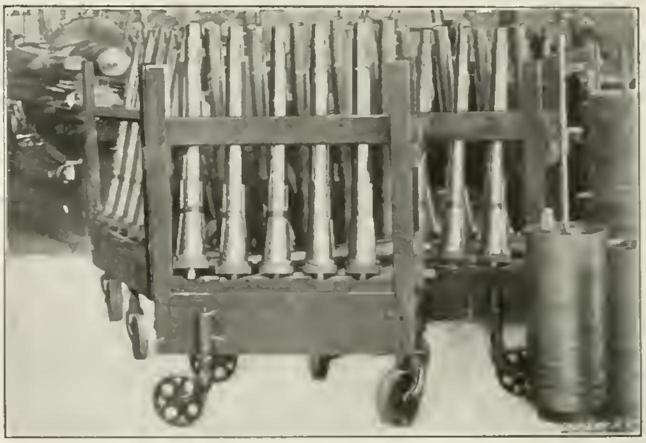


Fig. 3. Trucks used in Carrying the Work-spindles to the Various Departments

Now that the spindles have been rough turned, they are taken to a boring machine (in the trucks shown in Fig. 3), where the ⅞-inch hole is bored with a special oil-tube twist drill. The next operation is to rough bore and ream the tapered hole, which is performed in a lathe especially made for this purpose. After rough boring and reaming the tapered hole, it is finish bored, so that it is in a suitable condition for truing up the spindle for grinding. The recess *A*, Fig. 1, is also machined at the same setting, and the nose end *N* of the spindle is faced.

Broaching the Tang Slots

The spindle is now in condition for broaching the tang slots *G* used in driving the work-arbor. This is accomplished in a universal milling machine as shown in Fig. 6. The broaching-tool holder is held in the Kempsmith regular slotting attachment, and works in a sleeve *A*, which is fitted into the tapered hole of the spindle. This sleeve *A* has a keyway cut in it to prevent the broaching-tool holder *B* from turning while in operation. The broaching cutter *D* is adjusted by a collar *C*, which draws a wedge under it, and in this way raises the broaching tool to the proper height for each cut.

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* Address: Superintendent Kempsmith Mfg. Co., Milwaukee, Wis.

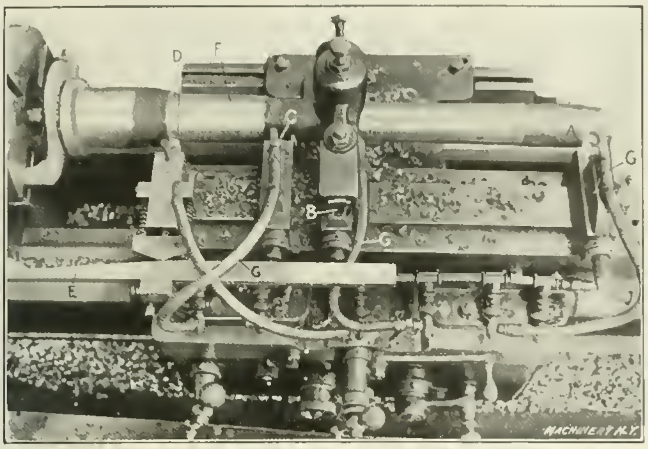


Fig. 4. Roughing-down the Work-spindle

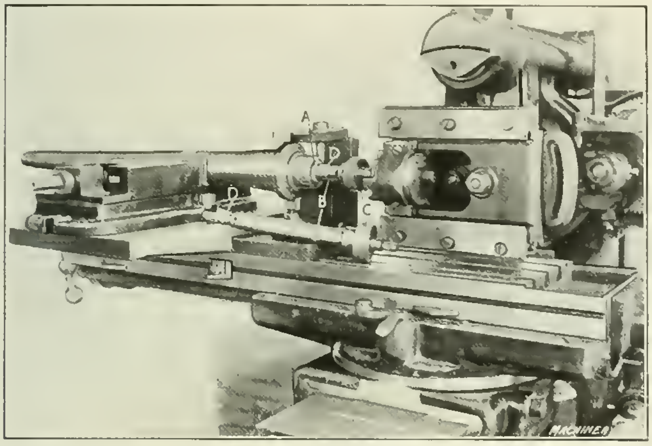


Fig. 6. Broaching the Tang Slots in a Milling Machine

The recess *A* in the spindle, Fig. 1, provides a clearance at the end of the cut, and allows the chips to drop away from the tool. The broaching-tool holder and adjusting collar are shown disconnected from the machine, lying on the table in Fig. 6. As is shown in Fig. 1, two slots *G* are broached in the spindle, and the sleeve *A*, Fig. 6, is also provided with two keyways (spaced 180 degrees apart), the broaching-tool holder being revolved for the second slot. After broaching, the center plug is inserted in the spindle, and is not removed until the spindle is ready for the internal grinding operation —No. 15.

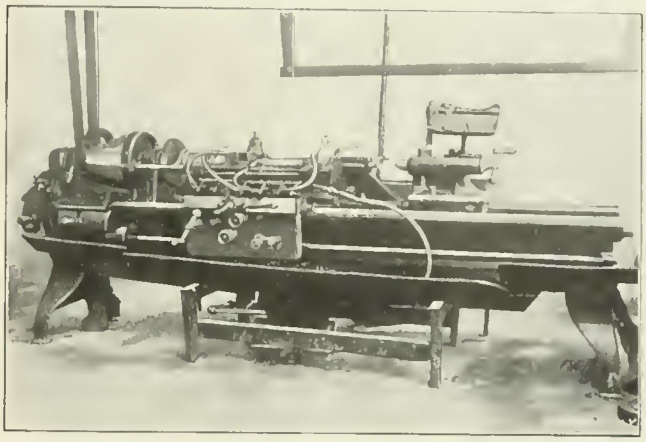


Fig. 5. General View of the Lathe in Fig. 4, showing Lubricating Tubes

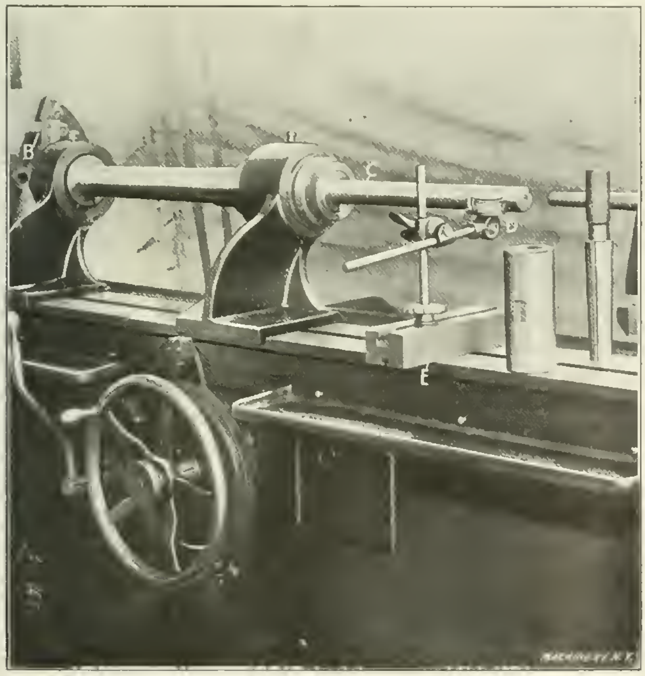


Fig. 8. Testing the Truth of the Tapered Hole by a Dial Test Indicator

With the center plug inserted in the nose end of the spindle, the nose is now turned to the required diameter—3 inches—and the outside diameter finish-turned in a lathe similar to that shown in Fig. 5. The hole *C* in the rear end of the spindle (see Fig. 1) is then drilled and tapped in the lathe, and the set-screw hole *D* drilled and tapped in the drill press.

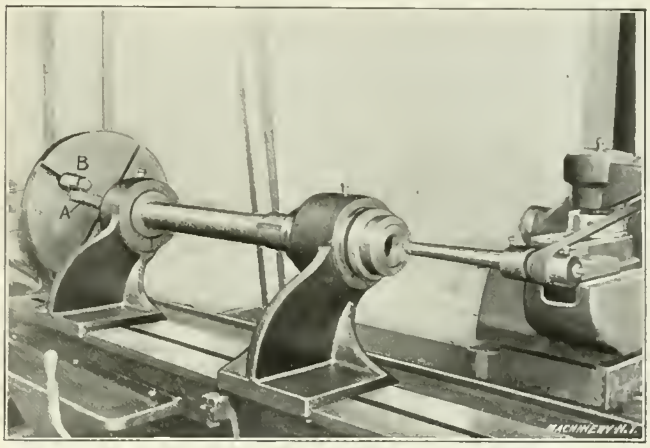


Fig. 7. Method of Holding Work-spindle while Grinding Hole

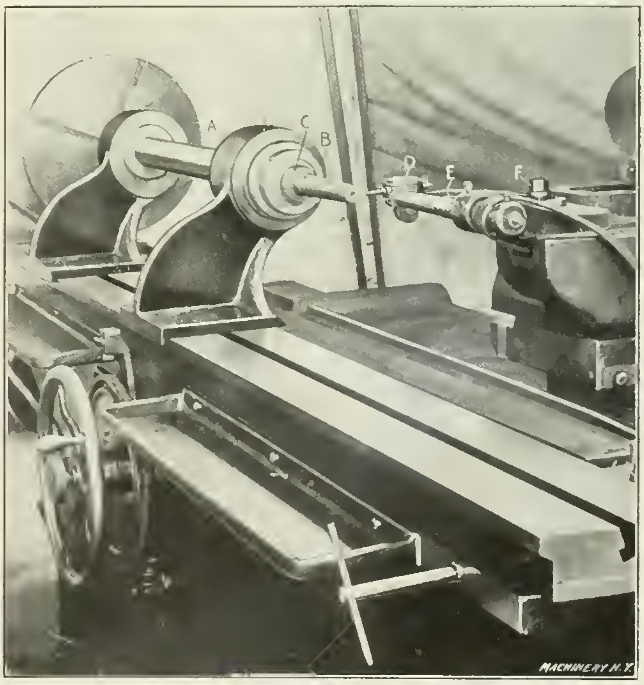


Fig. 9. Improved Method of Setting the Table to the Required Angle by a Dial Test Indicator

After this, the keyways *E* and *F* are milled in the milling machine, this operation being too simple to need description.

The work-spindles are now taken to a Pratt & Whitney thread miller, where the threads are cut on the nose and shank of the spindle. These threads are perfectly formed, as they are milled by cutters which are ground to the correct shape. After milling the threads, the spindle is placed in a universal grinder, where the external diameter is ground to the required size.

Setting the Spindle for Grinding the Tapered Hole

The most important operation in connection with the manufacture of a milling machine spindle, and the one which requires the most careful attention, is the grinding of the tapered hole. If this is not done correctly, and is not made to run true with the outside of the spindle, trouble will result. When grinding, the spindle is held in brackets, as shown in Fig. 7, and is driven by a dog *A*, clamped to the rear end of the spindle and which, in turn, is driven by a bolt *B* fastened to the faceplate of the grinder.

The spindles are tested before being removed from this machine, as shown in Fig. 8. A test-arbor *C*, which is ground perfectly true, is placed in the tapered hole, while a dial test indicator *D*, fastened to the block *E* as shown, is held against the revolving arbor. If it is found that the arbor does not run "dead" true, the internal grinding attachment is brought into operation, and light cuts are taken, until by a final inspection it is found that the arbor runs absolutely true. This inspection, however, is not the last one made to determine whether the spindle is ground perfectly true or not, as it is again finally inspected in the inspection department, but as this grinding operation is very carefully conducted, the spindles seldom come back for correction.

It is the usual custom for grinder hands, when doing taper work, to set the grinder table as near to the graduation mark as possible; then by the "cut-and-try" method they endeavor to obtain the desired result. The writer has known of some who never could get the taper just exactly right, and to overcome this difficulty the following method has been adopted. An arbor which has been ground perfectly true, and tapered on both ends, one end fitting the tapered hole in the spindle and the other ground to the taper that it is required to reproduce in the hole in the spindle, is placed in the tapered hole in the spindle as shown in Fig. 9. After the work-spindle *A* is set up in the jig as shown, the tapered arbor *B* is inserted. A dial test indicator *D* is then fastened to a bracket *E* which, in turn, is held to the internal grinding head by a collar screw *F*. The pointer of the indicator is set directly on the center of the arbor *B*, and the table traversed back and forth, until no movement is transmitted to the indicator needle, thus showing that the grinder table is set to the desired angle. When the table has been set correctly, the nut *C* is turned to withdraw the arbor *B*. It is then an easy matter to grind the hole in the spindle to the correct taper. It is absolutely necessary that the wheel center be at exactly the same height as the spindle center.

* * *

According to *Industritidningen Norden*, the General Swedish Electric Co., of Västeras, Sweden, is at the present time engaged in the building of five generators for a Norwegian electro-chemical industrial concern, each of which is of 17,000 kilowatts capacity. These generators are presumably the largest ever built. The weight of each machine is somewhat over 275 tons, the rotor alone weighing 102 tons. The finished shaft of the rotor weighs nearly 18 tons.

* * *

After the depression in the ship-building trade which has made itself felt for some time, the British ship-yards are apparently again experiencing a boom. The tonnage now under construction in the ship-yards in the United Kingdom represents the highest record in the annals of British ship-building, there being at the present time 496 vessels with a gross tonnage of 1,476,400 tons under construction. Out of this total 415,000 tons represent war-ships under construction.

THE BRAZING OF METALS

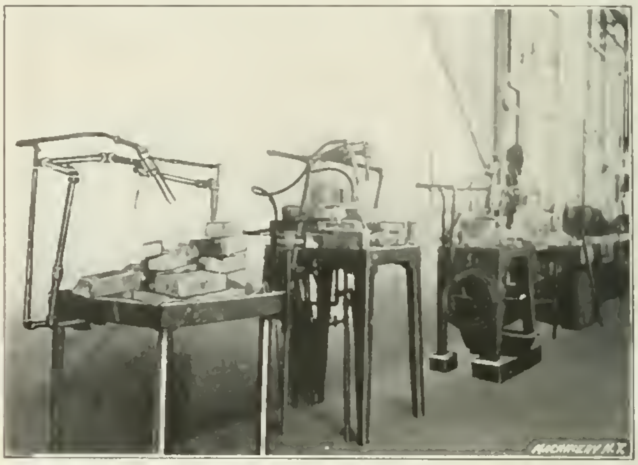
By J. L. LUCAS*

Although brazing, or the process of uniting two pieces of metal by means of a third metal which will melt at a lower temperature, is one of the oldest of the mechanical arts, at the same time it is one of the least understood. Ask a good brazer what makes the metals unite, or what test a good brazed joint will stand, and he is not able to tell you; he can do the "trick" all right, do it well and know when it is a good job, but that is all. The process of brazing was well known to the ancient Egyptians and was also used by the old German "monks" as many relics of their work indicate.

Cleaning

The secret of successful brazing is the thorough cleaning of the joint that is to be brazed. "Well cleaned is half brazed" is a true and well-known saying. While you can boil and burn out the dirt in a joint in the process of brazing, it is a poor way to do it, and the result will be anything but a good job.

The cleaning process should not be a wash or a dip, but a mechanical operation, that is, filing or grinding, or better still—the sand blast. A sand blast not only takes off the rust and dirt, but it leaves the sanded surface of the metal full of minute holes, which makes the best kind of a surface to receive and hold the spelter. It is also an ideal method for cleaning the work after brazing, as it can be done cheaper and better than in any other way.



A Gas Furnace Brazing Equipment

Brazing a Plain Joint

In brazing a plain joint, first clean the joint well, as previously stated. If brass parts are to be brazed they can be cleaned by "dipping," when they will take the spelter without any trouble, but a steel-to-steel or iron-to-iron joint should be mechanically cleaned. After this is done, the joint should be painted with a solution of calcined borax (burnt borax) or any of the brazing compounds in use. The pieces are then lightly driven together, or if the nature of the work will not admit of that, they should be strapped or wired, so that they cannot move during the brazing process. If driven together, the work should fit fairly well, because if the joint is too loose the brass will not stay in, the job will look "sloppy" and there will be no real strength to the joint. There is but little danger in making too tight a fit, as the brass will run into the joint where there is apparently no room for it to go.

Holding the Work while Brazing

To hold the parts together while brazing, drill a hole through them with a No. 29 drill, and use an 8d wire nail for a pin. This makes a good pin for any work up to 2 inches diameter or its equivalent. This does not add materially to the strength of the joint, but is used mainly to hold the parts in place while being brazed.

After pinning, paint the job again with a mixture of brazing compound and alcohol—"charging" it is termed by the brazer—and also paint the work one-half inch from each side of the joint with a mixture of black lead and machine oil.

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* Address: 3 Fox St., Bridgeport, Conn.

This confines the flux to one place, and also keeps the spelter from flowing away to where it is not needed, as well as saving the spelter and the work and rendering the latter much easier to clean. The work can now be put into the fire or to one side to dry. When treated in the manner described, the work can stand any length of time before brazing, as long as it does not get dirty or rusty.

Heating

Gasoline, coal, oil or gas can be used for heating, but gas is by far the best on account of the cleanness of the fire, although the others will do nearly as well, with a reduced fuel cost. There is, however, at least one brazing forge on the market that will effect a saving in gas, and still turn out good work. It is a simple, cheap, gas-saving forge and will pay for itself in a very short time by the economical use of the gas.

In building up around the work, use plenty of fire-brick to confine the heat and thus save the fuel, and fill the bed of the forge with bits of coke or broken fire-brick, (coke is better) to reflect the heat on the under side of the work. After the forge has been prepared properly, place the heavy part of the job in the fire so that it will get hot as soon as the rest of the work, and then slowly heat to a dull red color. Now take the brazing wire, hold it in the flame so as to heat it as near as possible to the melting point without melting it; then dip the wire in a mixture of the spelter and borax or a brazing compound, and apply to the joint. As the flux and spelter melt (borax and brass), turn the work so that the former will run to all parts of the joint, and while still turning the work, remove it from the fire and keep in motion until it "sets;" then lay it to one side to cool in the air. A job that is too large to be handled in this manner, may be cooled by allowing the air blast to strike the work.

Almost any ordinary wrought-iron or steel job can be brazed by heating it to a bright red color. Cast iron requires a bright yellow, and brass or copper will braze at a dull red. By using a softer grade of spelter, thereby lowering the "melting" temperature, and taking precaution to thoroughly melt the wire and spelter, a better braze will be the result. Excessive heat injures the brass by destroying the zinc properties that are contained in it. If the work is in a hurry, and especially if there is no good means of cleaning it, the piece can be dipped into a pail of soapy water while it is still hot. This will start the scale and render the work far easier to finish.

Materials

The wire used for brazing should be of special brass, intended for brazing; don't use any old piece of wire that is lying around the shop, and then wonder why it doesn't "stick." Brass wire 1/8 to 1/4 inch in diameter, according to the size of the job, is the easiest to handle.

Test

A joint well cleaned and well brazed, will stand a strain nearly equal to the tensile strength of the metal itself. A machine-steel collar with a one-inch hole, brazed onto a piece of cold-rolled steel, stood a test of 10,000 pounds without a sign of giving way. A cast-iron joint, when put through the proper brazing process, will give way on either side of the joint before the joint itself will move.

Cleaning the Work after Brazing

There are several methods of cleaning the work after brazing. If a sand blast is available, use it, as it has no equal for that purpose. The next best method is "pickling" in a weak solution of vitriol and water; about one quart of vitriol to a barrel of water makes a good "pickle." This is not as good a method as the sand blast, especially for tube work, as any acid left in the tube eats the metal and weakens the joint. The sand blast leaves the work clean and ready for the file, and also shows up all the imperfections in the brazing. An old-fashioned method of cleaning the work is as follows: When the work is nearly cool, dip it in a pail of soap suds; this loosens the flux and does not harden the metal. It is not recommended as good practice.

Cost

When work is done on the premium or piece-work basis, the cost can be made very low. As high as eighteen hundred to two thousand joints can be brazed in a day of ten hours, and ordinary automobile work can be brazed at a cost of fifty cents per hundred pieces for small work, and as high as four or even six cents per joint for the larger work.

Dip Brazing

Dip brazing may be practiced on certain classes of work and at one time was used extensively in the bicycle trade. The cost of the work is far lower, and the cost of cleaning is trifling, the brazing being done with a torch. The main difference between this and ordinary brazing is that the work is dipped into the spelter while the latter is in the liquid state.

Cast-iron Brazing

Almost any kind of a broken cast-iron joint can be brazed, and if well done is stronger than it was before breaking. The broken jaw of a 4½-inch bench vise, brazed some two years ago, has been in constant use ever since and shows no signs of giving out.

To make a good job, first heat the work to a dull red; this takes the dirt and grease out of the pores of the metal. Next clean the work with the sand blast, if available, or with a wire brush, and then apply the brazing powder to the broken surface of the work. This leaves the iron in a condition to take and absorb the spelter. Now fasten the broken parts firmly together, either by putting in a screw or holding them together with a twisted wire. When firmly bound, place the work in the fire and heat to a bright yellow color, in fact, almost to the melting point, and apply the brazing compound; then shut off the gas and allow it to cool without moving. There are several cast-iron brazing compounds on the market, but the method used in brazing is practically the same with each.

Brazing Brass and Copper

Although the process of brazing brass and copper, or as it is called by jewelers, "hard soldering" can be done at a lower heat than iron or steel work, still it calls for a higher degree of skill on the part of the brazer, as the spelter used will melt at a point but a few degrees less than that of the melting point of the brass that is being brazed. There are an endless number of spelters used for this work, but a mixture of 50 parts copper and 50 parts zinc will make a spelter that can be used on either "low" brass or copper, and with the addition of 6 or 8 parts silver, it also makes a good spelter for "high" brass.

A well-known silver solder used by the jewelry trade is a mixture of 70 parts silver and 30 parts copper, but for a small job a silver dime or quarter can be used, as they contain the correct proportions of silver and copper. Sal ammoniac will be found to give the best satisfaction for a brazing flux for work of this kind, and also has the advantage of always being at hand.

While it is important that brass work should be well cleaned, it need not be sand blasted as is the case with steel or cast iron. The cleaning process can be a dip or wash, and still give good results. A dip composed of 1/3 nitric and 2/3 sulphuric acid, well mixed in an earthen vessel, will clean a brass or bronze, and leave it in good shape to be brazed; the same dip can be used to remove the scale after brazing.

To do a good job of brass brazing, clean the work thoroughly by dipping it the same as you would for a steel job, and have the brass a good fit in the work. If it is not a good fit, the brass will not stay in, and it cannot be "staked up" the same as you would with a steel job. Don't have the blast too hot. Watch the job closely, and when it shows the first tinge of red, put on your spelter; as this melts, take the job from the fire and let it cool off in the air. Do not cool it off too quickly as the sudden contraction of the metal will start the brazing.

To remove the scale, "pickle" for ten or fifteen minutes in a nitric and sulphuric dip as before described. There are a few points to look out for, and one is not to overheat the work; give it time enough to heat gradually so as to melt the spelter properly.

MILLING, CROSS-DRILLING AND BURRING ATTACHMENTS—2

APPLICATION TO THE BROWN & SHARPE AUTOMATIC SCREW MACHINES

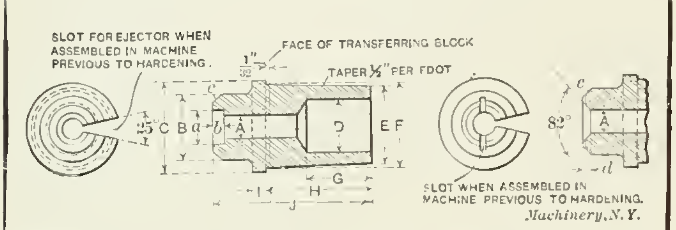
By DOUGLAS T. HAMILTON*

The method of holding the screw when presenting it to the saw is important, so that a description of the slotting bushings used in connection with the screw-slotting attachment will be given. Other devices of a special nature, such as, hexagon-head locating devices, slabbing attachment, spindle-indexing arrangement, cross-slide sawing and cross-slide slotting attachments, will be fully described in the following:

Slotting Bushings

In Table I is shown the standard form of slotting bushings used for holding fillister- and flat-head screws. The type of slotting bushing used for round- or button-head screws is similar to that shown for the fillister, except that in some cases the bushing is not counterbored for the head of the screw. The proportions for slotting bushings for the various sizes of Brown & Sharpe automatic screw machines are also given in Table I. The diameter of the hole *A* governs the diameter *B* of the front end of the bushing, and also the hole *D*. These sizes, of course, pertain only to bushings for standard screws, the slotting bushing being made to suit the work as desired. The diameter *A* should be made from 0.001 to 0.0015 inch larger than the screw diameter, while the diameter *a* should be made from 0.002 to 0.003 inch larger than the diameter of the shoulder or head of the screw, as the case may be.

TABLE I. PROPORTIONS FOR SLOTTING BUSHINGS


SLOT FOR EJECTOR WHEN ASSEMBLED IN MACHINE PREVIOUS TO HARDENING.
FACE OF TRANSFERRING BLOCK
1/32"
TAPER 1/2" PER FOOT
25°
C B a b A D E F
G
H
I
J
c
82°
A
d
SLOT WHEN ASSEMBLED IN MACHINE PREVIOUS TO HARDENING.
Machinery, N.Y.

Mch. No.	A	B	C	D	E	F	G	H	I	J
00	1/16 to 3/16 3/16 to 1/4	3/8 1/2	9/16 9/16	1/4 5/16	0.450 0.450	0.476 0.476	1/2 1/2	11/16 11/16	1/16 1/16	1 1
0	1/8 to 1/4 1/4 to 3/8	1/2 11/16	11/16 11/16	5/16 7/16	0.600 0.600	0.631 0.631	9/16 9/16	3/4 3/4	1/16 ..	1 1/8 1 1/8
2	3/16 to 5/16 5/16 to 1/2	5/8 7/8	7/8 7/8	3/8 9/16	0.750 0.750	0.792 0.792	5/8 5/8	1 1	1/8 ..	1 3/8 1 1/2

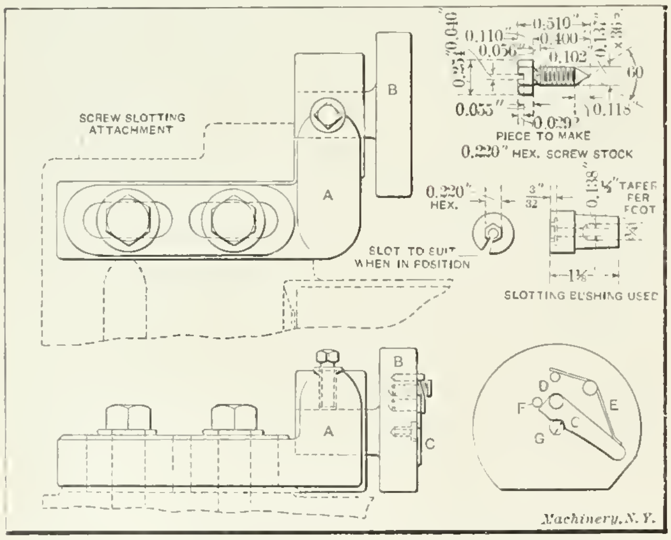


Fig. 8. Device for Locating Hexagon-head Screws in the Slotting Bushing

When a bushing is to hold a shouldered screw, and when the length of the shoulder is greater than or equal to the diameter of the shoulder, the diameter *A* is made to fit the body of the shoulder instead of the body of the threaded part of the screw. When the length of the shoulder is less than the diameter, the bushing is made to fit both the shoulder and the body of the screw. The screw head should also fit in the counterbored hole in the bushing. The distance between the shoulders on the screw should always be less than the distance between the shoulders in the bushing, so that the screw head alone will bear against the shoulder in the bushing. The distance *d* on the bushing for flat-head screws should be made equal to 1/2 the thickness of the head, when the body of the screw is greater than 1/4 inch. When the body of the screw is less than this, the head, as a rule, is usually sunk the full depth in the slotting bushing. The corner *c* should only be beveled when the diameter of the counterbored hole *A* will permit, otherwise the corner should not be beveled, but rounded slightly.

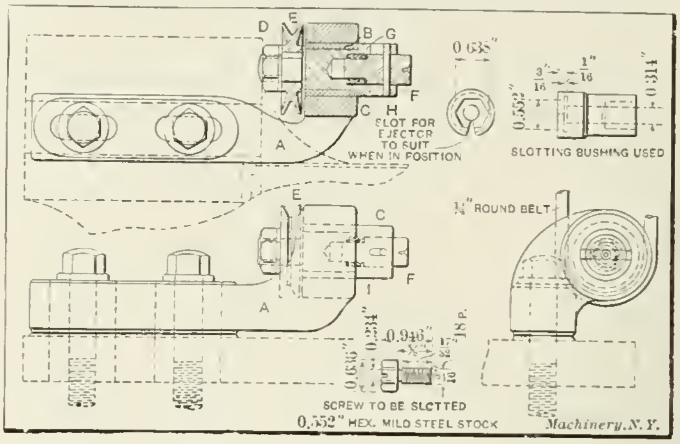


Fig. 9. Another Hexagon Screw Locating Device

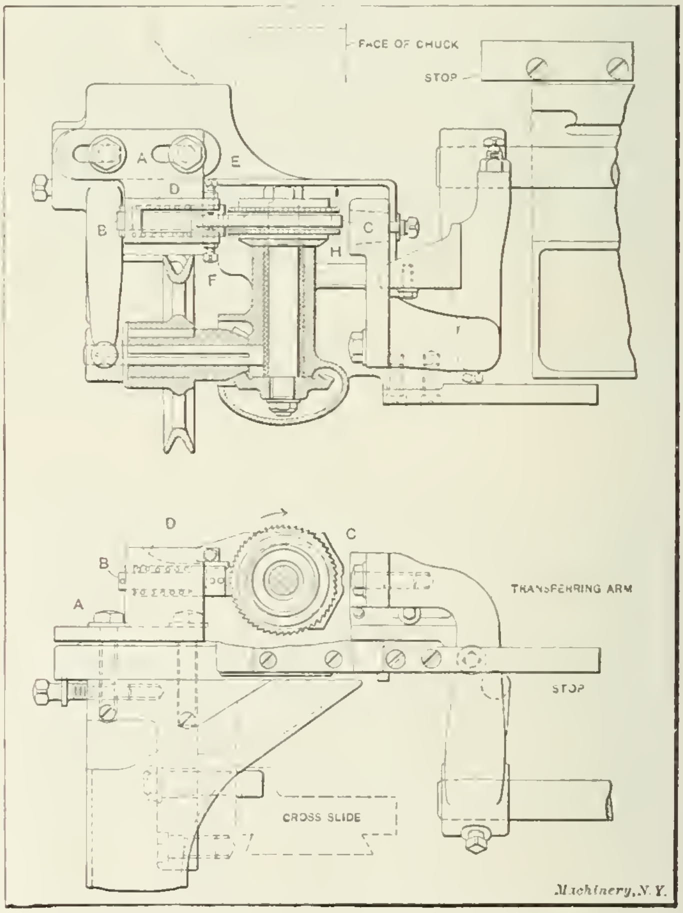


Fig. 10. Slabbing Attachment used on Screw-slotting Attachment

Slotting bushings are usually made from tool steel, and are not hardened until the cams have been tried out and the whole job is completed. The slot for the ejector is cut before the bushing is inserted in the transferring block, and the slot for the saw in the bushing for flat-head screws is cut when the bushing is held in position in the transferring block. When a bushing is to hold a fillister-head screw, as a rule the slotting saw does not touch the bushing at all, the depth of the counterbore *b* in the bushing being slightly less than the difference between the depth of the slot and the thickness of the head of the screw. The dimension *F* is not taken at the shoulder of the bushing, but is the largest diameter of the taper hole in the transferring block. This allows the bushing to drive tightly into the block, 1/32 inch being allowed for driving. It is customary, however, to make the dimension *F* slightly larger than necessary and fit it into the block when trying out the job. The bevel in the bushing for holding flat-head screws is made to suit the included angle of the head, the angle shown being that adopted by the A. S. M. E.

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* Associate Editor of MACHINERY.

Slotting Hexagon-head Screws

When the slot in the head of a hexagon screw has to bear some definite relation to the sides of the head, it is necessary that the screw be located in an exact position in the slotting bushing. The bushing for holding the screw has usually an impression in it, which fits the hexagon head, but it is another matter to get the screw to locate properly in the bushing. If the bushing is forced onto the work when it is attached to the bar, ten chances out of one the screw will not be located in the hexagon, but the corners will be torn off, and the screw broken off before it is severed from the bar. To obviate this difficulty, some device must be employed for locating the screw in the bushing, after it has been severed from the bar.

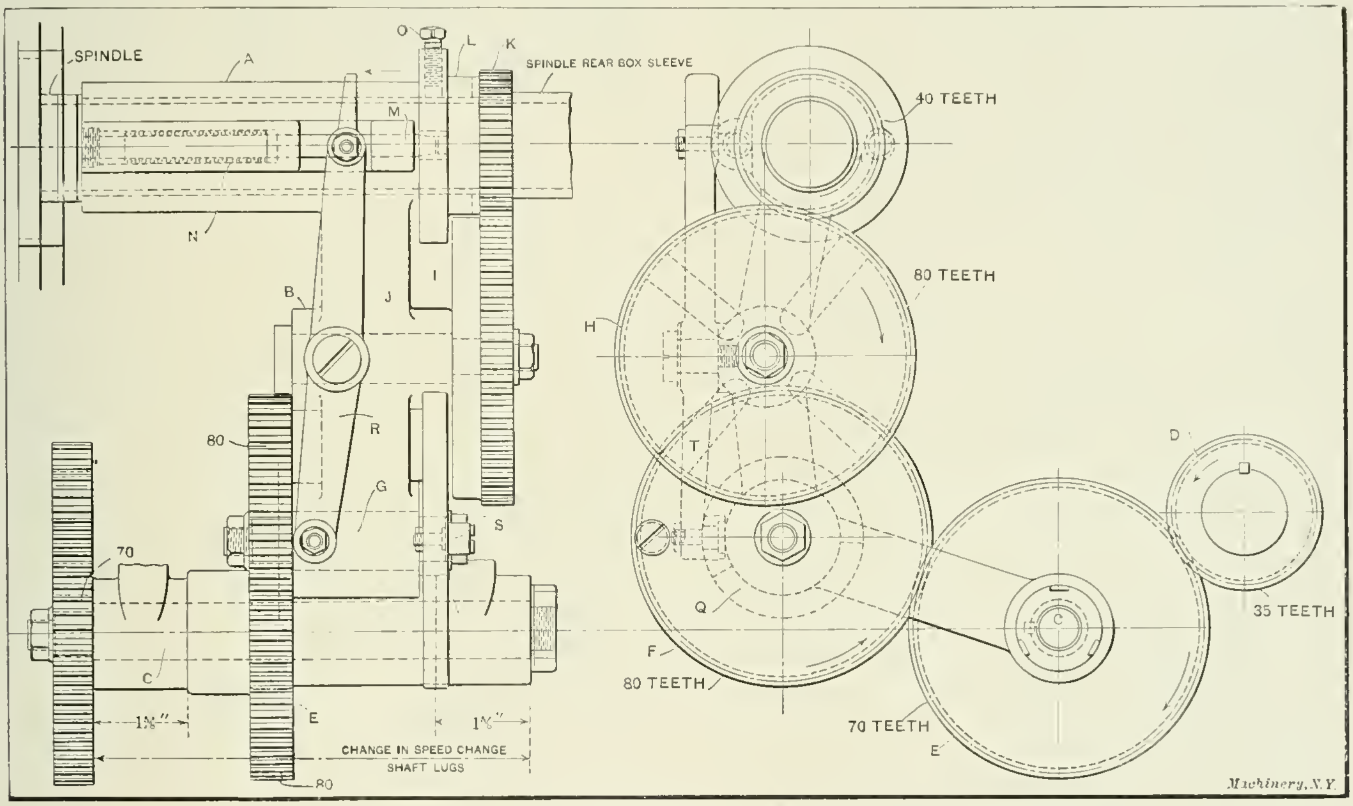

Fig. 11. Attachment for Indexing the Main Driving Spindle of a Brown & Sharpe Automatic Screw Machine

A device which is used for locating a hexagon-head screw in the slotting bushing is shown in Fig. 8, where the screw and slotting bushing are also shown. This device consists of a cast-iron bracket *A*, which is held on the slotting attachment, being retained in position with the same screws that hold the slotting attachment. Held in the boss of the bracket *A*, is a holder *B* to which is attached the locater *C*. This consists of a piece of sheet steel about 1/16 inch thick, held on a pin *D* and free to swivel. Pressing against this locater is a spring *E* which forces the locater against the stop pin *F*. A screw *G* acts as a stop, being adjusted in or out as desired to locate the head of the screw against the shoulder in the bushing, and also acting as a stop for the locater *C*.

In operation, as the screw is removed from the chuck by the slotting bushing, the arm, in ascending, is brought to dwell in an intermediate position, and is then advanced towards the locater *C*. As this locater is beveled, the screw forces it up, and the action of the spring turns the screw around in the bushing, so that the hexagon head is located properly, the arm at the same time advancing and forcing the screw in to the desired depth. The method of designing the transferring cam to dwell in this intermediate position will be described in connection with the burring attachment, in a future article.

In Fig. 9 is shown a device for locating hexagon-head screws in the slotting bushing which differs somewhat in principle from that shown in Fig. 8. This device consists of a cast-iron bracket *A*, which is fastened to the slotting attachment as previously described. The bracket is provided with a phosphor-bronze sleeve *B*, in which a spindle *C* is free to rotate. Keyed to the spindle *C*, and held by a nut *D*, is a grooved pulley *E*, which is driven by a 1/4-inch round belt from the overhead works. Held in the spindle *C* is a spring plunger *F*, which is pressed forward by an open-wound spring *G*. This spring plunger is prevented from rotating by a pin *H*, which fits in an elongated slot *I*, cut in the spindle *C*.

In operation as the slotting bushing lifts the screw from the chuck, the arm dwells in an intermediate position, travels forward and presses the screw against the rotating plunger *F*. As this plunger is driven slowly, and as the arm is advanced, the friction between the head of the screw and the plunger rotates the former. On the continued forward travel of the arm, the screw is located correctly in the bushing and forced in to the correct depth. The screw and the slotting bushing used for holding it are shown in the illustration, where the principal dimensions on the slotting bushing are also given.

Slabbing Attachment

A slabbing attachment which is fastened to the ordinary screw-slotting attachment is shown in Fig. 10. The screws which hold the slotting attachment to the frame of the machine are removed and the slabbing attachment *A* is seated on the top face of the base of the slotting attachment. The screws are again inserted, and the slabbing attachment fastened in position. The main body of the attachment is an iron casting, and a boss on it is bored out to receive a plunger *B* to which is attached a guide or ejector *C*. The plunger *B* is riveted to this guide member *C*, and a coil spring *D* is located behind the shoulder of the plunger to keep it out.

Two set-screws *E* and *F* with lock-nuts are provided for guiding the member *C*. This guiding or ejecting member *C* has an elongated hole bored in it, fitting over the saw arbor, so that the ejector can be forced back by the piece when it is being advanced to the slabbing saws by the transferring arm. The front face of the ejector *C* is knurled, so that the piece is prevented from rotating in the slotting bushing when the saws *H* and *I* commence to cut. This attachment is driven in the same manner as the ordinary screw-slotting attachment, and the bushing in which the work is held while being slabbed is also of a similar type. Of course, the exact shape of the bushing would depend entirely on the shape of the work. In the lower view, the driving mechanism has been removed to show the slabbing attachment more clearly.

Spindle Indexing Device

A device which converts the Brown & Sharpe automatic screw machine into a milling machine is shown in Fig. 11. This device was designed for making a special piece, which is shown at *A* in Fig. 12, where the cams for making the piece are also shown. Before taking up the making of this piece it will be necessary to describe the indexing device.

To apply this device, the pulleys *A* and *B* shown in Fig. 13 are removed, as is also the clutch mechanism. The outer sleeve *A* of the attachment shown in Fig. 11 is then slipped over the regular spindle. This sleeve is cast integral with a bracket *B*, the lower end of which is located on the shaft *C* shown in Fig. 13. This shaft is part of the belt-shifting arrangement which is used for obtaining two different speeds for the spindle when threading steel. The attachment is driven from the rear driving-shaft by the ordinary gears *D* and *E* which drive the belt-shifting arrangement as shown in Figs. 11 and 13. A 35-tooth gear *D* is placed on the driving shaft, which meshes with a 70-tooth gear *E* located on the shaft *C*. These gears drive an 80-tooth gear *F* on the stud *G*.

A trip and indexing mechanism somewhat similar to that used on the turret, is used here for indexing and locking the spindle. The 80-tooth gear *H* meshes with a 40-tooth gear *K* keyed to the sleeve *L* held on the spindle. This sleeve has two holes drilled in it, in which the plunger *M* fits. A spring *N* behind this plunger keeps it in contact with the sleeve *L*. This sleeve *L* is fastened to the main driving-spindle of the machine by a set-screw *O*. This attachment is operated as follows:

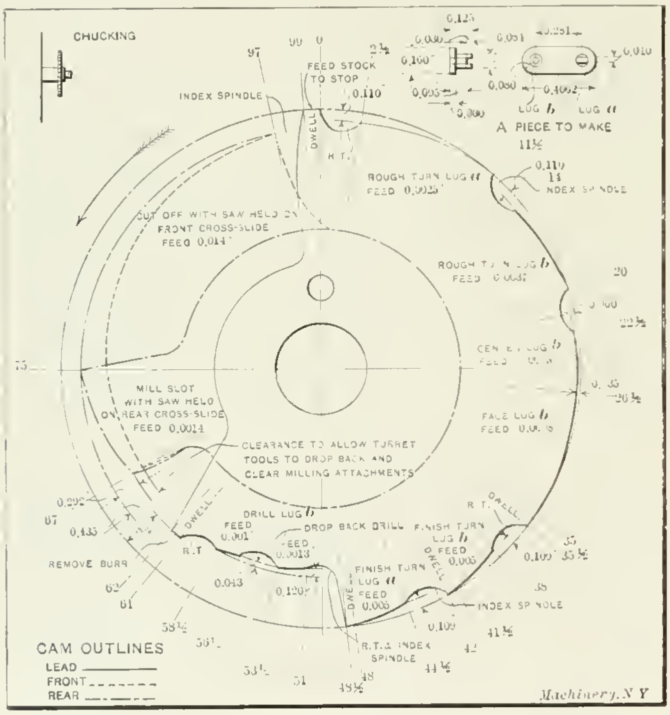

Fig. 12. Lay-out of a Set of Cams for Making a Piece requiring the Indexing of the Work-spindle

The dog on the drum held on the front cam-shaft, is set to trip the lever, which, when tripped, operates the tooth-clutch *P* Fig. 13, thus rotating the rear driving-shaft. As the rear driving-shaft rotates at 180 R. P. M., the gear *D* will revolve at the same speed, while the gear *E* will revolve at 90 R. P. M., and will transmit a speed of 90 R. P. M. to the gear *F*. This gear *F* carries a cam *Q*, and a roller attached to the lever *R* runs on this cam. Then when the dog trips the lever, the driving-shaft rotates, thus driving the gears, which in turn rotate the cam *Q*. As the cam *Q* is rotated, the arm *R* is moved in the direction indicated, which action withdraws the pin *M* from the bushing *L*. Now at the same time that the pin *M* is withdrawn, the roller *S* comes in contact with the slot *T* in disk *I* held on the stud *J*, thus rotating the disk on one quarter turn. This disk is provided with four slots *T*, and as this indexing device requires to be indexed 180 degrees to bring each part of the piece into position, the disk *I* is moved two spaces before another dog on the drum trips the lever that disengages the tooth-clutch *P*, Fig. 13. It can be seen, therefore, that with this arrangement the spindle is indexed in a similar manner to the work arbor of an automatic gear-cutter.

Referring to Fig. 12, it will be seen that the piece to be made has two lugs on it designated *a* and *b*. The stock from which this piece is made is of special shape, so that its outside circumference does not require to be finished; the lugs *a* and *b* are to be formed, drilled and slotted. The turning of these lugs presents a problem which is different from those ordinarily encountered on the Brown & Sharpe automatic screw machine. The work is not revolved at all, being indexed only to bring the stock into position for forming the two lugs. To turn these lugs, the turret is packed out an amount equal to one-half the distance between the center of the two lugs, and drilling attachments are used in the turret for holding hollow mills and drills used for turning and drilling the lugs. The order of operations for making this piece is as follows:

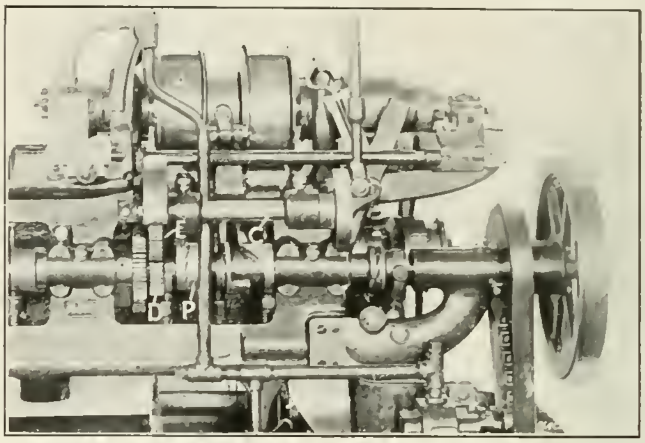

Fig 13. Illustration showing the Location of the Indexing Attachment

Order of Operations	Revolutions	Hundredths
Feed stock to stop	4½	1
Revolve turret	12	2½
Rough turn lug *a* with hollow mill held in drilling attachment, speed 684 R. P. M. at 0.0025 inch feed	43	9
Index spindle and revolve turret	12	2½
Rough turn lug *b* with hollow mill held in drilling attachment, speed 684 R. P. M. at 0.0037 inch feed	28	6
Revolve turret	12	2½
Center and face lug *b* with centering tool held in drilling attachment, speed 684 R. P. M. at 0.0013 inch feed to center and 0.0008 inch feed to face	62	13
Revolve turret	12	2½
Finish turn lug *b* with hollow mill held in drilling attachment, speed 684 R. P. M., at 0.005 inch feed	19	4
Index spindle	12	2½
Finish turn lug *a* with hollow mill held in drilling attachment, speed 684 R. P. M., at 0.005 inch feed	19	4
Revolve turret and index spindle	12	2½
Drill hole in lug *b* with drill held in drilling attachment, speed 3555 R. P. M. at 0.0013 inch feed	12	2½
Pull out drill to remove chips	14	3
Finish drill hole in lug *b* with drill held in drilling attachment, speed 3555 R. P. M., at 0.0011 inch feed	9	2
Revolve turret	12	2½
Remove burr and broach with tool held in floating holder	4½	1
Clear	24	5
Mill slot in lug *a* with special milling attachment held on rear cross-slide, speed 400 R. P. M., at 0.014 inch feed	(26)	(8)
Cut-off with special milling attachment held on front cross-slide, speed 480 R. P. M., at 0.014 inch feed	143	30
Index spindle	10	2
	476	100

Cross-slide Slotting Attachment

The special slotting attachment designed for cutting the slot in lug *a* shown in Fig. 12 is shown in Fig. 14. This attachment consists of a block *A*, the base of which is held to the rear cross-slide by a bolt and nut *B* and *C* as shown, the former fitting in the T-slot in the cross-slide. The spindle *D* passing through the casting which is bushed with a bronze sleeve, has attached to it a bevel gear *E*, meshing with a bevel gear *F* keyed to the vertical spindle *G*. This vertical spindle *G* also runs in bronze bushings. The pulley *H* is keyed to the rear end of shaft *D* and is held to it by a nut and washer as shown. A round belt which passes over a grooved pulley held on the countershaft, drives this pulley *H*, which, in turn, drives the slotting saw *I* held on the lower end of the vertical spindle. Adjustment is provided for the slotting saw *I* by varying the thickness of the washer *J*, and also by means of the adjusting nuts *K* and *L*. Gear *F* has a shank which fits in the upper member, so that the spindle *G* can be adjusted without affecting the position of this gear.

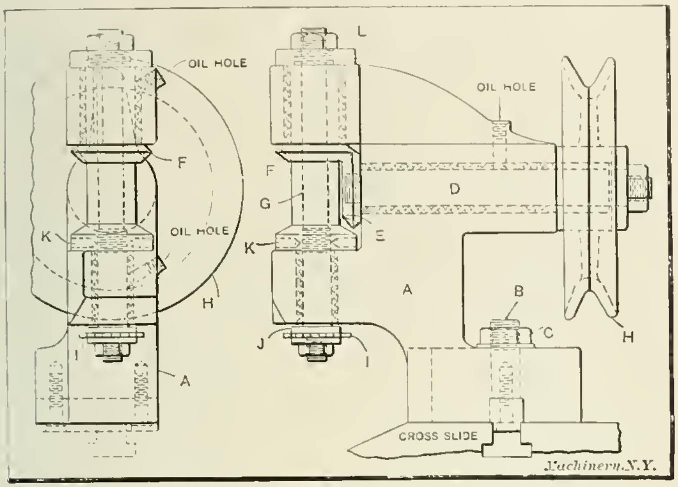

Fig. 14. Slotting Attachment held on the Rear Cross-slide

Cross-slide Sawing Attachment

The attachment which is used for cutting off the piece shown at *A* in Fig. 12 is shown in Fig. 15. This attachment is held on the front cross-slide, and consists of a holder *A* somewhat similar to the ordinary holder used for the circular form tools, and is also held to the cross-slide in a similar manner. A three-quarter inch flat belt, which passes over a pulley fastened to the countershaft, drives this attachment through the pulley *B*. This pulley *B* has a leather strip *C* fastened to it which increases the friction and gives a more positive drive to the cutting-off saw. The pulley *B* is keyed to a shaft *D*, and also held to it by a nut and washer as shown. The shaft *D* which passes through a bronze bushing held in the holder *A* has a helical gear *E* cut on its forward end. This helical gear meshes with a mating gear *F* held on the cutter spindle *G*, which is located at right angles to the spindle *D*. The spindle *G* fits in a bronze sleeve held in the holder *A*, and is provided with a shoulder *H* against which the slotting saw *I* is held by the nut *J*. The guard *K* is used to prevent the work from springing away from the saw when almost cut off.

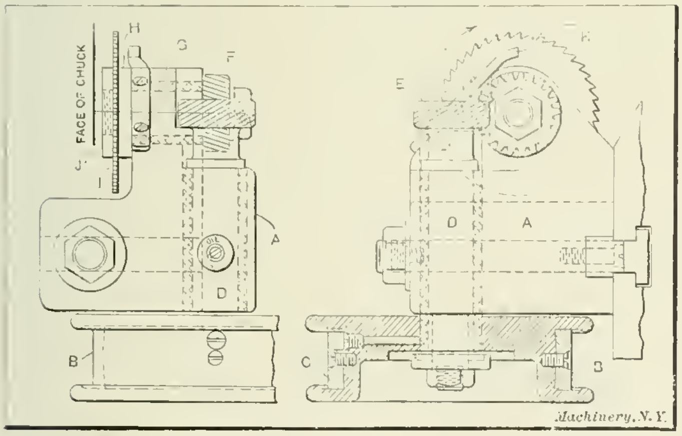

Fig. 15. Sawing Attachment held on the Front Cross-slide

VANADIUM IN CAST IRON

In a paper read before the American Foundrymen's Association, Mr. G. L. Norris stated that an addition of 0.1 per cent of vanadium to cast iron necessitates an increase in the selling price of from three-quarters to one cent per pound; hence the use of vanadium in cast iron is confined to such classes of work as can stand a material increase in cost in return for the special qualities obtained. Vanadium increases the strength of the cast iron to which it is added from 10 to 25 per cent. Vanadium also gives an element of toughness to cast iron which is very apparent in machining the castings. This toughness, together with the uniform fineness of grain, due to the even distribution of graphite, makes vanadium cast iron superior for such purposes as gas and steam engine cylinders, valve and piston bushings, piston rings, glass bottle molds, etc.

Three or four years ago the New York Central lines equipped one of its locomotives with a pair of cast-iron cylinders containing vanadium. The performance of this pair of cylinders over a test period of about two years was so satisfactory that 500 or more locomotives on these lines are now equipped with similar cylinders. The test of the original pair demonstrated that over twice the normal mileage of ordinary cast-iron cylinders could be obtained with such cylinders before reboring. The loss in casting these cylinders was extremely low, no cylinders being scrapped at all for the first 183 locomotives ordered. The same results have been reported by a builder of large gasoline engines for marine use. In this particular case, the number of cylinders formerly lost when tested after machining, was excessive, due to porousness of certain sections.

Piston rings and cylinder and valve bushings of cast iron with vanadium have been thoroughly tried and adopted by a number of leading railroads on account of the greatly increased length of service obtained. A very interesting application of vanadium has been for glass bottle molds. These are chilled castings, and are usually covered with engraving. The iron has to be clean, close and uniform in grain, machineable, and take a good polish. The first cast-iron bottle molds of this kind were made a little over a year ago and proved to have a longer life; it was also found possible to increase the speed of the bottle machines, as the glass did not appear to stick to these molds to any extent. This can be readily accounted for by the uniformity of the grain and freedom from mottled spots.

The field of application for vanadium in bearing metals has recently been receiving considerable attention, and already some very interesting results have been obtained. One of the most notable of these has been the performance of a vanadium bronze bearing metal in a step bearing of a grinding machine. The load on the bearing of this machine ranges between 1000 and 1100 pounds per square inch, and the great difficulty heretofore has been to secure a metal that would stand up under this pressure, and give satisfactory results with regard to wear and friction. A number of bearing metals of high reputation have been tried out in this machine, and some of them have only lasted fifteen to sixteen hours. The vanadium bronze bearing metal tested was based on the standard P. R. R. car box bronze mixture, with an addition of about 0.05 per cent vanadium. Bearings from this mixture have been in service for a year with entire satisfaction. The amount of wear on these bearings has been very small, and, as a matter of fact, the operators of the machines have been unwilling to have the bearings taken out for measurement as they are entirely satisfied with their performance.

As a result of the very satisfactory performance of these bearings, the mechanical department of this same works has recently started tests of standard babbitt metal with the addition of a small quantity of vanadium. This babbitt has only been in service about a month in electric motors, but it is showing up very satisfactorily, and promises to prove superior to the standard babbitt.

* * *

Don't forget that gasoline is a good lubricant for lapping.

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MACHINERY

DESIGN—CONSTRUCTION—OPERATION

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OCTOBER, 1911

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MACHINERY is published in four editions. The practical work of the shop is thoroughly covered in the Shop Edition, $1.00 a year, which comprises approximately 700 reading pages. The Engineering Edition—$2.00 a year, coated paper $2.50—contains all the matter in the Shop Edition, about 300 pages a year of additional matter and forty-eight 6 x 9 Data Sheets filled with condensed data on machine design, engineering practice and shop work. The Foreign Edition, $3.00 a year, comprises the same matter as the Engineering. The Railway Edition, $2.00 a year, is a special edition including a variety of matter for railway shop work—same size as Engineering and same number of Data Sheets.

ARTICLES TO MANUFACTURE

We are often asked to suggest articles that can be manufactured with a comparatively simple shop equipment. Many mechanics who desire to start in business for themselves are unable to find anything to make that seems likely to be profitable. If they have an article that will sell, the problem of securing capital to promote it is generally easy of solution.

Readers of MACHINERY will oblige us by calling attention to articles that would be suitable for small shops to manufacture, especially if the product is something that should be used in machine shops. The desirable characteristics of such articles are: potential market, simplicity, novelty and reliability. A patented article is preferable to one that is not protected, as the investment of capital is more easily secured for its manufacture.

* * *

"IT CAN'T BE DONE"

Paradoxical as it might seem, there is truth in the saying that it is generally the man who does not know that a thing can't be done, that does it. This is especially true in the engineering and scientific field. Engineers and men of science often assume as axioms that certain things are impossible, and they never try to demonstrate the contrary. They hardly ever think of the means by which these apparently impossible things could be accomplished. It is the man who does not know—that is, the man who is not imbued with the idea of the impossibility of accomplishing a certain object—that goes ahead, tries it, and often succeeds. Many examples could be cited which prove this to be true. However, it is necessary to recall but one, as this one is at the present time so prominently before the public eye as to be appreciated by everybody. Only a few years ago one of the great American scientists, Prof. Simon Newcomb, stated that successful flights with a heavier-than-air machine were impossible and he proved to the satisfaction of a good many other scientists and engineers that his contention was scientifically correct. Yet men who knew very much less of science than Prof. Newcomb—men who did not know that it was impossible to fly—accomplished the feat.

In the machine building business it is not unusual that a young enthusiastic mechanic proposes to do something that has never been done before, and old level-headed men will tell him half-pityingly, half-sarcastically that "this thing can't be done." But the young man does not know that it cannot be done, so he goes ahead, if he can do so without overstepping the authority of the men above him, designs his machine or device, and it does the work. No doubt it is many times better to be too conservative than to rush heedlessly into a new and uncertain undertaking, but nevertheless we should be careful about stating definitely that it is impossible to accomplish certain things. Many times great opportunities are lost by checking the enthusiasm and the ability of an inventive mind with a repetition of that time-worn expression: "It can't be done."

* * *

PERSONALS AND OBITUARIES

Readers of MACHINERY will confer a favor by promptly sending to the editor personals and obituaries of men prominent in the machinery trade. We particularly wish notices of changes made by men in responsible positions, such as foremen, superintendents, general managers, chief draftsmen, etc. When such changes are made, we are glad to notice them in the personal column of MACHINERY. These notices are not printed simply to please the persons mentioned; they are regarded as items of news, as useful in their way as any of the other news items published.

Obituaries of men who have accomplished mechanical work worthy of note are always desirable. Information of value is often conveyed in accounts of the lives of men who have passed away, and the wide-awake progressive mechanic is benefited by knowing something of the history of the machines and methods that he uses in manufacturing. We shall be glad to receive personals and the obituaries of prominent mechanics from any reader.

* * *

SIMPLICITY OF MANUFACTURING METHODS

Manufacturing methods may be roughly divided into two general classes as regards equipment, the first being that in which standard machines and tools and simple methods are used, and the second that in which special machines, tools and processes have been developed to cheapen the cost and enhance the quality of the product.

One of the surprises that often awaits the visitor to manufacturing plants is finding simple methods and tools used in a class of manufacturing that he had supposed required complicated methods and machines for economical production. On the other hand, some of the products on the market, which to the uninitiated seem very simple to make and which *can* be made in a simple manner, are manufactured with costly machinery and often by methods that are regarded as trade secrets.

Visiting manufacturing plants is educational in the highest degree, but few can afford the time and money required to make extensive inspection trips. The next best means of obtaining such valuable experience and at low cost is reading MACHINERY. The knowledge of how things are made outside of one's own realm may be extremely valuable to the mechanic who sometime has to handle materials or turn out products of a similar nature. If given the problem without having knowledge of the methods commonly employed, he might spend much time and money in developing costly ways and means imagined to be necessary for success. On the other hand, he might blunder in assuming that a simple product could be produced in a simple manner with cheap machines, and find, too late, that he had made a costly mistake.

As a rule, the larger the output of a simple product, the more complicated are the machinery and processes employed. Take, for example, the sewing machine needle, which is as simple a thing almost as can be imagined. One concern in the United States has nearly monopolized the manufacture of machine needles through its development of peculiar machinery and methods that produce high-grade needles very cheaply. If a thing is made in comparatively small numbers, the methods and tools used are usually simple, unless a part absolutely requires an unusual process to produce it successfully.

ATWOOD'S AEROPLANE FLIGHT

The aeroplane flight of Henry Atwood from St. Louis to New York, begun August 14, finished August 25, and covering a distance of 1265 miles, is a remarkable feat and one of significance as to the future of the aeroplane. It does more to demonstrate the practicability of the aeroplane for certain services than all the fancy flights and maneuvers of daring aviators who have risked life and limb in their performance. Atwood's aviation exploits have been marked with a sober regard for safety of himself and machine. Nine-tenths of the accidents that have befallen aviators have been due to freak exhibitions, spiral dips, swoops and curves that throw enormous stresses on the engines and framework of aeroplanes, because of the gyroscopic effect of the revolving masses. When aviators abandon dare-devil exhibitions, height flights and other foolhardy "stunts," aviation will undoubtedly progress much more rapidly in the estimation of the sober-minded public than it has through the freak flights of the last two or three years.

* * *

COMPLICATED VS. SIMPLE MACHINE DESIGNS

Some time ago we had the opportunity of inspecting a new machine designed to perform certain work more rapidly than by the ordinary means. The machine was the first development of its kind and the designer looked upon it with considerable pride. A casual observer, however, could not refrain from thinking that a machine consisting of such a mass of levers, handwheels, adjustments and slides is hardly the thing to put into the hands of the ordinary machine operator. Many a machine designer seems to entertain a certain pride in the fact that he is accomplishing his ends by means of a complicated mechanism, and will describe with eloquence and enthusiasm the wonderful harmony with which a long train of gears and levers will work. As a matter of fact, however, the most ingenious designs are the simplest ones—those that contain the fewest parts. This, of course, is recognized by everyone who has any mechanical common sense. It requires a designer of the greatest ability to bring the complicated design, which under favorable conditions will perhaps perform its work properly, down to a simple mechanism involving only a few parts and performing its work with absolute reliability. The less complicated machine is not so likely to get out of order, and if once out of order, it is much easier to put back into working condition again. There was a time when a machine with many features ingeniously combined seemed to attract the prospective customer, but that time has practically passed. At the present time it is the simple, easily operated machine that is in greatest demand. The designer with a new and brilliant idea should put as much stress upon making his design simple as upon getting it to work at all. A machine for doing nearly anything within reason can be designed by almost any fairly good designer, provided he is permitted to make it as complicated as he likes, but it is the true mechanical genius only who is able to design a simple machine to perform complex operations.

* * *

TRACKAGE OF LARGE U.S. RAILWAY SYSTEMS

The following railroad systems in the United States each have a trackage of over 5000 miles, including switches, turnouts, etc.:

Atchison, Topeka & Santa Fe	10,471.18
Atlantic Coast Line	11.426.08
Baltimore & Ohio	5,570.34
Chicago & Northwestern	9,827.31
Chicago, Burlington & Quincy	11,757.88
Chicago, Milwaukee & St. Paul	9,697.50
Great Northern	7,414.80
Illinois Central	8,255.51
Missouri Pacific	7,282.36
New York Central	13.227.64
New York, New Haven & Hartford	6,480.77
Northern Pacific	6.280.72
Pennsylvania	11,197.51
Rock Island	8.144.36
St. Lonis & San Francisco	7,470.75
Southern	9,781.30
Southern Pacific	10,248.27
Union Pacific	7,177.78

PRICES OF JOB WORK PERFORMED ON MACHINE TOOLS

In order to make a satisfactory answer to a request for the rates charged by machine shops in some of the principal manufacturing centers for job work performed on planers, lathes, boring machines and other machine tools of various sizes, we addressed a circular letter to concerns in Cincinnati, Ohio, Cleveland, Ohio, Hartford, Conn., Newark, N. J., Providence, R. I., Rochester, N. Y., Rockford, Ill., and Worcester, Mass., and the following quotations are the gist of the replies received:

"The usual rate charged in Cleveland is 60 cents an hour. This rate is considered too low by many concerns, but they say that if they try to get more it results in dissatisfaction and they lose the work. We had some planing done about a year ago on a 48-inch by 48-inch by 30-foot planer driven by a 10 H.P. motor which was charged to us at $1.50 per hour."

"The machine shop proprietors in Cincinnati usually charge about 60 cents per hour for ordinary machines, although some of the larger companies charge 75 cents an hour for ordinary machines. They are, however, few in number. The usual charge for heavy machines such as large-size planers, lathes and boring machines is from $1.00 to $1.25 an hour. We think the majority of machine shops charge 60 cents an hour for ordinary machines and $1.00 an hour for heavy machines."

"The rates charged for machine work in Hartford vary considerably in the different shops. In our own case we charge from 60 cents to $1.00 per hour according to the nature of the work and size of the machine employed. We would say that the average price in and around Hartford is between 65 and 70 cents per hour."

"The rate in Newark is 60 and 75 cents and $1.00 per hour, depending upon the cost of machine and equipment doing the work."

"The usual hour rates charged for job work performed on planers, lathes, boring machines and other machine tools in Providence vary considerably throughout the different shops. The general rate for good machine work seems to run between 60 and 70 cents per hour. Very fine work, such as die work and tool work, generally runs up to 90 cents per hour. These figures have been obtained from various sources and appear to be very nearly uniform rates. Of course, these prices are likely to be affected by the quantity of the work and the promptness with which the work is paid for."

"The majority of shops doing job work in Rochester charge 75 cents per hour, although there are some cases where work is done for 60 cents, but 75 cents is the prevailing rate."

"We think that 60 cents an hour for general machining is a common charge among the job shops in Rockford. Recently to help out a concern whose factory was destroyed by fire we allowed them to use some eight or ten of our machines; among others was a planer that cost us, installed, in the neighborhood of $5000. We charged an hourly rate for the use of this machine of 60 cents. For the lathe that cost $300 or $400 the charge was 20 cents an hour."

"It is a custom of Worcester manufacturers to charge from 50 to 75 cents per hour for job work performed on planers, lathes, boring machines and other machine tools of various sizes, the exact amount depending upon the machine used and the grade of the shop. We think it safe to say that the average price in our city would be 60 cents per hour."

* * *

Experiments made at the McGill University by Mr. J. W. Evans of Bellville, Ont. apparently demonstrated that the titaniferous iron ore, which abounds in Quebec and Ontario, can be converted directly into steel by an electric process and thus made commercially valuable. Tool steel of superior quality can be produced at a cost of about 2 cents a pound. One experiment was made with a one-half ton electric furnace into which 230 pounds of ore were placed and from which 110 pounds of steel were produced. The steel was poured directly into molds and cast into lathe and planer tool shapes, which were ready for use after being hardened, tempered and ground.

TOOLS AND METHODS USED IN THE WINDSOR MACHINE CO.'S PLANT

The accompanying halftones and line engravings illustrate some interesting tools and methods used in the shop of the Windsor Machine Co., Windsor, Vt. Several of the methods and devices used in the plant of this company have been previously described in MACHINERY (see the November, 1908, and November, 1910, numbers). The present article, therefore, will be devoted to a few special tools and devices, most of which have been developed at a recent date.

Chuck for Facing Gear Blanks

The facing of gear blanks in an ordinary chuck so that the two sides become exactly parallel, is a difficult operation, and unless some special means are provided for accomplishing the desired result, it is almost impossible to obtain an accurate job. In Fig. 1 is shown a special chuck which is used for holding gear blanks while facing one side of the blank in the Jones & Lamson turret lathe. The interesting feature of this chuck is the construction of the vise jaws which are shown in detail in the halftone Fig. 2 and the line engraving Fig. 10. The gear blanks are first drilled, bored and reamed, one side being faced in the usual way. They are then clamped in the chuck shown, for facing the other side. Later they are turned, eight or ten at a time, on a nut arbor.

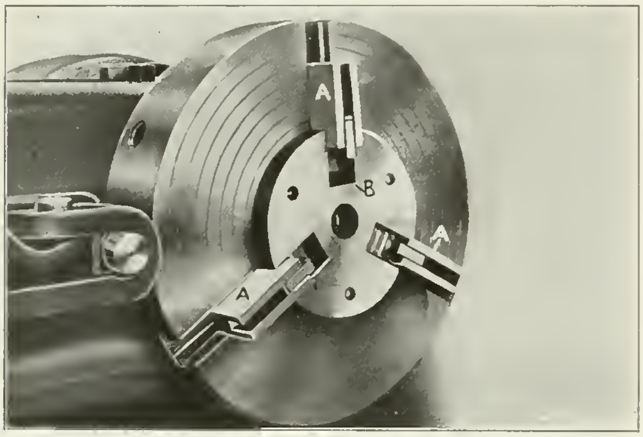


Fig. 1. Chuck with Special Jaws for Holding Gear Blanks while Facing

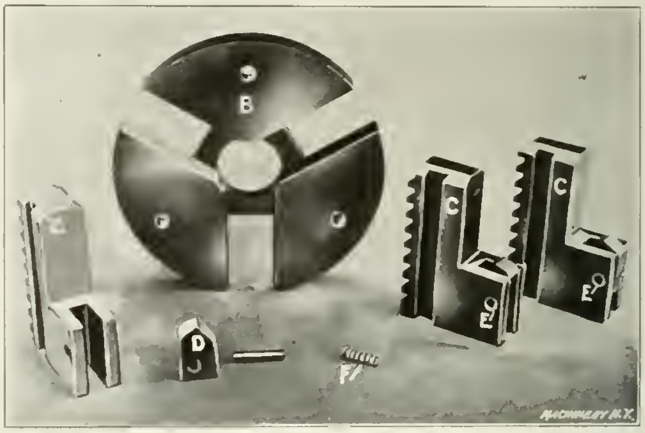


Fig. 2. Parts of Chuck shown in Fig. 1

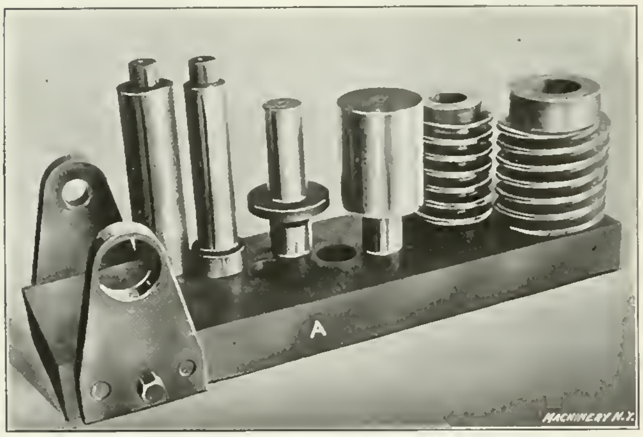


Fig 3. Gage for Testing Worms and Worm-wheels

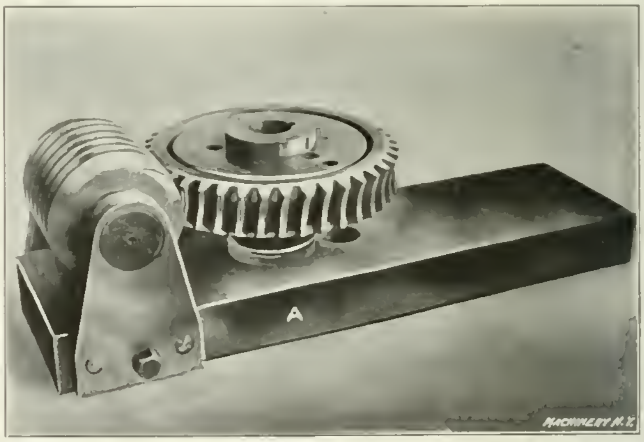


Fig. 4. Gage in Fig. 3 in Use

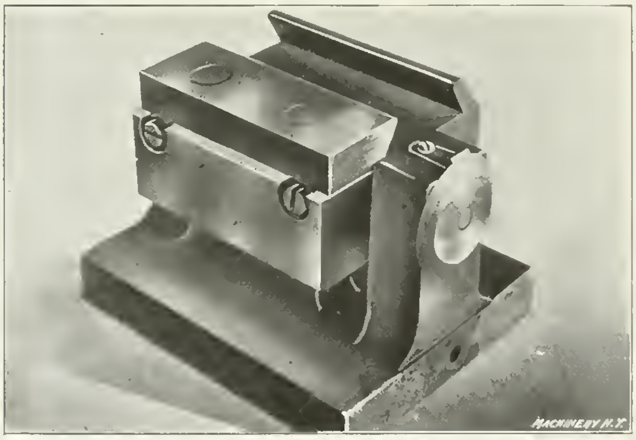


Fig. 5. Holder for Forming Tools while Grinding the Forming Surfaces

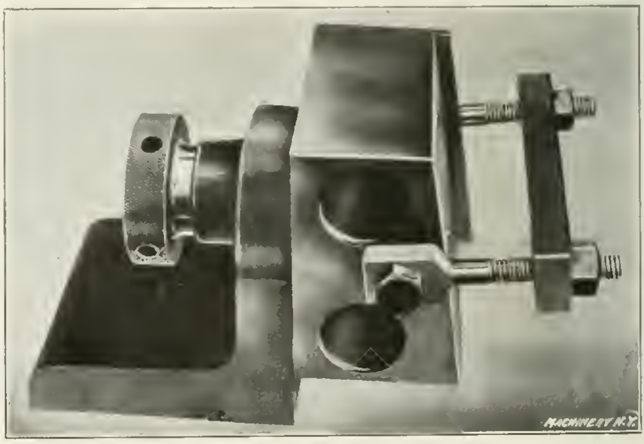


Fig. 6. Holder for Forming Tools while Grinding Top Surface

In Fig. 1, where the chuck is shown assembled and ready for operation, the special jaws are shown at *A*. At *B* is shown a plate which is bolted to the face of the chuck and which is trued up for each lot of gears being faced. Provided the gear blanks are clamped solidly against plate *B*, this insures that the two sides of the blanks will run true in all cases. A detail view of plate *B* is shown in Fig. 2. The jaw proper is shown at *C* in Figs. 2 and 10, and at *D* in the same illustrations is shown an auxiliary swinging jaw which is pivoted at *E* in jaw *C*. When a piece of work is not clamped in the chuck, jaw *D* is held in a normal position by spring *F* which is inserted in hole *K* in jaw *C*, and which forces together surfaces *G* on the auxiliary jaw and the jaw proper. When a gear blank is being clamped in the chuck, the points *H* of jaws *D* bear against the work, and as the point *H* is inside of the pivot *E*, with relation to the chuck, the work is forced against plate *B* instead of being lifted away from its bearing surface as is frequently the case in an ordinary chuck. When a chuck provided with jaws of this kind, and trued up as mentioned, is used, it is possible to face work within 0.0002 inch of being true.

Testing Devices for Spur and Worm Gears

Figs. 3, 4 and 9 show some illustrations of testing devices or gages for inspecting spur gears and worm-gears used in the Gridley automatic machines. In Fig. 3 the worm-gear testing device is shown with its studs, arbors and master worms. As will be noticed, separate holes in base block *A* and separate studs are provided for each worm-and-gear set to be tested. The studs, holes and master worms are all plainly marked, so that it is almost impossible to make a mistake. The usual order of procedure when inspecting gears and worms by this testing device is to first test the gear in conjunction with the master worm, and afterward to test the gear again in conjunction with the worm with which it is actually to mesh. In this way a double check on the accuracy of both worm and gear is afforded. In Fig. 4 the worm-gear testing gage is shown in use, the worm-gear in this case being tested with its master worm.

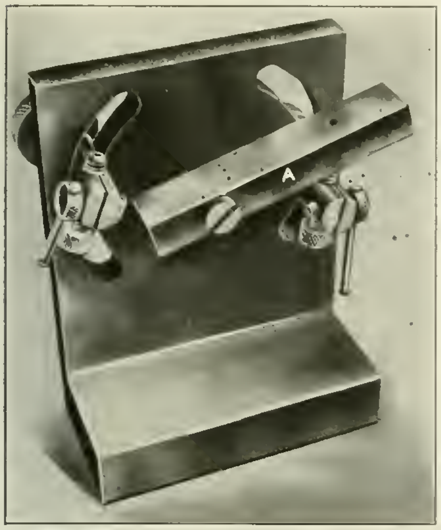


Fig. 7. Device for Truing Grinding Wheels for Forming Tools

In Fig. 9 the block used for testing spur gears is shown. In this case also one gear of a pair is first tested with a master gear and then the two gears which are to mesh are tested by running them together. Separate holes and studs are provided in this case also for each set of gears, the studs, holes and master gears being marked in the same way as already mentioned in the case of the worm-gear testing device. The gage blocks are made from cast iron and are provided with tool-steel, hardened and ground bushings for the studs upon which the gears are mounted. These studs are also made of tool steel and hardened.

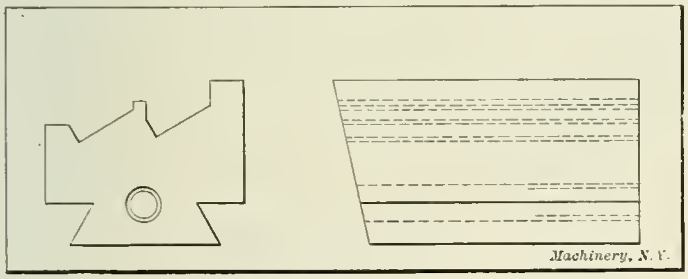


Fig. 8 Type of Tool ground in Fixtures shown in Figs. 5 and 6

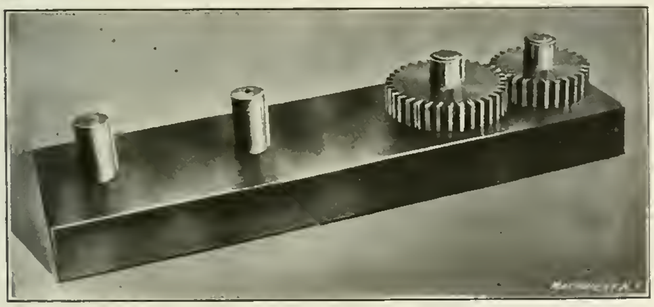


Fig. 9. Spur Gear Testing Device

The devices shown are very simple, but constitute a convenient and accurate method of inspection. While the gages are not in any way universal, they have the advantage of being "fool-proof." In interchangeable manufacturing, gages intended for but one purpose are generally preferable to so-called "universal" testing devices as the chances of mistakes are fewer, and such mistakes as misreadings of graduations, or the slipping of some slide or part after the gage has once been set, are entirely eliminated.

Holders for Grinding Forming Tools

In Figs. 5 and 6 are shown two devices which are used when grinding the formed surfaces of forming tools used in the Gridley automatic machine. In Fig. 8 is shown a sample of the style of tools ground with the aid of these fixtures. The holders are attached to the table of a Brown & Sharpe surface grinder by means of a magnetic chuck. The device in Fig. 5 is used for grinding the shape of the formed surfaces of the forming tool, the tool being held by the dove-tail of the fixture, in practically the same way as it is held in the automatic machine when in use. As indicated in the halftone illustration, the holder can be swiveled to any angle in order to accommodate the grinding of the various surfaces of the tool. The holder in Fig. 6 is intended for grinding the flat top surface of the tools.

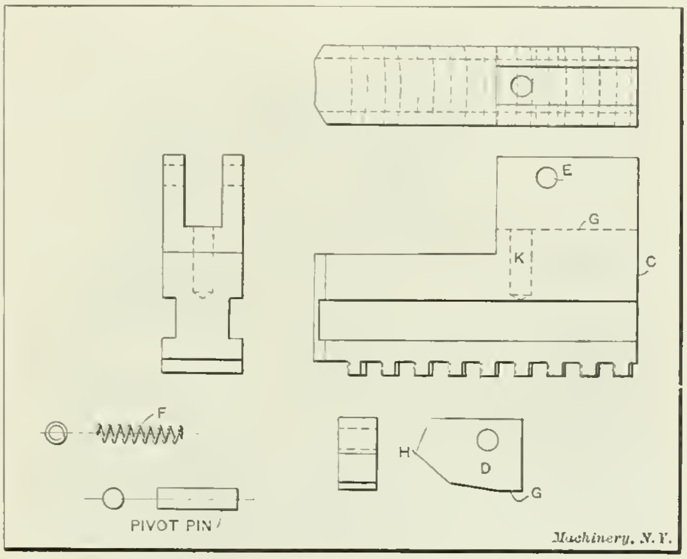


Fig. 10. Details of Chuck shown in Fig. 1

The device shown in Fig. 7 was designed for truing the sides of the wheel for grinding forming tools for bevel gears and other work of similar nature, on which a double angle has to be formed. A diamond is held in a flat holder which slides on the guide *A*, the position of this guide being governed by the location of the adjustable stops *B* and *C*. After the stops have been set so as to give to the wheel the desired angles, it is only necessary to turn the guide from the one to the other in order to true the wheel to the correct shape as often as desired. All forming tools are ground after hardening so as to insure as great accuracy as possible.

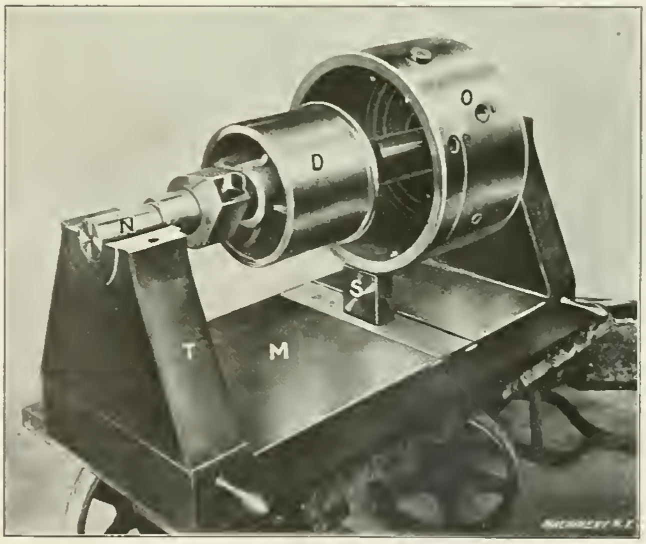


Fig. 11. Jig for Drilling Cam Drums

Jig for Drilling Forming Cams and Cam Drums

In Fig. 11 is shown a jig which is used for drilling the holes in the cam drum used on the Gridley multiple-spindle automatic machines. In Fig. 13 the jig is shown in detail. When the drums *D* are being drilled, they are held on arbor *N*, which latter rests in bearings in frame *M*. After the drum has been placed on the arbor, as shown in Fig. 11, it is pushed inside of the sleeve *O*, which holds the guide bushings for the drill. The drums are located in the correct position inside of the drill bushing sleeve by means of the pin *P*, Fig. 13. The distance in the longitudinal direction is governed by the stop collar *R*. At *S* is shown a support which carries the weight of the arbor and sleeve when the removable support *T* is taken off to permit the removal of the drum that has been drilled and the mounting of a new drum on the arbor. As will be noted from the halftone illustration, the arbor *N* and sleeve *O* are rotated for bringing the bushings in line when drilling the successive holes. This arrangement of the jig makes it very convenient to handle when in operation. It insures also absolute interchangeability as regards all the drums.

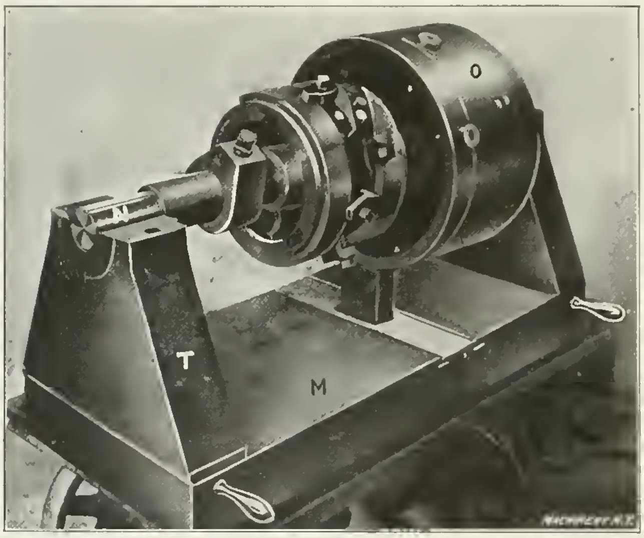


Fig. 12. Jig in Fig. 11 used for Drilling Forming, Return and Cut-off Cams

In Fig. 12 the same jig is shown, used in this case, however, for drilling the forming, cut-off and return cams used on the multiple spindle automatic machines built by the company. In this case a master drum is used, onto which the various cams are clamped in their proper positions as determined by stop plugs. The master drum is then pushed into the drill bushing sleeve, and the cams drilled the same as the drum. As the master drum is mounted on the arbor *N* the same as the cam drums, and as the cams are drilled from the same jig bushings in the sleeve *O* as is the drum, perfect duplication of the location of the holes drilled is insured. In Fig. 14 is shown a detail of the master drum indicated in Fig. 12. The cams to be drilled are located on the master drum by the removable collars *B* and *G* and the pins *A*, *F*, *K* *L* and *M*. The clamps *C*, *E*, *H*, *I* and *J* hold the cams in place during the drilling operation. As will be noted in Fig. 12 the frame *M* and the arbor *N* are made long enough so that the master drum can slide out of the sleeve *O* after the cams have been drilled and removed from the master drum, without removing the support *T*. Hence it is only in the case of drilling the cam drums that this support has to be removed. One of the advantageous features of this device, in addition to the accuracy that it makes possible, is that it saves the operator from lifting or turning over a heavy jig and for this reason saves time in its operation.— E. O.

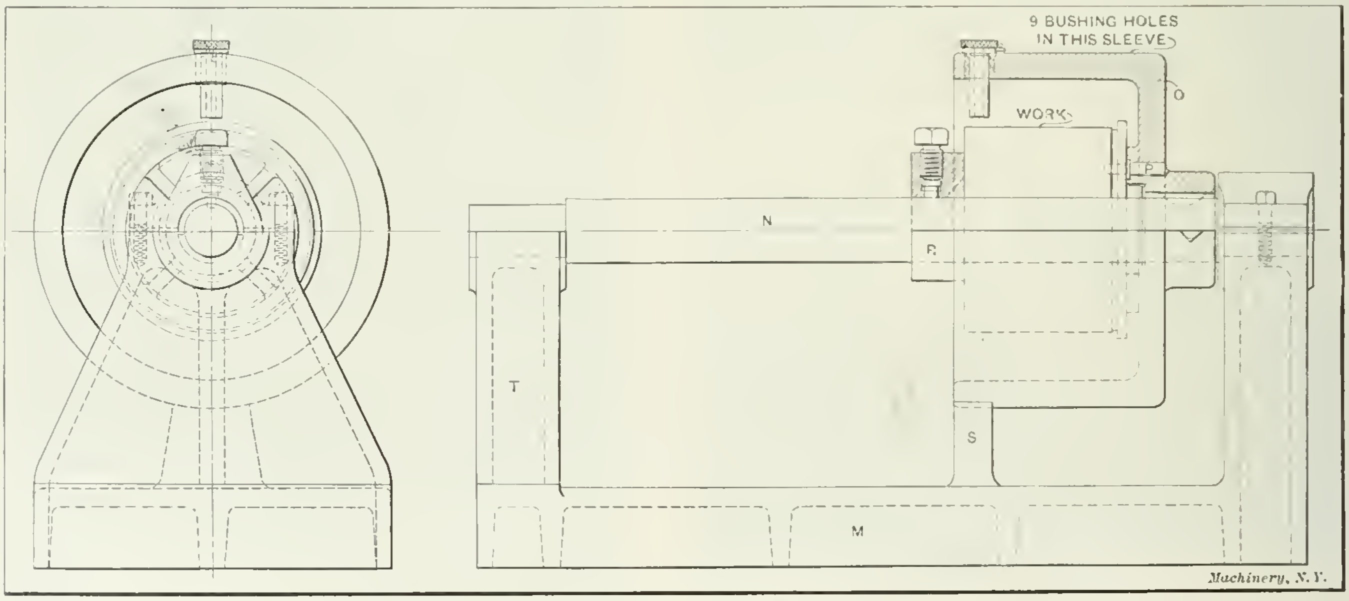


Fig. 13. Details of Jig in Fig. 11

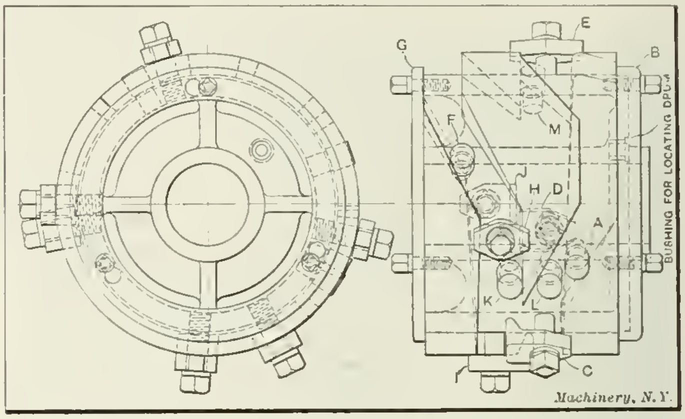


Fig 14. Master Cam Drum shown in Place on Arbor in Fig. 12

* * *

It is reported that a new method for electroplating aluminum has recently been patented by Carl Rümpler of Schöneberg, near Berlin, Germany. A film of brass containing not less than 50 per cent copper and a small quantity of zinc (the less zinc the deposit contains the more tenaciously it will adhere) is deposited on the aluminum. In order to obtain the desired deposit, a small quantity of a haloid such as potassium chloride, bromide or iodide is used in the bath. The solution used is as follows:

Water	1 gallon
Double potassium and copper cyanide	5 ounces
Double potassium and zinc cyanide	2 ounces
Sodium sulphite	5 ounces
Caustic potash	2 ounces
Potassium chloride	1 ounce

Brass anodes are used and about 1.8 volt with a current density of from 2 to 3.6 amperes per square decimeter. The time required to deposit the film is from one to two minutes. After this operation the current should be shut off, and the aluminum transferred to the plating solution.

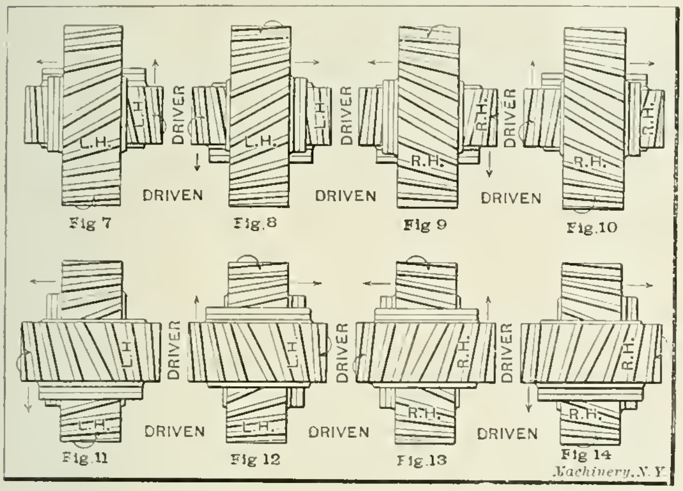
SPIRAL GEAR DESIGN—2*

By JAMES H. CARVER†

In the first installment of this article four cases dealing with spiral gears with the shafts parallel were referred to. In the present installment four cases of spiral gearing with the shafts at right angles will be dealt with. These cases, numbered consecutively with the cases stated in the previous installment, are as follows:

5. Shafts at right angles, ratio equal, and center distance approximate.
6. Shafts at right angles, ratio equal, and center distance exact.
7. Shafts at right angles, ratio unequal, and center distance approximate.
8. Shafts at right angles, ratio unequal, and center distance exact.

In the accompanying Data Sheet Supplement the procedure to follow in calculating the required dimensions for these four cases is outlined, the data sheets being arranged in the same manner as those in the September number of MACHINERY.



Figs. 7 to 11. Thrust Diagrams for Spiral Gears with Shafts at Right Angles

The accompanying illustration gives a diagram for gears with shafts at right angles, the purpose of this diagram being the same as of that shown in the former installment of this article. The explanation given in connection with the former diagram should be referred to.

5. Shafts at Right Angles, Ratio Equal, and Center Distance Approximate

The sum of the spiral angles of both gears must in this, and in all the following cases, equal 90 degrees, and the direction of the spiral must be the same for both gears. When the spiral angles of both gears equal 45 degrees, the pitch diameters of both gears will be equal, and are found by the formula (see Data Sheet Supplement for notation):

$$D = \frac{N}{P_n \cos 45^\circ} = \frac{N}{0.70711\, P_n}$$

The other formulas are the same as those given in the previous installment.

6. Shafts at Right Angles, Ratio Equal, and Center Distance Exact

After deciding upon an approximate spiral angle of one gear, the number of teeth in each gear is found nearest the value $C\, P_n \cos\phi$ where ϕ is this approximate spiral angle, and C the exact center distance. If $\dfrac{N}{P_n \cos a} = C$, or $N = C\, P_n \cos a$, then N would be an approximate number of teeth with an exact spiral angle, but by making $a = \phi$, an approximate angle, then $N = C\, P_n \cos\phi$, or an exact number of teeth, after which, as shown in the following, an exact angle a can be found, for

$$\frac{N}{P_n \cos a} + \frac{N}{P_n \cos\beta} = 2C$$

where a is the exact spiral angle of one gear, and β the exact spiral angle of the other, but $\beta = 90^\circ - a$, or $\cos\beta = \sin a$. Then

$$\frac{N}{P_n \cos a} + \frac{N}{P_n \sin a} = 2C,$$

or

$$\frac{1}{\cos a} + \frac{1}{\sin a} = \frac{2CP_n}{N}$$

Multiplying by $\sin a \cos a$, gives:

$$\sin a + \cos a = \frac{2CP_n}{N} \sin a \cos a$$

Squaring,

$$\sin^2 a + 2 \sin a \cos a + \cos^2 a = \frac{4C^2P^2_n}{N^2} \sin^2 a \cos^2 a.$$

But,

$$2 \sin a \cos a = \sin 2a, \text{ and } \sin^2 a + \cos^2 a = 1.$$

Further,

$$\sin^2 a \cos^2 a = \tfrac{1}{4} \sin^2 2a.$$

Then,

$$1 + \sin 2a = \frac{C^2 P_n^2}{N^2} \sin^2 2a,$$

or

$$\sin^2 2a - \frac{N^2}{C^2 P_n^2} \sin 2a = \frac{N^2}{C^2 P^2_n}$$

Solving this equation we get

$$\sin 2a = \frac{N^2}{2\, C^2 P^2_n} \pm \sqrt{\frac{N^2}{C^2 P^2_n} + \left(\frac{N^2}{2\, C^2 P^2_n}\right)^2}$$

which is the equation for finding twice the required angle.

7. Shafts at Right Angles, Ratio Unequal, and Center Distance Approximate

Here the only two terms which may not be decided upon at the outset are the number of teeth in each gear. Each, of course, must be a whole number and correspond with the center distance, angle of spiral, and normal pitch. Let

$$\frac{N}{P_n \cos a} + \frac{n}{P_n \cos\beta} = 2\,C,$$

and

$$\frac{N}{n} = R, \text{ or } N = R\, n.$$

Then

$$\frac{Rn}{P_n \cos a} + \frac{n}{P_n \cos\beta} = 2\,C.$$

Multiply by $P_n \cos a \cos\beta$. Then,

$$R\, n \cos\beta + n \cos a = 2\, C\, P_n \cos a \cos\beta$$
$$n\ (R \cos\beta + \cos a) = 2\, C\, P_n \cos a \cos\beta,$$

and

$$n = \frac{2\, C\, P_n \cos a \cos\beta}{R \cos\beta + \cos a}$$

which gives the number of teeth in the pinion in terms of the center distance, angle of spiral, and normal diametral pitch.

When a spiral angle of 45 degrees is used, the last formula becomes, by substituting the numerical values of the cosine of both angles, which is 0.70711;

$$n = \frac{2\, C\, P_n\ 0.70711 \times 0.70711}{R \times 0.70711 + 0.70711}$$

or

$$n = \frac{1.41\, C\, P_n}{R + 1}$$

8. Shafts at Right Angles, Ratio Unequal, and Center Distance Exact

This case is met with when two spiral gears are to replace two bevel gears, or when the conditions of the design demand an exact center distance and unequal ratio. The normal pitch, the ratio of number of teeth in large to small gear, the exact center distance, and the approximate spiral angle a of the large gear are all given or assumed. Then the number of teeth in the small gear is found from the formula:

$$n = \frac{2\, C\, P_n \sin a}{R \tan a + 1}$$

which is found as follows:
Let

$$\frac{N}{P_n \cos a} + \frac{n}{P_n \cos\beta} = 2\,C,$$

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* With Data Sheet Supplement.
† Address: 761 Eastern Ave., Schenectady, N. Y.

or twice the center distance, or

$$\frac{N}{P_n \cos a} + \frac{n}{P_n \sin a} = 2\,C.$$

Let

$$\frac{N}{n} = R, \text{ or } N = R\,n.$$

Then

$$\frac{R\,n}{P_n \cos a} + \frac{n}{P_n \sin a} = 2\,C.$$

Multiply by $P_n \sin a \cos a$. Then,

$$Rn \sin a + n \cos a = 2\,C\,P_n \sin a \cos a,$$
$$n\,(R \sin a + \cos a) = 2\,C\,P_n \sin a \cos a,$$

or

$$n = \frac{2\,C\,P_n \sin a \cos a}{R \sin a + \cos a}$$

Divide by $\cos a$. Then,

$$n = \frac{2\,C\,P_n \sin a}{R \tan a + 1}$$

The formula $R \sec a + \operatorname{cosec} a = \frac{2\,C\,P_n}{n}$, which is used in finding the exact spiral angle is found in the same manner as in some of the preceding cases. Let,

$$\frac{N}{P_n \cos a} + \frac{n}{P_n \cos \beta} = 2\,C, \text{ and } \frac{N}{n} = R, \text{ or } N = Rn.$$

Then,

$$\frac{R\,n}{P_n \cos a} + \frac{n}{P_n \sin a} = 2\,C.$$

Multiplying by $\frac{P_n}{n}$, we have:

$$\frac{R}{\cos a} + \frac{1}{\sin a} = \frac{2\,C\,P_n}{n}$$

or

$$R \sec a + \operatorname{cosec} a = \frac{2\,C\,P_n}{n}.$$

This exact spiral angle is found by trial, by substituting values found in a table of secants and cosecants in the equation, after the proper value of the last member in the equation has been found from known values. About 45-degree angles will probably be the most used, unless for some reason of design, the spiral angle of one gear must be greater than that of the other. In using trigonometric tables to find values to satisfy the equation given, use first tenths only for trial, then hundredths, and so on, as the required value is approached. This shortens the work considerably. In solving this last equation, a table of functions, giving values to minutes, is necessary, as the value of its right-hand member must be to thousandths of an inch.

* * *

MILLING SCREW MACHINE CAMS*

By LEWIS A. WHITE†

The method of milling cam lobes for the Brown & Sharpe screw machine cams by using the vertical milling attachment and the spiral geared universal head, was described in an article entitled "Milling Screw Machine Cams," in the January, 1911, number of MACHINERY, engineering edition. In this article a method for calculating the angle to which the index head and milling attachment are to be set, was also given. This angle is determined with reference to the lead of the cam lobe and the spiral lead for which the milling machine is geared, and the general rule for finding the angle is as follows:

The sine of the angle to which to set the index head and vertical milling attachment equals the lead of the cam lobe divided by the spiral lead.

From this rule the required angle can, of course, be found by carrying out the required calculations. In the article previously referred to a method was outlined by means of which a spiral lead could be so selected that the angle would be within five minutes of either a whole or a half degree, as this facilitates accurate setting. In the following, a method is given, by means of which, by adopting certain constant spiral leads, the angle to which to set the index head can be found without calculation when the lead of the cam lobe is known. As the calculation is eliminated, there are no chances of mistakes, and while the results obtained are approximate only, they are close enough for all practical purposes. The method is as follows: When constant spiral leads, as given in the accompanying table, are used, multiply the cam lead by 10, and the product equals the angle to which to set the index head in degrees and decimals of a degree. (To multiply the cam lead by 10, simply move the decimal point one figure to the right.)

TABLE OF CONSTANT SPIRAL LEADS

Spiral Lead	Cam Lead	Greatest Error in Setting
5.76	From 0.00 to 1.40	4 minutes
5.818	From 1.41 to 2.00	6 minutes

The spiral lead of 5.76 can be used for most cross-slide and many lead cam lobes.

Example: Find the angle to which to set the index head when the lead of the cam lobe is 0.725 inch?

From the table given we find that the lead of spiral to be used in this case is 5.76, and from the rule given the angle is found to be 7.25 degrees, or 7 degrees 15 minutes. As the theoretically correct setting angle is 7 degrees 14 minutes, the approximation, it will be seen, is closer than the accuracy it is possible to obtain in setting the index head to its graduations. The index head cannot be set very much closer than to one-third or one-quarter degree. This accuracy can be obtained, however, if care is taken.

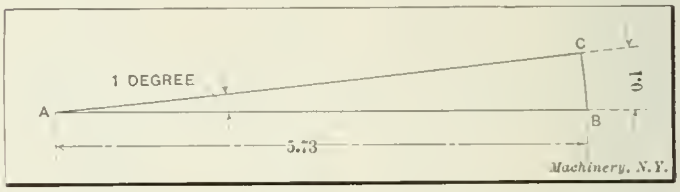

Illustration of Principle on which Method for Finding Setting Angle is based

[The readers of MACHINERY will be interested in the method by means of which the constant spiral leads are obtained. Assume that in the accompanying illustration line *BC* represents the lead of the screw machine cam, and that this lead is 0.1 inch. Assume further that the setting angle *BAC* is found by the rule given by the author. This angle is then 1 degree. The corresponding spiral lead is $\frac{0.1}{\sin 1 \text{ deg.}} = \frac{0.1}{0.01745}$ = 5.73. If the sines of angles were proportional to the angles as expressed in degrees and minutes, we could now adopt 5.73 as a constant spiral lead, and find the setting angles by multiplying the cam lead by 10, as explained. The sines of angles, are, however, not directly proportional to the angles, but increase at a rate somewhat less than that of the angles. Hence, in order to obtain a closer approximation by the method outlined we do not adopt 5.73 for the constant spiral lead, but a slightly greater lead; hence 5.76 is adopted for the smaller cam leads and angles and 5.818 for the greater leads and angles. These values, of course, are determined by trial, the object being to introduce as small an error as possible. A still smaller error would be introduced by using the intermediate lead 5.788 for the intermediate cam leads, but as the greatest error now introduced does in no case exceed 6 minutes, this additional lead is not required. The advantage of using as few constant leads as possible is that the gearing may be left intact while cams with slightly different leads are being milled.—EDITOR.]

* * *

The small end of the taper plug gage is the basis for measurement of taper shanks. Hence if a shank is shorter than the standard, it will carry the number of the standard if its small end corresponds in diameter to that of the plug. For example, a screw slotting bushing 0.450 inch diameter at the small end, 1 inch long, having a taper of ½ inch to the foot, is the B. & S. No. 5 taper, and so on.

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* See MACHINERY, engineering edition, January, 1911: "Milling Screw Machine Cams."

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MAKING THE RONEO PENCIL SHARPENER

The pencil sharpener shown assembled to the right in Fig. 1 is a small device that has been put on the market by the Roneo Co., 371 Broadway, New York City. This pencil sharpener is made for the Roneo Co. by the Sloan & Chace Mfg. Co., Newark, N. J., manufacturer of special machinery, tools and dies. The machining operations are mostly of the straight-work variety, the manufacturing operations deriving their chief interest from the product. However, there are some tools of interest employed which are worth while recording.

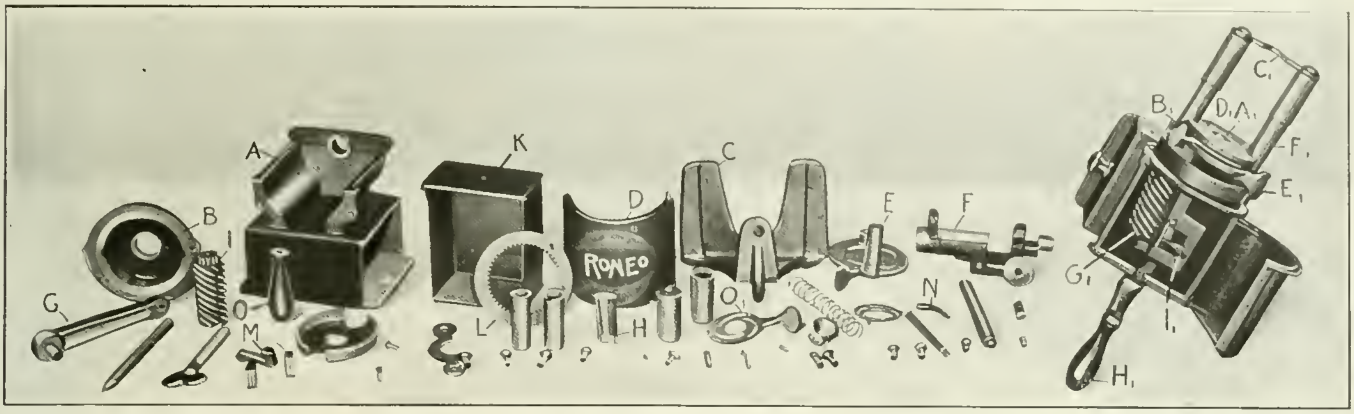

Fig. 1. The Roneo Pencil Sharpener before and after Assembling

Method of Operating the Roneo Pencil Sharpener

In operation, the pencil is placed in the jaws A_1, which are opened by depressing the thumb-lever B_1, the pencil being forced in against the helical cutter G_1, and resting in the groove in the plate C_1. The feed-body D_1 is then drawn back by pressing and pulling on the thumb-lever E_1. As this feed-body is acted upon by a spiral spring held in the hollow sleeve F_1, the pencil is automatically fed to the helical cutter G_1. All that is necessary now is to turn the handle H_1 to the right. A fine or blunt point can be obtained by moving the thumb-stop I_1 in the required direction.

Manufacturing Operations

The main casting shown at *A* is made from cast iron, milled, drilled and then japanned. As the machining operations on this main casting are of a very simple character, they need not be described. The same remarks apply to the front cover shown at *B*. This casting, while being machined in the lathe, is held in a chuck provided with suitable jaws, and the casting is faced, the hole bored and reamed, and the shoulder or boss around the hole faced. After this, the casting is placed in a drill jig and the screw holes are drilled and tapped. Previous to the machining operations, the casting is japanned. The table clamp *C* is also a plain casting and passes through the japanning, drilling and tapping operations. The top cover shown at *D* is first japanned, then drilled and the name put on by the ordinary transfer method.

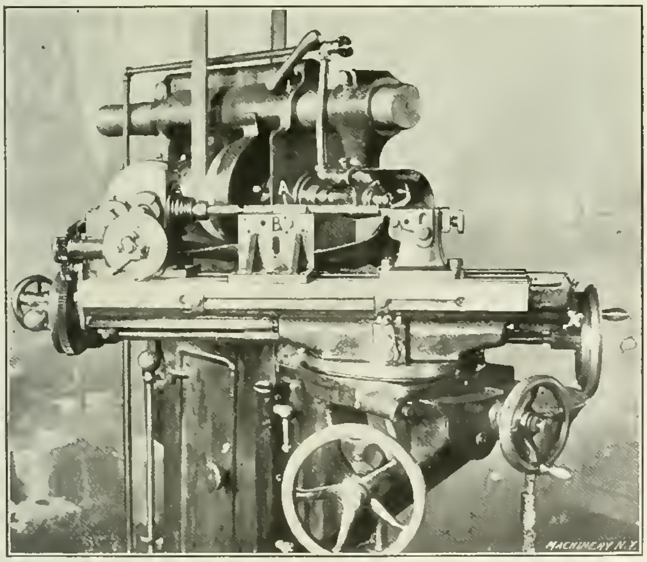

Fig. 2. Cutting the Teeth in the Bar from which the Six Helical Cutters are made

The feed-body shown at *E* is a plain casting which is japanned, then machined in the lathe and counterbored, after which the holes are drilled and tapped in a simple jig. The cutter holder *F* is made from cast iron and is japanned, then drilled and reamed, after which it is placed in a milling machine and milled to length. It is then placed in a pair of jaws held in an ordinary chuck in the lathe, when one end is turned; then the casting is reversed and the other end turned, drilled and tapped. The cast-iron crank lever *G* requires only one hole to be drilled in each boss; these holes are then tapped and the screw is placed in the boss in one end on which the wooden handle *O* is fitted. The pencil controller *H* is a die-casting, and requires no machining operations except facing and tapping a hole in one end.

Making the Helical Cutter

Making the helical cutter, is possibly the most interesting operation on this pencil sharpener, and in fact this is the most important part. This helical cutter is shown at *I* with the pinion assembled. The first operation on this cutter is to turn up a bar from which six cutters are made. This bar is then notched on the end which is used for driving when forming the teeth. The rod is then placed in the milling machine, as shown in Fig. 2, where the grooves forming the teeth are cut, the rod resting on a block *A*, which is attached to an angle-plate *B*. The machine is set to cut a spiral giving a helix angle of 45 degrees; eight teeth are cut in the cutter.

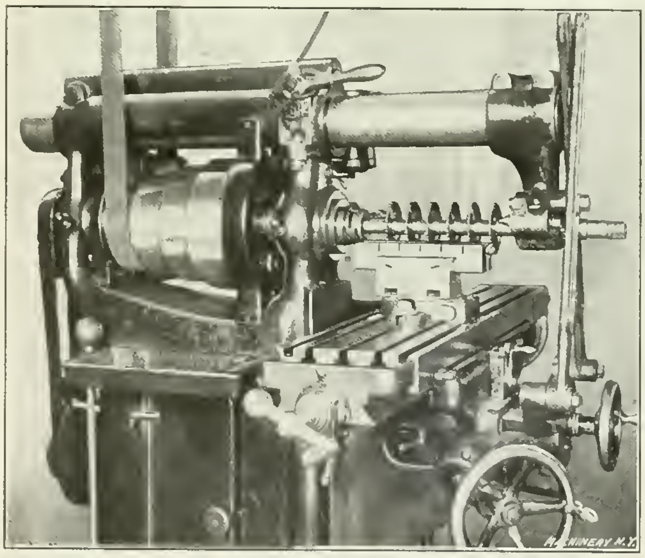

Fig. 3. Cutting the Helically-cut Bar into Lengths sufficient for Six Cutters

After cutting these grooves in the rod, it is taken to the milling machine shown in Fig. 3, where it is cut up into the desired lengths. The device for holding the bar while cutting is a simple fixture, consisting of vise jaws provided with V-grooves in which the bar is held, and six circular saws are used to cut up the bars to the required lengths. The next operation is to bore and tap the hole in the cutter for the reception of the pinion. This operation is accomplished in a hand screw machine, and as it is of a simple character needs no description. After the drilling and tapping operation, the cutter is then ready for hardening, and after hardening the pinion is assembled in it.

The teeth in this cutter are under-cut so that a knife-edge will be formed, which is conducive to free and clean cutting. The cutter is also ground, and a special machine has been rigged up for performing this operation. This machine is shown in Fig. 4. The cutter is mounted on the centers, and is guided by a pin *A* which fits in the grooves of the cutter. This pin rotates the cutter as the carriage travels back and forth. The pin *A* is carried past the end of the cutter, so that the latter can be indexed for each succeeding tooth. The indexing is accomplished by a link *B* which imparts an oscillating motion to the disk *C*. This disk *C*, in turn, moves a finger *D* which indexes the cutter for each tooth. The finger *D* operates the disk against the tension of the spring *E*. The indexing of this machine is entirely automatic.

Tools for the Dust Pan and Internal Gear

The next part of interest is the dust pan, which is shown at *K* in Fig. 1. This pan is first blanked with the sub-press punch and die* shown in Fig. 5, where the blank is also shown. The hole in which the knob is held is also punched in this operation.

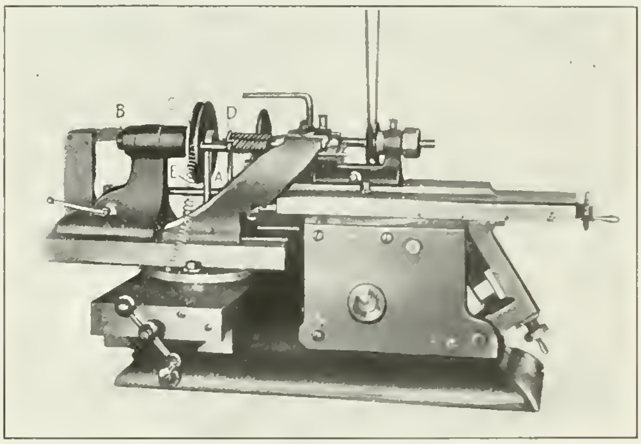

Fig. 4. Grinding the Teeth of the Helical Cutter in a Semi-automatic Machine

The next operation is the drawing up of the box, which is accomplished in the punch and die shown to the right in Fig. 6. The blank is located in the correct position by the guides *A*, and as the punch *B* descends, it forces the blank down into the die, thus drawing up the sides of the box. As will be noticed this box is drawn with square corners, which is easily accomplished by this method of manufacture. The die-stripper *C*, of course, is actuated by springs held in the die-bolster. A completed dust pan is shown at *D* standing on top of the punch.

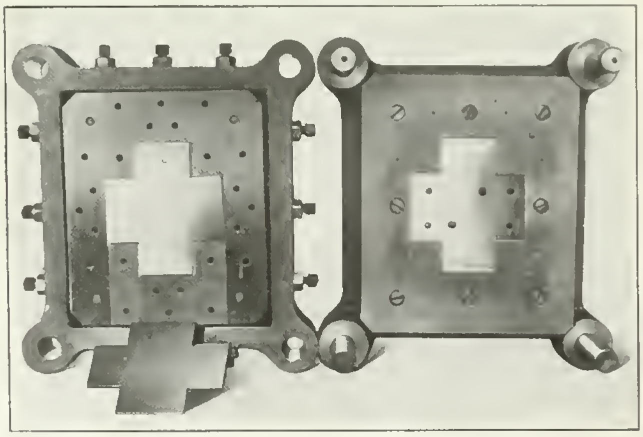

Fig. 5. Sub-press Punch and Die for Blanking out the Dust Pan

Another interesting sub-press punch and die, shown to the left in Fig. 6, blanks out the internal gear shown at *L* in Fig. 1. The teeth are formed in the same operation. This die is of the ordinary sub-press construction, but, as the reader will see, it is a fine piece of tool work. Two blanks are shown at *E*, beside the punch and die. *F* is the punch-holder and *G* the die-holder.

Referring to Fig. 1, three pencil jaws shown at *M* are blanked out in a punch and die of sub-press construction, then casehardened and nickel-plated, after which the three blanks are riveted together, thus making one jaw. Three of these completed jaws (nine blanks in all) are required in each pencil sharpener. The point adjustment lever, which is shown at *N* Fig. 1, is blanked and pierced in one operation, and then bent in a simple bending die. This point adjustment lever is so made that by moving it in one direction the point of the pencil passes over the top of the lever, while if moved in the other direction the point comes against the lever. This provides for making a sharp or blunt point on the pencil as desired.

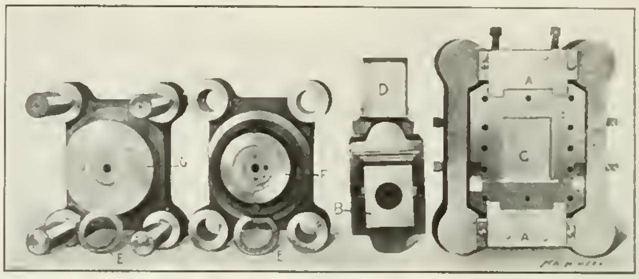

Fig. 6. Sub-press Punches and Dies for Forming the Dust Pan and Blanking the Internal Gear

The jaw adjuster shown at *O* is blanked out in the punch press, after which it is placed in another die where the eccentric slots are cut. Small pins driven into the jaws fit into these eccentric slots, and in this way the jaws are adjusted to hold various sizes and shapes of pencils. The range of the jaws is from 3/16 to 7/16 inch. After the eccentric slots are cut out, the handle is bent in a simple bending die. All the other parts shown in Fig. 1 are produced by simple operations—in punch presses and screw machines—and need no description.

Fig. 7. View of the Assembling Room

This simple little device requires a large number of machining operations, and has a greater number of parts than would at first be thought necessary. However, each part has its own peculiar function to perform, and adds to the efficient operation of the pencil sharpener. The final assembling of the parts is practically all done by hand, some of the parts being assembled during the process of manufacture. A general view of the assembling room is shown in Fig. 7. About 200 of these pencil sharpeners are turned out per day by the Sloan & Chace Mfg. Co.

D. T. H.

* * *

The dust produced in grinding brass castings is a valuable consideration and should be caught and saved because of its intrinsic value—also to preserve the health and comfort of the operatives. One of the makers of disk grinders provides a simple exhaust hood which gathers all the dust and deposits it into a barrel. This dust more than paid for the operator's time in finishing brass scale beams from the sides of which about 1/32 inch was removed.

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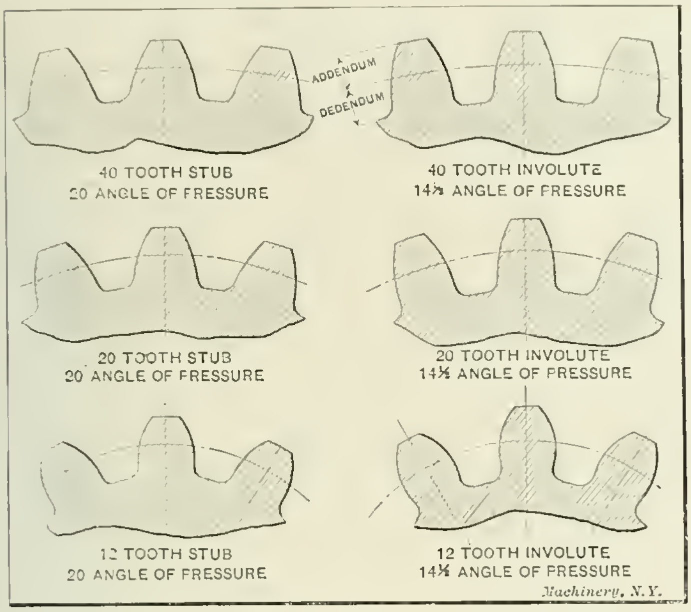
*For a detailed description of sub-press die construction, see "Sub-Press Work at the Sloan & Chace Shops," December, 1906, engineering edition, and MACHINERY'S Reference Series Book, No. 26, "Modern Punch and Die Construction."

THE STUB GEAR-TOOTH*

By V. BROCKBANK†

Ever since the stub gear-tooth began to be advocated a few years ago, the demand for gears with this type of tooth has steadily increased. Its application has been particularly successful in the case of automobiles, as increased efficiency and excellent results in all respects have been obtained. A comparison with the usual form of gear tooth will be of interest. We have on the one hand the ordinary involute tooth of 14½-degree angle of pressure, with an addendum of 0.3183 times the circular pitch and a dedendum of 0.3683 times the circular pitch. In the stub gear-tooth, on the other hand, we have an angle of pressure of 20 degrees, with an addendum of 0.250 and a dedendum of 0.300 times the circular pitch.



Comparison between Standard and Stub Type Gear Teeth

DIAMETRAL PITCH GEAR TOOTH PARTS FOR STUB TEETH

Diametral Pitch	Equivalent Circular Pitch	Thickness of Tooth on Pitch Line	Addendum	Working Depth	Depth of Space below Pitch Line	Whole Depth
½	6.2382	3.1416	1.5708	3.1416	1.8849	3.4557
¾	4.1888	2.0944	1.0472	2.0944	1.2566	2.3038
1	3.1416	1.5708	0.7854	1.5708	0.9424	1.7278
1¼	2.5133	1.2566	0.6283	1.2566	0.7539	1.3822
1½	2.0944	1.0472	0.5236	1.0472	0.6283	1.1519
1¾	1.7952	0.8976	0.4488	0.8976	0.5385	0.9873
2	1.5708	0.7854	0.3927	0.7854	0.4712	0.8639
2¼	1.3963	0.6981	0.3490	0.6981	0.4188	0.7678
2½	1.2566	0.6283	0.3141	0.6283	0.3769	0.6910
2¾	1.1424	0.5712	0.2856	0.5712	0.3427	0.6283
3	1.0472	0.5236	0.2618	0.5236	0.3141	0.5759
3½	0.8976	0.4488	0.2244	0.4488	0.2692	0.4936
4	0.7854	0.3927	0.1963	0.3927	0.2355	0.4318
5	0.6283	0.3141	0.1570	0.3142	0.1884	0.3451
6	0.5236	0.2618	0.1309	0.2618	0.1571	0.2880
7	0.4488	0.2244	0.1122	0.2244	0.1346	0.2468
8	0.3927	0.1963	0.0981	0.1963	0.1177	0.2158
9	0.3491	0.1745	0.0872	0.1745	0.1046	0.1918
10	0.3142	0.1571	0.0785	0.1571	0.0942	0.1727
11	0.2856	0.1428	0.0714	0.1428	0.0857	0.1571
12	0.2618	0.1309	0.0654	0.1309	0.0785	0.1439
13	0.2417	0.1268	0.0604	0.1208	0.0725	0.1329
14	0.2244	0.1122	0.0561	0.1122	0.0673	0.1234
15	0.2094	0.1047	0.0523	0.1047	0.0627	0.1150
16	0.1963	0.0982	0.0491	0.0982	0.0589	0.1080
17	0.1848	0.0924	0.0462	0.0924	0.0554	0.1016
18	0.1745	0.0873	0.0436	0.0873	0.0523	0 0959
19	0.1653	0.0827	0.0413	0.0827	0 0495	0.0908
20	0.1571	0.0785	0.0392	0.0785	0.0470	0.0862
22	0.1428	0.0714	0.0357	0.0714	0.0423	0.0785
24	0.1309	0.0654	0.0327	0.0654	0.0392	0.0719
26	0.1208	0.0604	0.0302	0.0604	0.0362	0.0664
28	0.1122	0.0561	0.0280	0.0561	0.0336	0.0616
30	0.1047	0.0524	0.0262	0.0524	0.0313	0.0575
32	0.0982	0.0491	0.0245	0.0491	0.0294	0.0539
34	0.0924	0.0462	0.0231	0.0462	0.0277	0.0508
36	0.0873	0.0436	0.0218	0.0436	0.0261	0.0479

The first proportions of stub gear-teeth, which are still used to a fairly large extent, were not according to the dimensions just given, but were based on the use of two diametral pitches; one diametral pitch, say 8, was used to obtain the addendum and dedendum, while another diametral pitch, say 6, was used to obtain the thickness of the tooth, and the number of teeth, etc. The chief disadvantages of this system are that the depth of the tooth is not a direct function of the circular pitch, and that this system can be used only in combination with diametral pitch gears. When the stub gear-tooth is made according to the proportions given in the first paragraph of this article, the system can be applied to either diametral, circular, or millimeter pitch gears. In the accompanying illustration it will be seen that the strength of the stub gear-tooth is considerably greater than the strength of the corresponding standard gear tooth, the increase in strength amounting in some cases, for a small number of teeth, to nearly one hundred per cent. It has been said that the increased angle of pressure of the stub gear-tooth system increases the pressure on the bearings, but this increase is very slight, theoretically, and may be ignored in practice. The sliding contact of the teeth diminishes as the pressure increases.

CIRCULAR PITCH GEAR TOOTH PARTS FOR STUB TEETH

Circular Pitch	Circular Pitch (Decimal Equivalent)	Diametral Pitch	Thickness of Tooth on Pitch Line	Addendum	Working Depth	Depth of Space below Pitch Line	Whole Depth
2	2.0000	1.5708	1.0000	0.5000	1.0000	0.6060	1.1000
1 7/8	1.8750	1.6755	0.9375	0.4687	0.9375	0.5624	1.0311
1 3/4	1.7500	1.7952	0.8750	0.4375	0.8750	0.5250	0.9625
1 5/8	1.6250	1.9333	0.8125	0.4062	0.8125	0.4874	0.8936
1 1/2	1.5000	2.0944	0.7500	0.3750	0.7500	0.4500	0.8250
1 7/16	1.4375	2.1855	0.7187	0.3593	0.7187	0.4311	0.7904
1 3/8	1.3750	2.2848	0.6875	0.3437	0.6875	0.4124	0.7561
1 1/3	1.3333	2.3562	0.6666	0.3333	0.6666	0.3999	0.7332
1 5/16	1.3125	2.3936	0.6562	0.3281	0.6562	0.3937	0.7218
1 1/4	1.2500	2.5133	0.6250	0.3125	0.6250	0.3750	0.6875
1 3/16	1.1875	2.6456	0.5937	0.2968	0.5937	0.3561	0.6529
1 1/8	1.1250	2.7925	0.5625	0.2812	0.5625	0.3374	0.6186
1 1/16	1.0625	2.9568	0.5312	0.2656	0.5312	0.3187	0.5843
1	1.0000	3.1416	0.5000	0.2500	0.5000	0.3000	0.5500
15/16	0.9375	3.3510	0.4687	0.2343	0.4687	0.2811	0.5154
7/8	0.8750	3.5904	0.4375	0.2187	0.4375	0.2624	0.4811
13/16	0.8125	3.8666	0.4062	0.2031	0.4062	0.2437	0.4468
3/4	0.7500	4.1888	0.3750	0.1875	0.3750	0.2250	0.4125
11/16	0.6875	4.5696	0.3437	0.1718	0.3437	0.2061	0.3779
2/3	0.6666	4.7124	0.3333	0.1666	0.3333	0.1999	0.3666
5/8	0.6250	5.0265	0.3125	0.1562	0.3125	0 1874	0.3436
9/16	0.5625	5.5851	0.2812	0.1400	0.2812	0.1687	0.3093
1/2	0.5000	6.2832	0.2500	0.1250	0.2500	0.1500	0.2750
7/16	0.4375	7.1808	0.2187	0.1093	0.2187	0.1311	0.2404
3/8	0.3750	8.3776	0.1875	0.0937	0.1875	0.1124	0.2061
1/3	0.3333	9.4248	0.1666	0.0833	0.1666	0.0999	0.1832
5/16	0.3125	10.0531	0.1562	0.0781	0.1562	0.0937	0.1718
1/4	0.2500	12.5664	0.1250	0.0625	0.1250	0.0750	0.1375
1/5	0.2000	15.7080	0.1000	0.0500	0.1000	0.0600	0.1100
3/16	0.1875	16.7552	0.0937	0.0468	0.0937	0.0561	0.1029
1/6	0.1666	18.8496	0.0833	0.0416	0.0833	0.0499	0.0915
1/8	0.1250	25.1327	0.0625	0.0312	0.0625	0.0374	0.0686
1/9	0.1111	28.2743	0.0555	0.0277	0.0555	0.0332	0.0609
1/10	0.1000	31.4159	0.0500	0.0250	0.0500	0.0300	0.0550
1/16	0.0625	50.2655	0.0312	0.0156	0.0312	0.0187	0.0343
1/20	0.0500	62.8318	0.0250	0.0125	0.0250	0.0150	0.0275

The advantages of the stub tooth may be stated as follows:

1. Greater strength.
2. Equal arc of rolling contact to the 14½-degree involute.
3. Extreme sliding contact avoided.
4. More even wearing contact.

As a disadvantage it may be mentioned that we require a greater number of rotary cutters to cover a given range of teeth. For the standard involute system eight cutters are required, whereas the stub-tooth system requires sixteen in order to produce good gears. When a generating machine, such as the Fellows gear shaper is used, only one cutter is required for each pitch, as the cutting action of this machine is that of a pinion meshing with a gear-wheel.

The tables accompanying this article give the dimensions of stub-tooth parts for diametral and circular pitches, and for modules given according to the metric system. These tables are based on an addendum of 0.250 and a dedendum of 0.300 times the circular pitch, as stated above.

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* See also MACHINERY, engineering edition, April, 1908: "The Stub-tooth Gear."

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MILLIMETER MODULE GEAR TOOTH PARTS FOR STUB TEETH

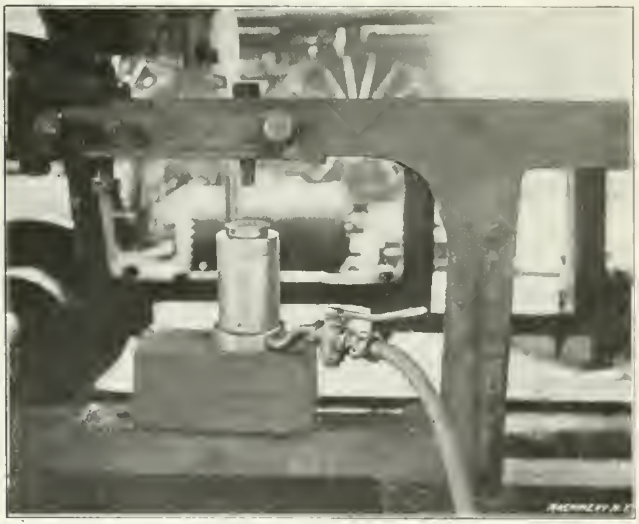
Millimeter Module	Circular Pitch in Inches	Thickness of Tooth on Pitch Line	Addendum in Inches	Working Depth	Depth of Space below Pitch Line	Whole Depth of Tooth
1	0.1236	0.0618	0.0309	0.0618	0.0371	0.0680
1¼	0.1546	0.0773	0.0386	0.0773	0.0463	0.0849
1½	0.1855	0.0927	0.0463	0.0927	0.0555	0.1018
1¾	0.2164	0.1082	0.0541	0.1082	0.0649	0.1190
2	0.2473	0.1236	0.0618	0.1236	0.0741	0.1359
2¼	0.2783	0.1391	0.0695	0.1391	0.0834	0.1529
2½	0.3092	0.1546	0.0773	0.1546	0.0927	0.1700
2¾	0.3401	0.1700	0.0850	0.1700	0.1020	0.1870
3	0.3710	0.1855	0.0927	0.1855	0.1112	0.2039
3½	0.4329	0.2164	0.1082	0.2164	0.1298	0.2380
4	0.4947	0.2473	0.1236	0.2473	0.1483	0.2719
4½	0.5566	0.2783	0.1391	0.2783	0.1669	0.3060
5	0.6184	0.3092	0.1546	0.3092	0.1855	0.3401
5½	0.6802	0.3401	0.1700	0.3401	0.2040	0.3740
6	0.7421	0.3710	0.1855	0.3710	0.2226	0.4081
7	0.8658	0.4329	0.2164	0.4329	0.2597	0.4761
8	0.9895	0.4947	0.2473	0.4947	0.2967	0.5440
9	1.1131	0.5565	0.2782	0.5565	0.3338	0.6120
10	1.2368	0.6184	0.3092	0.6184	0.3710	0.6802
11	1.3605	0.6802	0.3401	0.6802	0.4081	0.7482
12	1.4842	0.7421	0.3710	0.7421	0.4452	0.8162
14	1.7316	0.8658	0.4329	0.8658	0.5194	0.9523
16	1.9789	0.9894	0.4947	0.9894	0.5936	1.0883

* * *

PNEUMATIC BOLT KNOCKER

Driving out locomotive frame bolts is one of the jobs in a railway shop that sometimes causes trouble, as occasionally a bolt cannot be budged by ordinary means and it is necessary to resort to drilling. Small cannon are used in some shops for shooting out tight bolts, and while this method is very successful, it is also rather dangerous, as the cannon frequently does more than is necessary: it knocks out the bolt and sends it up through the shop roof for good measure.

A very effective and safe device for removing frame bolts is shown in the illustration. This is a pneumatically operated "bolt knocker," consisting simply of a cylinder and plunger. Connection is made with the pneumatic hammer "air line" and the movements of the plunger are controlled by the valve shown, the valve being opened to admit air beneath the plunger for each stroke. The plunger in its "down" position should be a little distance from the bolt, as the illustration shows, to obtain a good blow. The plunger of this particular knocker has a shoulder on its lower end that engages a corresponding shoulder in the cylinder when in its highest position. Were it not for this feature, the plunger might inadvertently be forced out with disastrous results; in fact, the lack of such a safety device on a tool of this kind resulted in the loss of at least one life. This type of knocker is used in the Chambersburg shops of the Cumberland Valley R. R.



Pneumatic Bolt Knocker for Removing Locomotive Frame Bolts

THE PHOROGRAPH

By FREDERICK H. MOODY*

Mechanisms, in general, present but little difficulty in the analysis for the determination of the relative movements of the various members; anything, however, that tends to simplify such an analysis is generally welcomed by designers. A number of systems have been devised and tried out with more or less success, but the majority of them have been eventually dropped for the pure and simple drafting-board method.

The method of analysis to be here described has all the desired advantages; it is simple and may be rapidly applied. It was originated by Mr. T. R. Rosebrugh, professor of electrical engineering at the University of Toronto, and was called by him the "phorograph." So simple did it seem that it has been adopted for instructive purposes by the mechanical engineering department of that institution. It might incidentally be mentioned that Prof. Rosebrugh has invented several graphical systems of analysis, as applied to vectoral analysis of different conditions, one of which, in particular, might be noted; it is a system of thoroughly analyzing alternating-current circuits, considering the various phenomena due to phase relations, etc., for both motor and generator. This graphical solution of an otherwise complex subject is remarkably simple, and considers all phases of the subject in a manner quite as thoroughly as would an analytical solution, the graphical method having the added advantage of making the errors possible of ready detection, as well as rendering the problem capable of an easy solution by bringing the visual organs into play with the reasoning faculties.

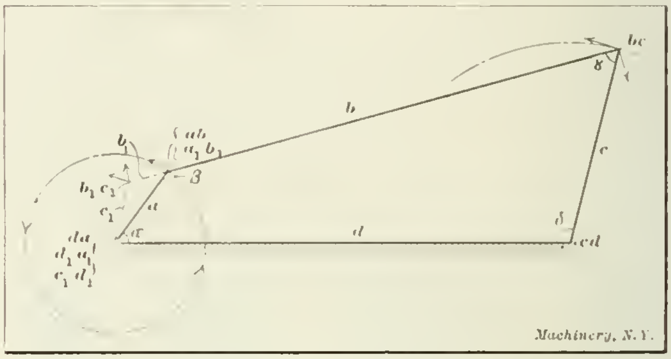


Fig. 1. Simple Four-link Mechanism to illustrate the Theory of the Phorograph

To return to the subject: The system is based on the fact that in nearly all mechanisms there is at least one member revolving at a uniform speed, and to which the motion of all the other parts moving at variable speeds is referred. This is true in such common examples as the steam engine with its uniformly revolving crank; the shaper, with its constant-speed drive shaft; the slotter, with its constant-speed shaft; and many other similar mechanisms too numerous to mention.

As an example, consider the plain four-link mechanism, shown in Fig. 1, the links being *a*, *b*, *c* and *d*, of which *a* is revolving at a uniform speed and *d* is stationary, representing the frame. It is clear that links *b* and *c* are moving at speeds depending on their relative locations with regard to constant-speed link *a*. If, by some means, a point on the link *a* could be found that would have exactly the same speed as some point on the link *c* at a given instant, the velocity of that point on link *c* would be fully determined, since the speed of each of the many points on link *a* is known from its constant rotative motion. As a means of designating, call the joints of the links the combined letters of the adjacent links; thus, the joint between link *a* and *b* is *ab*.

If the link *a* be revolved in the direction indicated, up to a certain point the angle β will continue to decrease. This means that while the link *a* is revolved in a counter-clockwise manner with respect to stationary part *d*, the link *b* is revolved in a clockwise manner with respect to the moving link *a*. Thus, any point on link *b* produced, to the left of joint *ab*, is moving upward with respect to *a*, while points on *b* to the right are moving downward. Bear in mind, however, that every point in b, and b produced, has exactly the same direction of motion relative to the point of revolution ab, and every point in b to the right of ab has a point to the left of ab that has an exactly similar motion. This equivalent point, for lack of a better name, is called the "image" of the real point and is indicated by sub-letters; thus, the point bc in the link b has a counterpart or image b_1c_1 somewhere along the line b produced, to the left of ab. Due consideration must be given to the fact that link b will only revolve counter-clockwise until a and c are parallel, after which they move in the same rotary direction. This depends on whether or not b_1 c_1 and bc are on the same side of ab. For matters of explanation, this feature need not be dwelt upon.

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Now consider the point bc as a point in the link c instead of in link b. As such, its motion is in a counter-clockwise direction with regard to the center of rotation cd. Since the link d is stationary, any point on any link pivoted to d and parallel to c will have a motion in the same direction as any point in c. Hence, if through point da a line be drawn parallel to c, some point in it will have a motion about da exactly the same as the point bc about cd; but some point in b produced has a motion similar to point bc considered as a point in b. Therefore the point b_1c_1 where these two constructed lines intersect will be the image of the point bc. Hence, the point b_1c_1 has all its motions about da exactly the same as the original point bc about cd. It must be remembered, however, that these images are only instantaneous; that is, for every new position of each of the links the images change location.

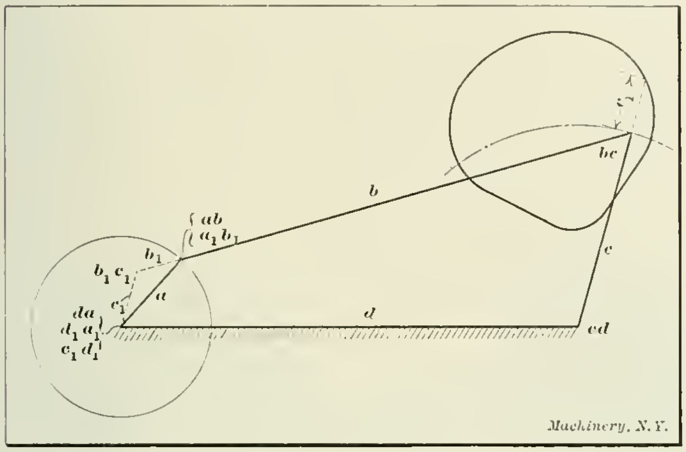

Fig. 2. Simple Four-link Mechanism showing the Application of the Phorograph

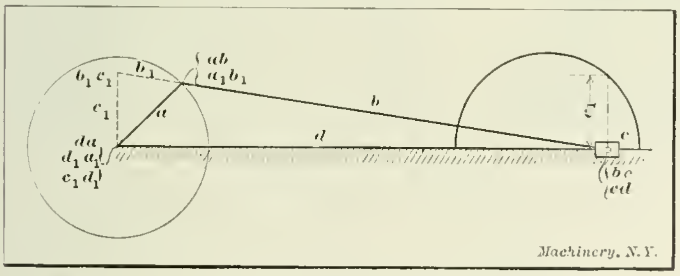

Fig 3. Four-link Mechanism, One Member of which is sliding as in an Engine, analyzed by the Phorograph

The link c_1 will then be the image of the real link c. If the length of a be a measure of the velocity of the point ab to some scale, the length c_1 will represent the instantaneous velocity of the point bc to the same scale. There is thus provided a ready means of determining the velocity of any point in the mechanism by "imaging" it onto the constant-speed link a. (The link a is considered as a large member of sufficient size to include the images in all positions.)

The point da will, of course, be its own image, being already on a. Similarly the image of ab and the point ab are one and the same; the image of cd will be at the point da. The underlying idea is to find images on the uniformly revolving link a that have exactly the same characteristics as the real points on their respective members; these images revolving instantaneously at a uniform speed, can thus have their speeds determined.

Fig. 2 shows an application of the phorograph to a similar mechanism. After determining the images b_1 and c_1 of links b and c for a number of different locations of the crank a, these different lengths c_1 are plotted along c from the point bc as indicated; the inverted pear-shaped diagram indicates the velocities of the point bc at the different positions along its path of motion.

Coming to a four-link mechanism in which one of the members is sliding, as in the engine mechanism indicated in Fig. 3, the conditions are somewhat different, but still the phorograph principle holds good: a is the constant-speed crank; b, the connecting-rod; c, the sliding crosshead; and d, the stationary frame. The junctures of b and c at bc, and c and d at cd, are coincident points, though it is quite apparent that the motion between b and c is quite different to that between c and d. As a point in b, the image of bc will be at b_1c_1, somewhere along bc produced; also as b_1c_1 has a horizontal motion, it must be in a vertical line through da, as only such points in a have a horizontal motion. Thus the image will be at the point where the two lines intersect, as indicated at b_1c_1. This image b_1c_1 may be obtained for any position of a.

A shaper mechanism is outlined in skeleton in Fig. 4. Here, a very simple means of analyzing the exact movements of the ram is shown. a is the crank; b, the sliding crank-block; c, the shaper lever; d, the frame; and e, the ram. The images of cd and da will be at the latter point, at the center of rotation of the constant-speed link a. As it revolves, the block b slides up and down c. The image a_1b_1 of the point ab—the joint between a and b—is that joint itself, as there is no relative link movement between the two. As a point in link b, the point bc moves in a line parallel to link c; as a point in the link c, it moves at right angles to the link c, so that the juncture of these two lines, at b_1c_1, is the image of the point bc. Being a point on the uniformly moving link a, it has the same movement as the original point bc. The distance between b_1c_1 and c_1d_1 corresponds to the distance between bc and cd; so in order to obtain the full image of the link c, we must join cd and b_1c_1, producing this line to meet a tangent from the point ce. From this point of intersection, drop a perpendicular to cut a line through c_1d_1 and b_1c_1 produced, in the point c_1e_1. The line between the points c_1d_1 and c_1e_1 is the image c_1 of the link c, obtained by simple proportion, this method of obtaining it being simply a constructional means of so doing. Laying out this distance c_1 from the point ce, for various positions of a, gives the velocity diagram of the ram to the same scale, as the length a represents the velocity of the point ab.

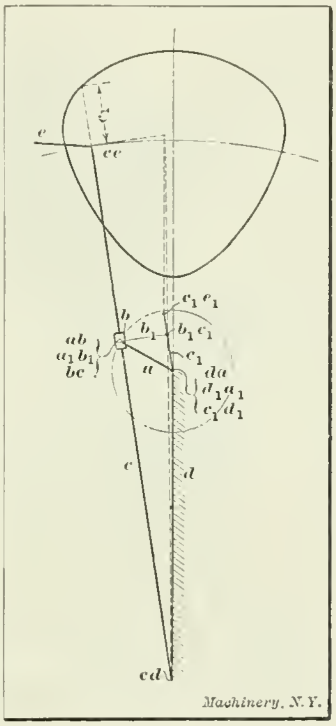

Fig. 4. Whitworth Quick-return Motion of a Shaper, analyzed by the Phorograph

Designers will find this phorograph of invaluable assistance in the analyzing of mechanisms. Although it may be difficult of comprehension at the first reading, a little practice will make its use quite simple.

* * *

It has been found difficult to make large steel gears out of steel castings on account of the difficulty of getting a perfectly sound casting. One machine tool builder in the Middle West, therefore, has abandoned the use of steel castings for large gears, and instead shrinks a forged steel ring onto a cast-iron gear body, much in the same way as tires are shrunk onto car wheel centers. Very satisfactory results are obtained in this way.

AUTOMATIC FEEDS FOR POWER PUNCHING PRESSES*

By HART PRESTON

Many articles formerly made of cast metals are now produced equally as strongly, and more cheaply, of stamped sheet metal through the adaptation of various automatic press-feeds. While the prime feature of all automatic feeds is the increased output which they effect, they also possess, in many cases, the valuable feature of reducing the number of operations, as well as the number of operators, required. Another important feature of automatic press-feeds is the safety which they insure to operators, as compared with the ordinary hand-fed presses. Various feeds are entirely automatic, the operator having only to keep the machines constantly supplied with the metal from which the punchings are made. However, on dial and other feeds which only automatically carry the work forward, under and away from the dies—especially on riveting, assembling, clinching and forming operations on pieces previously blanked or cut out in another press—an operator is required to feed each separate piece into the feeding mechanism.

As with all other machinery, simplicity and accuracy, combined with an increased output, are the prime essentials of automatic feeds for power punching presses. The illustrations accompanying this article show not only simple, accurate and positive automatic feed mechanisms, but in some instances, machines so nearly "human" that the operators simply sit idly by and "watch the machines do all the work." While the illustrations show the simpler types of automatic feeding devices, it is interesting to note that some of these devices have been perfected to such a degree that two or more of the various types of feeds mentioned are often combined in one press for automatically producing some of the most common hardware specialties—a case where rapid action, and consequent cheapness is very essential.

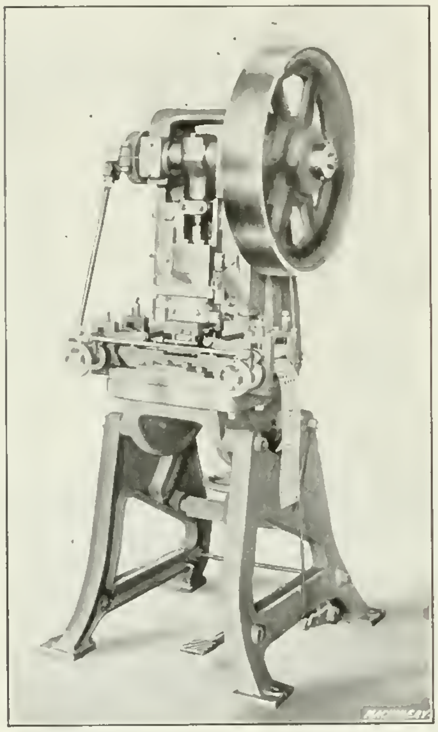

Fig. 1. Press with Double Roll Feed

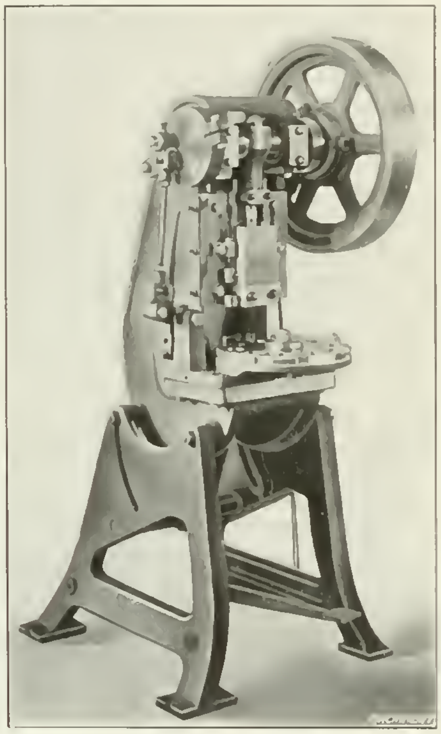

Fig. 2. Press with Dial Feed

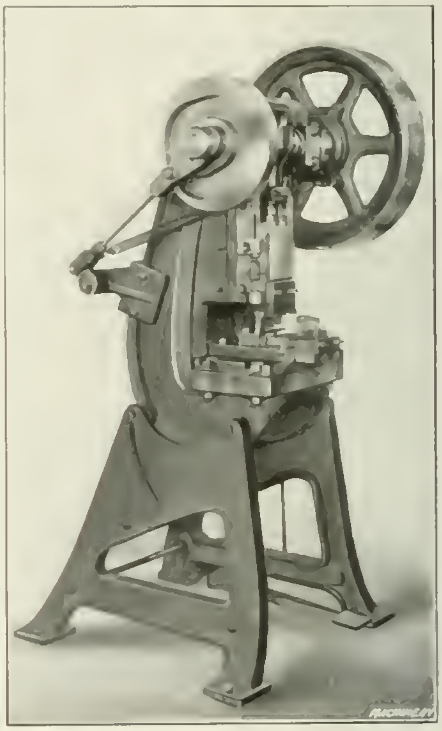

Fig. 3. Slide Feed Arrangement

Double Roll Feeding Attachment

Fig. 1 shows what is termed a double roll feed attached to an open-back inclinable power press. The press, when in use, is set on an incline, thus permitting the cut and formed work to automatically fall away from the dies by gravity. This style of feed is applicable to almost any type of press but, like most other feed mechanisms, it is adapted only to a limited range, namely work produced from a flat sheet or coil, either with plain blanking or cutting dies or with combination cutting and forming dies. Roll feeds consist of rolls of varying diameter and length, with a variable "feed-stroke," and while they insure accurate feeding and a saving in material, their actual value to each individual manufacturer depends primarily upon the size and shape of the article made, the construction of the dies, and whether single or gang dies are used.

The feeding device attached to the press in Fig. 1 is adjustable by sixteenths for feeding up to 1½ inch at each stroke of the press. The journals or boxes for supporting the rolls are adjustable to accommodate varying gages of metal. Pivoted releasing-levers or arms, bearing upward against powerful springs in each of the journals supporting the upper rolls, extend inwardly and under adjustable set-screws attached to the slide or ram of the press. Depending upon the manner in which they are attached, these roll feeding devices can be arranged to feed the stock from front to back or *vice versa*, or from right to left or *vice versa*. The stock is fed forward on the up-stroke or return of the shaft and slide, and as the slide descends, the set-screws mentioned, bearing down on the pivoted releasing-arms, lift up the upper rolls momentarily, releasing the pressure upon the strip of metal, so that, in the event of any unevenness in the thickness of the metal or any variation in the feeding, a pilot or guide-pin on the dies may locate the strip before the dies actually perform their work. The press and double-roll feed in Fig. 1, operating the gang dies shown, have a capacity for cutting six finished washers at each stroke of the press, running at 100 R. P. M.—an output of 360,000 washers per day of ten hours.

Fig. 4 shows a special double roll feeding mechanism operating on a straight-sided press equipped with gang dies for performing various operations on strip steel for expanded metal lath. The stock is fed into the machine in flat strips previously cut to the proper width. The first or forward set of rolls has a series of milled V-grooves for ribbing or V-ing the flat ribs longitudinally as they are fed into the machine. Passing from this first set of rolls into the dies, the strip is gradually slitted and expanded, and then automatically discharged by the rear set of rolls, which latter have, besides the V-grooves, a series of slots cut in them to match the shape of the stock that is slitted. This feeding device is adjustable for feeding up to 2 inches at each stroke of the press, the machine operating at 250 R. P. M.

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* For further information on this and kindred subjects, see MACHINERY, August, 1911, engineering edition, "Design of Power Presses and Shears," and other articles there referred to. See also MACHINERY, September, 1909, "Simple and Automatic Stop-pins for Press Work," and "Two Feed-stops of Wide Utility"; and MACHINERY'S Reference Book No. 13, second edition, Chapter V, "Stop-pins for Press Work," and Reference Book No. 26, second edition, Chapter VI, "Feed Stops for Presses."

Rack and Pinion Double Roll Feed

In Fig. 5 is shown a small open-back inclinable press fitted with another special double roll feeding mechanism. In this case, however, instead of having the eccentric or feeding arm connecting the cam on the shaft directly with the rolls, the drive is imparted from an eccentric on the shaft to a vertical-traveling rack, which, through its pinion and a series of bevel gears and an endless chain, acts as the drive for the rolls. This construction is what is termed a "rack-and-pinion" feed, and is resorted to in many cases where the work is of such a nature that it is desired to have the front of the press as open and free from arms as possible, to permit more ready accessibility to the dies and work. This is the prime reason for the use of this construction in this instance. The purpose of the press is the cutting out of corn plaster. The medicated cloth for the plasters, in strips about 4 inches wide and 48 inches long, is fed into the machine on a hard maple board of a slightly greater length and width, the board being fed forward about 1¾ inch at each stroke of the press. The work is performed by a group of hollow punches of the same construction as these regularly employed for cutting cloth, paper and other fibrous materials. Owing to the expense involved in the amount of unusable scrap or cut material, these dies are "staggered" or "zig-zagged" to permit cutting the plasters as close to each other as possible, thereby making use of the maximum amount of material in each strip. The first set of three punches cuts out only the center or "corn" opening, while, at the following stroke of the press, as the stock is fed forward, the second set of three punches cuts out the completed cloth ring for the plaster. The punches for cutting the center opening are so constructed that the cloth is pushed up into them, and gradually automatically ejected through an opening in the back of the slide or ram to which the punches are attached. After the second operation the cut disks or rings are removed or stripped from the punches (or, more literally speaking, cutting dies); they are left on the maple board and taken back to the work-bench where the simpler operations are performed by hand to finish the plaster. In the meantime another board with its strip has been fed into the machine. The machine operates at 100 R. P. M., producing 300 rings per minute.

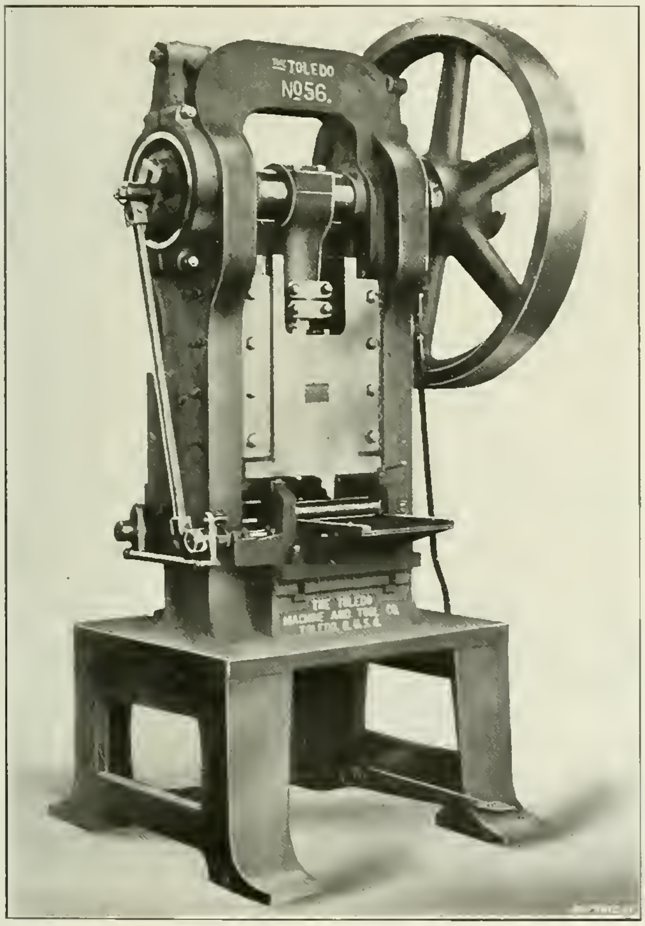

Fig. 4. Double Roll Feeding Mechanism attached to a Straight-sided Prese

Dial Feeds

Fig. 2 illustrates what is designated as a dial or rotating feed, because of the fact that the work is automatically carried forward to and away from the dies by a continually revolving dial or feeding-table. This table is operated by a pawl and ratchet connected with an eccentric attached to the shaft of the press. The feeding dials are provided with holes varying in number according to the size and shape of the work and the size of the bed of the press to which the feed is fitted. Into each of these holes is fitted a tool-steel bushing or chuck with a milled opening to match the shape of the piece to be operated upon. These bushings are removable, a different set of bushings being required for each shape or size of piece. To prevent the pieces from dropping through these openings in the bushings until the dial brings them to the dies, a stationary cast-iron plate is bolted onto the bolster or bed-plate of the press, directly beneath the revolving dial. This plate has only openings to correspond to the dies used. In some cases the cut pieces, ready to be formed, are automatically fed into the dial or rotating plate by a hopper or tube rigidly secured to the press bed. This, however, is feasible only on circular, square, or other regular shaped blanks. Irregular shaped blanks must in almost all cases be fed into the dial by hand, and as speed is the prime reason for the employment of this style of feed, it should be so arranged as to leave the front or feeding end of the press and feeding table as accessible as possible for the operation. This is the distinctive feature of the dial feeding mechanism shown in Fig. 2.

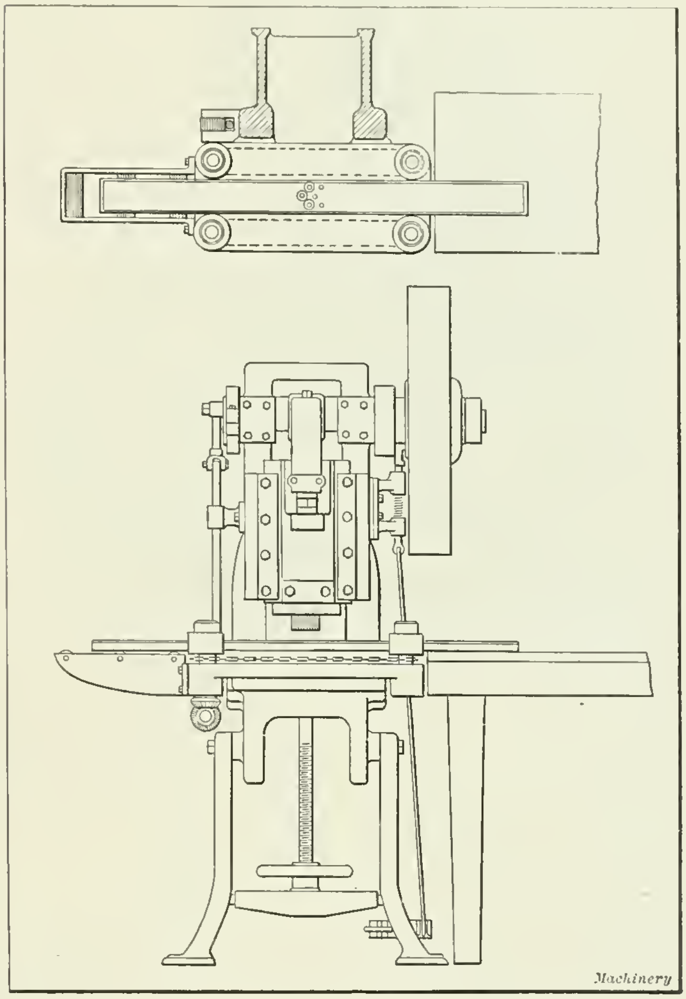

Fig. 5. Feed Arrangement used on Press for Cutting Corn Plasters

Dial-fed presses are widely used by manufacturers of curtain brackets, cartridges, torpedoes, locks, hardware, watches, and, in general, for articles requiring several forming operations, the dial feeding mechanism permitting of using gang dies for performing from one to four successive operations on certain classes of stampings in one press. One western telephone manufacturer uses one press fitted with a double-roll feed and ten other presses fitted with dial feeds for performing twenty-nine operations on a single stamping of light gage steel and of a very irregular shape.

The dial-fed press shown in Fig. 2 is also fitted with an automatic bottom lift-out (not shown) for ejecting the finished stampings from the dies, and with an automatic safety device attached to the trip-lever for the clutch, which automatically stops the press if the dial is not properly fed forward.

Coin and Hopper Feeds

The feed mechanism shown attached to a toggle-joint embossing or coining press in Fig. 6 was designed not only to facilitate the feeding and discharging of blanks that were to be embossed in this press, but also with a view of reducing the danger of hand feeding. This feeding attachment is entirely automatic in its action, the operator simply keeping the hopper or receiving tube properly filled with blanks (flat cut disks). The disks are carried, singly, from the tube directly onto the lower die by means of the swinging arm shown, which extends downward and is secured to the lower knuckle or rocking arm for operating the slide or pressure-ram. This arm is adjustable, and so arranged that feed fingers to suit work of different size and shape can be readily attached to it. While a different feed-finger and tube are necessary for each different piece of work, few changes or adjustments are required for changing over from one size to another, the changes being made in about fifteen minutes. After being embossed, the work is automatically discharged from the dies and press by means of a spring collar and two pivoted feed fingers, the latter being actuated by the two tapered pins shown attached to the front of the upper die-holder. This feeding device, when attached to the style press mentioned, operates at about 50 strokes per minute, and will handle work ranging from about 3/8 to 2 inches diameter. It can be used to advantage on regular-shaped work such as souvenir coins, medallions, trade-checks, telephone slugs, etc.

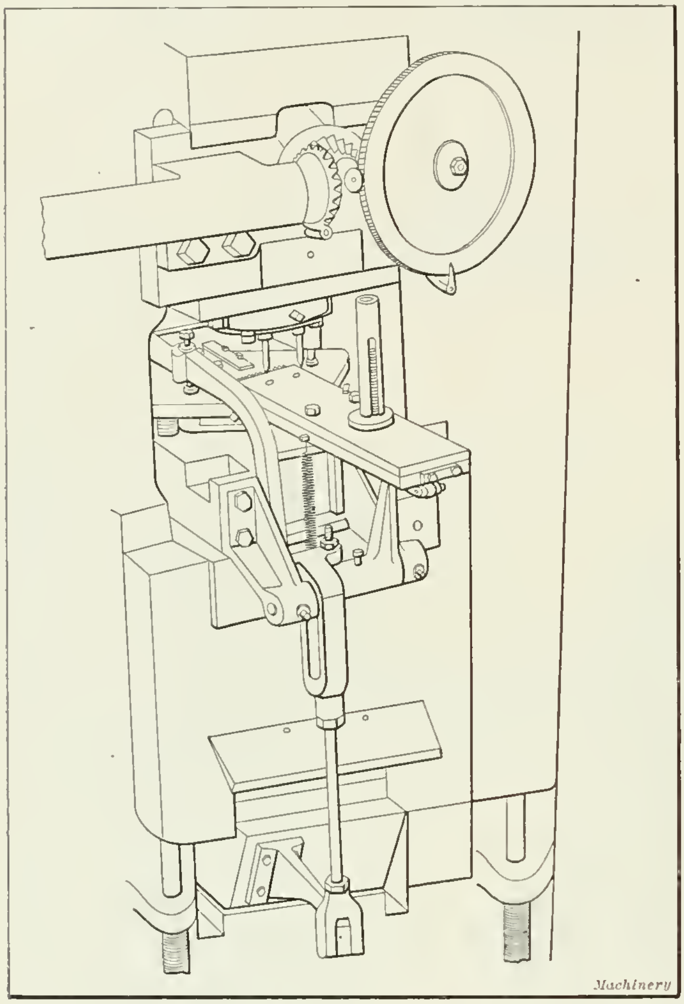

Fig. 6. Embossing Press with Coin or Hopper Feed

Slide Feeds

The feed mechanism attached to the small press in Fig. 3 is another "accident preventer," designed for use in connection with parts requiring forming operations, which, owing to the irregular shape of the pieces, make hand feeding necessary. Even experienced operators are at times careless in feeding or removing the work and, again, in starting the press. The slide feed shown eliminates accidents from such causes, as the only time that the operator's hands get into the dies is after the operation has been completed, the press stopped, and the dies returned to the front of the press for the removal of the finished piece, and the insertion of another. After placing the piece in the dies and "tripping" or starting the press, the dies are automatically carried back to their proper position under the forming punch by means of the toggle-arms connected to the cam and eccentric collar on the end of the shaft. This cam provides not only a positive, quick feed, but also a quick return of the dies to the front of the press after the work is finished. This style of feed is extensively employed in connection with the manufacture of small odd-shaped automobile radiator tubing, bottle caps, jewelry, and gas fixtures.

Chute and Hopper Feed

The development of the automatic manufacture of tin cans and articles of pieced tinware has brought out many automatic feeds and other press attachments. One of the most interesting automatic feeds for this class of work is that illustrated in Fig. 7. A horning and riveting press is here shown fitted up for automatically assembling and clinching together lard-pails and the ears for holding the wire which forms the pail-handle. Instead of the operator using one hand to hold the pail and the other to place the ear on the clinching die, he merely places the pail on the die, which is attached to the horn or mandrel shown, trips the press, and the punch, descending on the pail and ear, the latter being previously fed to and located on the lower die, securely clinches the two tightly together. The revolving hopper *A* is filled with ears, and as it rotates the ears fall by gravity through the various openings in the side or wall of the hopper and into

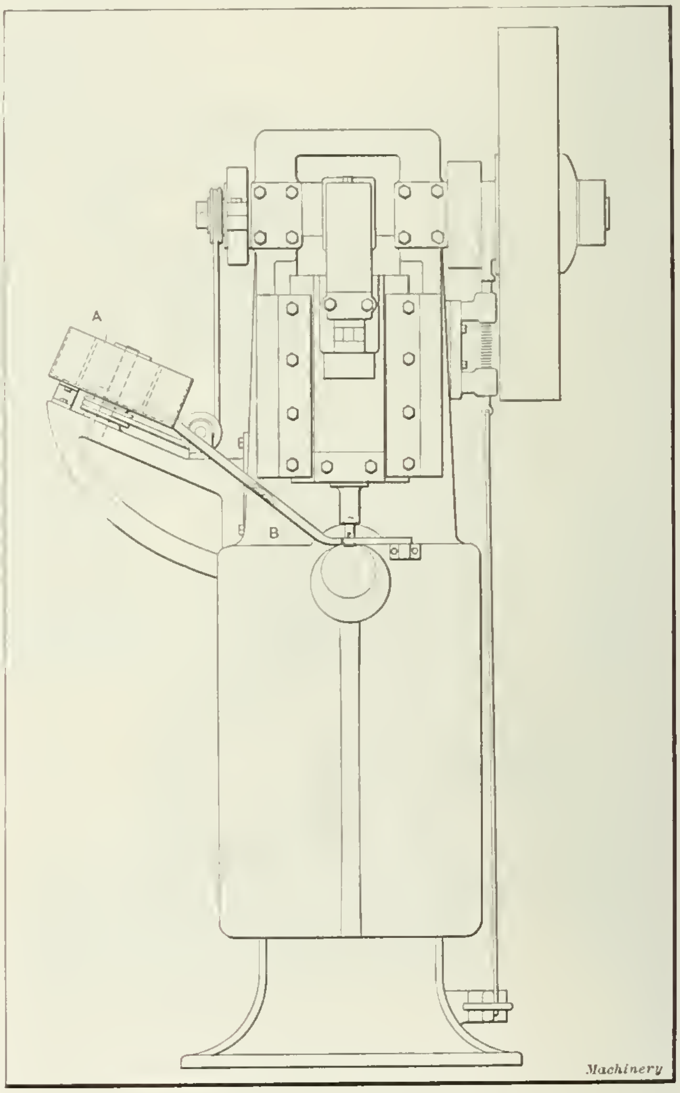

Fig. 7. Press with Chute and Hopper Feed Arrangement

the chute *B*. The chute does not convey the ears directly to the die, but to a point about 1¼ inch to the rear of the die. The press and dies are fitted with a sliding arm or feed finger located at the rear of the dies and connected with the slide or ram of the press proper by means of a pair of links. As the slide recedes from the work on the up-stroke, these links force the sliding feed-arm forward a fixed distance, and as the arm moves past the open end of the chute, it carries one ear forward and onto the dies. The arm remains in this position until the press is tripped. When the press is tripped and the slide descends, the motion of the links returns the feed-arm to its normal position at the rear of the dies, permitting another ear to slide down in front of it. This arrangement gives the operator the entire use of both hands, which is a big item in tinware factories where every operation is "piece-work." With the equipment described above, an operator can easily "ear" from three to four thousand pails per day of ten hours, each pail, of course, having two ears attached to it.

Automatic Perforating and Notching Devices

The automatic perforating and notching machines shown in Figs. 8 and 9 are of exceptional interest, and intended for unusual classes of work. Fig. 8 shows a horizontal perforating and notching press designed for perforating and notching gasoline tank-heads. The pieces to be operated on are centered and clamped in position between the clamping disks attached to the adjustable clamping arm shown. The press is then tripped, perforating a hole at each stroke of the press and running continuously until the entire periphery of the tank-head is perforated with rivet-holes, when the clutch is automatically disengaged and the press stopped. The finished work is then removed and another piece inserted. The press operates at a speed of about 100 strokes per minute, and has a capacity for work of from 24 to 60 inches diameter. Changes to suit different diameters of work and varying spacing of the perforations or notches can be quickly made.

Fig. 9 shows an upright perforating press and attachments for perforating the openings in the sides of strainer drums for cider presses. While this work could undoubtedly be performed more quickly "in the flat" by perforating several complete rows of the holes at one stroke in a wide double-crank press, two factors are to be considered in favor of doing the work shown in this smaller and necessarily slower press. One of these is that the flange, or that portion of the drum which is left solid (not perforated) is turned inward on the bottom of the drum, which requires that the balance of the drum also be left solid to prevent the slides buckling or wrinkling while the bottom flange is turned onto the cylinder; and the second is that this equipment is not only cheaper, but it is also so arranged that the automatic attachment can be removed and the press fitted with a bed, horn or other attachments for ordinary hand-fed operations such as blanking, forming, riveting, etc.

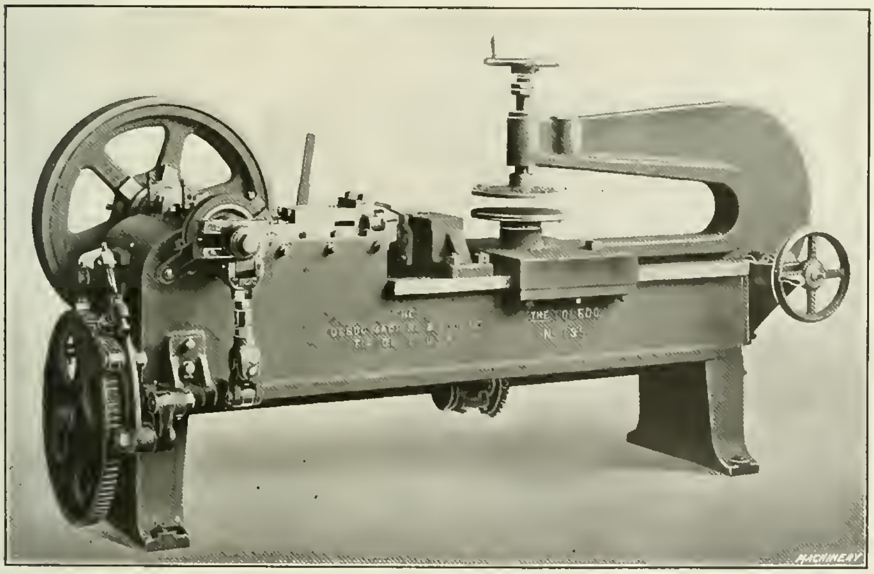
Fig. 8. Horizontal Perforating and Notching Press

The flanged cylinder, after being placed over the perforating horn, is securely locked and held in place by means of the adjustable three-jawed chuck shown, the jaws of which are grooved to suit the different gages of metal in the lighter and medium sized drums. After locking these jaws, the press is started and continues in operation until the entire drum is perforated, when the clutch is automatically thrown out and the press stopped to permit the removal of the finished drum, and the insertion of a new one. The press makes 100 strokes per minute, perforating two rows of holes—top to bottom—at each stroke. The dies are inverted for the work referred to, that is, what is ordinarily the lower die is attached to the slide or ram, and the punch holder and punches are attached to the mandrel shown. An automatic stripper for stripping or removing the work from the punches is provided. This attachment, as well as the attachment on the press in Fig. 8, is fitted with an adjustable automatic indexing and feeding mechanism operated by a pawl and ratchet.

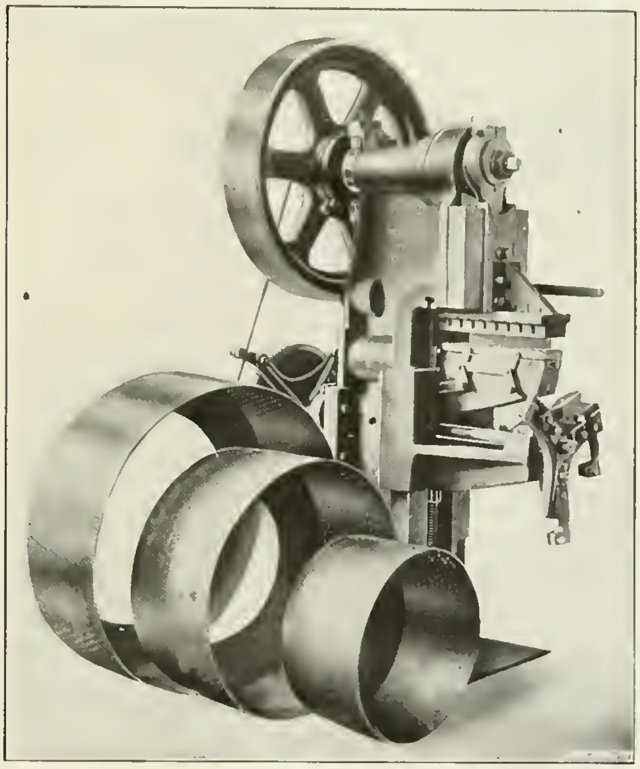
Fig. 9. Upright Perforating Press

The automatically fed presses described are all labor-cost reducers and increased-work producers. While the initial cost of such equipment may sometimes appear high, it is, proportionately, no higher than that of other automatic machinery.

* * *

Several times in the past, the experiments carried on in Sweden for ascertaining the possibilities of the use of peat as a fuel in boilers, have been referred to in MACHINERY. According to the *Mechanical World* some experiments have now been carried out in connection with using powdered peat for firing boilers. For blowing the powder into the combustion chamber under a boiler, an electric fan was used. The air was heated in the smoke flues of the furnace to about 200 degrees F. previous to blowing, and it was possible to regulate the amount of air and powder with great precision. It was found that one ton of coal was equivalent in heating value to 1.397 ton of peat powder, the latter being of poor quality, and to 1.214 ton if better quality was used. The cost of raising the same amount of steam with peat powder and with coal compares as follows: The ton of coal necessary to raise the required amount of steam cost $3.96, and the 1.214 ton of peat powder required for the same amount of steam cost $2.76. In using the powder, however, some coal is required for the start, the additional cost being $0.50, bringing the total cost for the powder to $3.26, a saving of 17 per cent.

DESIGN OF DISHED SPROCKETS

By M. TERRY*

Eccentric design, or rather design of eccentrically loaded parts has always given and still gives considerable trouble to designers. While there is no reason why curved beams cannot be designed strong or rigid enough for the purpose, they are to be avoided whenever possible. A curious and perhaps the only exception to the above is to be found in the case of overhung bearings.

A typical case is shown in Fig. 1. *A* is a side member of a motor-car frame; *B*, a chain-driving sprocket; *C*, the driving shaft; and *D* a bracket bolted to the frame and supporting both the shaft and the sprocket.

If the sprocket alone be considered, the proper way to design it is to place the teeth in the plane of the web and have both symmetrical with the hub, as in Fig. 2.

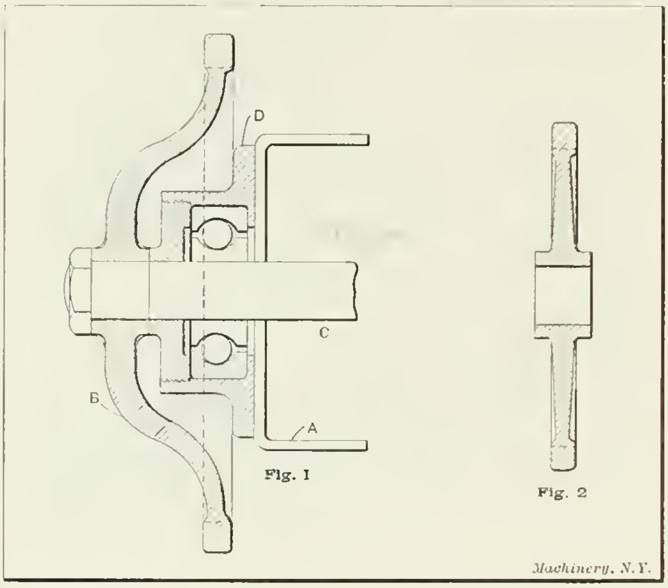

Fig. 1. Typical Example of Dished Chain Sprocket of an Automobile
Fig. 2. Plain Chain Sprocket

The sprocket shown in Fig. 1 is practically a curved beam carrying an eccentric load; its web is subject to complex stresses, and it must be made heavier than the web in a symmetrical design. This offsetting of the web is known as "dishing." Webs are invariably dished in towards the supporting bearing.

The only disadvantage incurred consists, as pointed out above, in introducing complex stresses in the web, and the resulting necessity for heavier design. The amount of this disadvantage lies beyond the scope of the present article, and it will not be discussed in detail. The advantage of dishing consists in lessening the amount of bending moment due to the overhung load.

No attempt to develop general formulas applicable to all cases will be made, but a few simple cases completely worked out will sufficiently illustrate the principles involved.

Case 1. Fig. 3 shows a symmetrical sprocket with a cored hub. The total load of 1000 pounds is equally distributed at two points, *a* and *b*. The shear and moment diagrams follow from the load diagram. The case is very simple and no calculations need be given.

Case 2. Fig. 4 shows a dished sprocket with the plane of the load coinciding with the edge of the supporting wall; in all other respects it is similar to Case 1. It will be seen at a glance that on account of the eccentricity of the load with respect to the hub, there is a tendency for the sprocket to turn clockwise in the plane of the paper thus producing an upward pressure on the shaft at *a* and downward pressure at *b*. These pressures can be easily calculated. Calling the reactions of the shaft at *a* and *b*, R_1 and R_2 respectively, and taking moments about *a* gives

$$1000 \times 15 = R_2 \times 6$$

$$\text{Hence } R_2 = \frac{1000 \times 15}{6} = 2500 \text{ pounds upward.}$$

Taking moments about *b* gives

$$1000 \times 9 = R_1 \times 6$$

$$\text{Hence } R_1 = \frac{1000 \times 9}{6} = 1500 \text{ pounds downward.}$$

These are the reactions of the shaft at *a* and *b*. The pressures on the shaft at the two points are equal to the respective reactions but opposite in direction. This explains the load diagram; the shear and moment diagram construction is based on the load diagram. The calculations involved are very simple and numerical results can be obtained by a mere glance at Fig. 4.

Case 3. This is identical with Cases 1 and 2, except that the load is applied 6 inches from the supporting wall, as shown in Fig. 5. To construct the load diagram, take moments about *a*.

$$1000 \times 9 = R_2 \times 6$$

$$\text{Hence } R_2 = \frac{1000 \times 9}{6} = 1500 \text{ pounds.}$$

Taking moments about *b*

$$1000 \times 3 = R_1 \times 6$$

$$\text{Hence } R_1 = \frac{1000 \times 3}{6} = 500 \text{ pounds.}$$

As in Cases 1 and 2, the shear and moment diagrams are self-explanatory.

These three cases differ from each other only in location of the applied load. By comparing their bending moments it will be observed that:

In Case 1, the moment is positive and equal to 12,000 inch-pounds at *c*;

In Case 2 the moment is negative and equal to 9000 inch-pounds at *b*; and

In Case 3, the moment is negative at *b*, where it equals 3000 inch-pounds, and positive at *c*, where it amounts to 6000 inch-pounds.

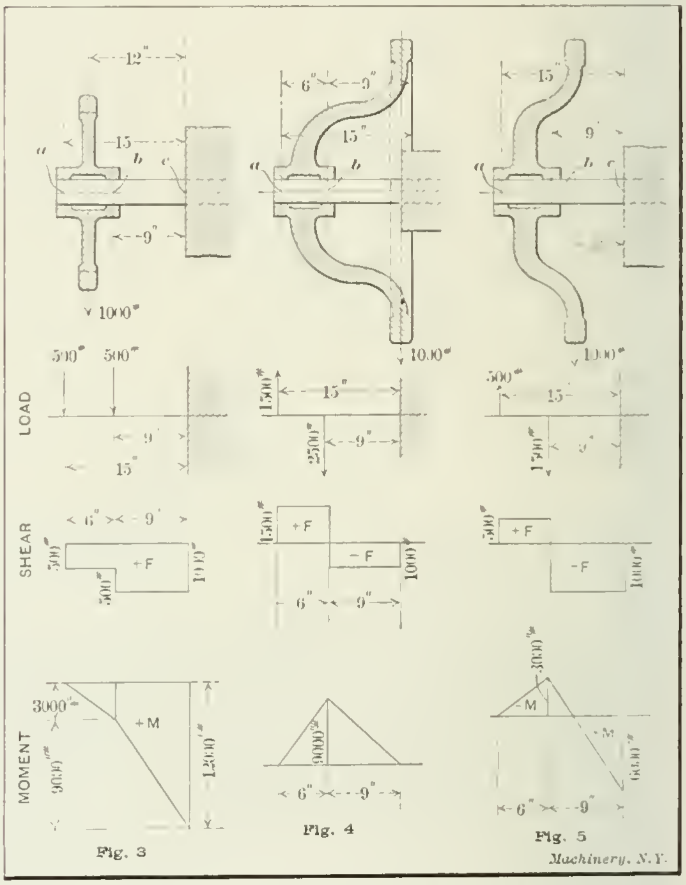

Fig. 3. Plain Cored Chain Gear with its Load, Shear and Moment Diagrams. Fig. 4. Cored Chain Gear dished to have Drive in Plane of Support, accompanied by its Load, Shear and Moment Diagrams. Fig. 5. Cored Chain Gear with an Intermediate Amount of Dish, accompanied by its Load, Shear and Moment Diagrams

It is evident then that the shaft is subject to less severe stresses in the third case than in the preceding two. The sprocket, too, has less offset in Fig. 5 than in Fig. 4.

It would then be of practical importance to know just how much the sprocket need be dished in order to reduce the positive and negative moments on the shaft to the least possible values. By placing the load at various distances from a and constructing or calculating in each case the resulting bending moments, two curves can be plotted as in Fig. 6, representing moments at b and c. Their values are positive above the line AB, and negative below. As a matter of fact, the two curves are straight lines parallel to each other. At a point where the load is 10½ inches from a, the positive and negative moments are 4500 inch-pounds each; immediately to the right or left of this point one of the moments increases while the other decreases

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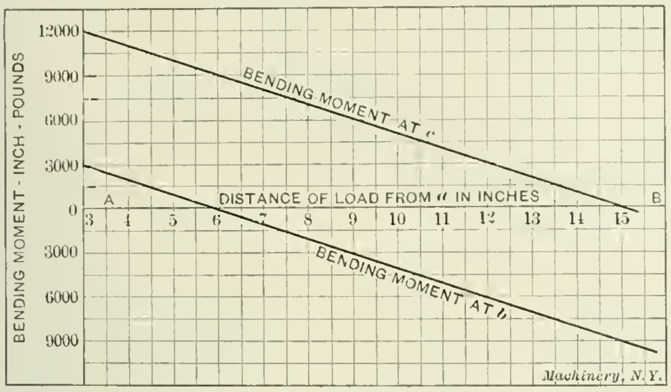

Fig. 6. Curves giving Bending Moment for Different Offsets of Cored Dished Wheels

Cases 4 and 5, Figs. 7 and 8 differ from the others in the matter of distribution of load. The hub, it will be noted, is well fitted to the shaft, and the load is distributed throughout its length, whereas in the first three cases the hub was cored, and the load was considered as concentrated at two points. The total load is now 1200 pounds, and since the hub is located close to the supporting wall, Cases 4 and 5 constitute a group distinct from the one just discussed, and consequently no direct comparison of the two groups can be made.

Case 4. This design is merely a case of a uniformly loaded beam and is illustrated by Fig. 7. While the case in itself is very simple and does not require any laborious proofs and calculations, nevertheless a thorough discussion of it will be given for the sake of a better understanding of Case 5 which is far more difficult.

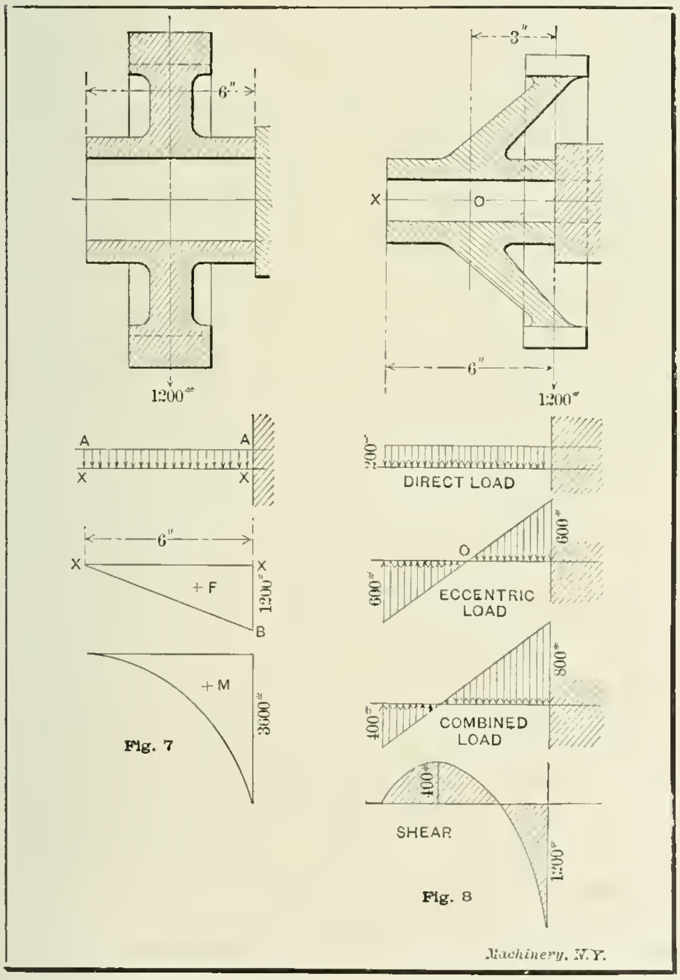

Fig. 7. Plain Gear with Load, Shear and Bending Diagrams. Fig. 8. Dished Gear with Direct, Eccentric and Combined Load, and Shear Diagrams

The load diagram is represented by a straight line AA parallel to the shaft, thus indicating that the shaft is everywhere equally loaded. Let the center line of the shaft represent the axis of XX; taking the origin at the free end of the shaft, the following equation for the load line can be written:

$$w = k$$

where w is the load at any point on the shaft in pounds per linear inch, and k is a constant. In this particular case $k = 1200 \div 6 = 200$. Therefore

$$w = 200 \text{ pounds.} \qquad (1)$$

By definition, the shearing force at any normal section of a beam is the algebraic sum of all the transverse forces on one side of the section. Therefore, the following equation for shear can be written:

$$s = \int wdx$$

Substituting for w its value from (1) and integrating

$$s = \int w\,dx = \int 200\,dx = 200\,x + c_1 \qquad (2)$$

To determine the constant of integration c_1, make $x = 0$; in other words, apply equation (2) at the origin. The term $200x$ then drops out, its value becoming zero.

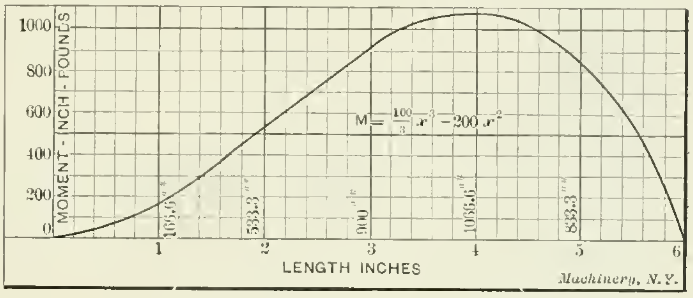

Fig. 9. Bending Moment Curve of Gear in Fig. 8

Therefore, $s = c_1$ when $x = 0$.

Remembering the definition of shear, it will be found that s at the origin is zero. Consequently $c_1 = 0$ and equation (2) reduces to

$$s = 200x. \qquad (3)$$

In the same manner as shear is a definite integral of load, moment is a definite integral of shear.

$$M = \int s\,dx = \int 200\,x\,dx = 100\,x^2 + c_2 \qquad (4)$$

To determine the value of c_2, make $x = 0$. Then $M = c_2$. But M at the origin is zero.

Therefore, $c_2 = 0$, and equation (4) reduces to

$$M = 100x^2 \qquad (5)$$

Comparing the load, shear, and moment diagrams with equations (1), (3) and (5) the following facts are noted:

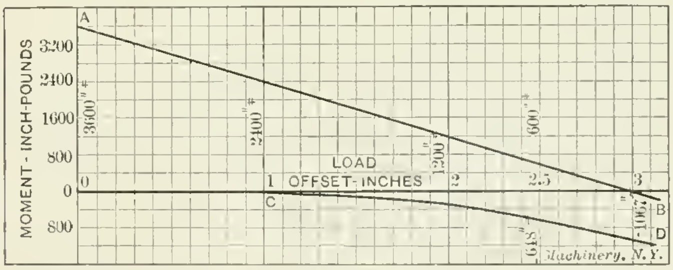

Fig. 10. Curves giving Bending Moment for Different Offsete of Dished Wheels

1. Line AA is everywhere equally distant from the axis XX; in other words, ordinates are independent of abscissas, which fact is represented by equation (1) where w is a constant and not a function of x.

2. The shear is represented by a slant line starting from the origin. Ordinates are everywhere directly proportional to abscissas which agrees with equation (3) $s = 200x$, where s varies directly as the first power of x.

3. The moment is represented by a parabola, which again agrees with equation (5), $M = 100x^2$ being the equation of a true parabola.

For the benefit of readers unfamiliar with analytical geometry and calculus, the following simple directions will be found useful for constructing shear and moment diagrams and for determining shear or moment at any point.

The first part of the preceding discussion explains the construction of the load diagram; to find the numerical value of shear at any point take the corresponding point on the load diagram and then merely multiply the values of the ordinate (in the case at hand it is 200 pounds) by the distance of the selected point from the free end of the shaft. In other words, take the "area" of the rectangle in the load diagram bounded by AA, XX, the ordinate at the origin, and the ordinate at the point in question. Measure one side of the rectangle to a scale in pounds and the other in inches; the product gives pounds of shear at that point. For example at 6 inches from the origin, shear $= 200 \times 6 = 1200$ pounds. Having obtained a few of these values, and selecting any suitable scale (say 100 pounds $= 1$ inch) lay off ordinates at various points on the shaft proportional to the values of shear at those points, and the shear diagram is thus obtained. An actual trial will prove it to be a straight inclined line.

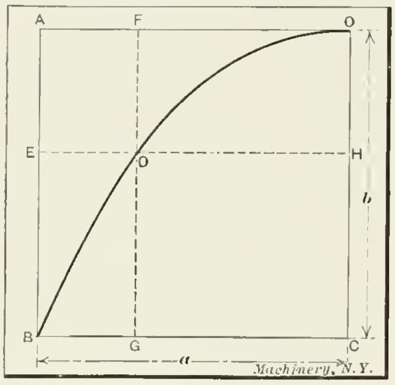

Fig. 11. Method of Determining Area of a Parabola or Portions of it

The moment diagram can be constructed from the shear diagram in precisely the same manner as the latter was constructed from the load. For example, to find the value of moment 6 inches from the origin take the "area" of the triangle formed from the origin up to the 6-inch point, in this case at the wall:

$$M = 1200 \times 6 \times ½ = 3600 \text{ inch-pounds.}$$

At 3 inches from the origin,

$$M = 600 \times 3 \times ½ = 900 \text{ inch-pounds.}$$

In computing the "area" of the shear triangle, measure ordinates in pounds, and abscissas in inches, the product giving inch-pounds.

Case 5. This is identically the same as Case 4 except that the load is now offset 3 inches to the right of O, the center of the hub; *i. e.*, it is in line with the edge of the supporting wall as in Fig. 8.

The problem of loading can be broken up into two parts: 1, pressures on the shaft due to direct load; and 2, pressures on the shaft due to the eccentricity of the same load. The direct load being 1200 pounds, the pressure per linear inch is 200 pounds and this part of the load diagram is precisely the same as in Case 4.

It is clear that owing to the eccentricity of the load, the gear in Fig. 8 has a tendency to rotate clockwise in the plane of the paper, producing upward pressures on the shaft to the left of O, and downward pressures to the right of it; these pressures are assumed to be proportional to their distances from O. They are maximum at both ends of the hub and gradually decrease to zero at O, thus forming two triangles of pressures. The resultant of each triangle is located, of course, two-thirds the distance of the extreme pressure from O, *i. e.*,

$$2/3 \times 3 = 2 \text{ inches.}$$

The two resultants then form a couple or moment whose value is $R \times 4$ inch-pounds where R is the value of either resultant in pounds, and 4 is the distance between the resultants in inches. This moment is produced by the eccentricity of the applied load (1200 pounds), and must be numerically equal to the moment of the latter about O.

Therefore,

$$R \times 4 = 1200 \times 3$$

or

$$R = \frac{1200 \times 3}{4} = 900 \text{ pounds.}$$

If F is the pressure at X in pounds per linear inch, then

$$F \times 3 \times ½ = R = 900 \text{ pounds.}$$

or

$$F = \frac{900 \times 2}{3} = 600 \text{ pounds.}$$

The two load diagrams can be combined algebraically into one, as shown in Fig. 8 and the load line thus obtained can be represented by the following equation:

$$w = 200x - 400 \qquad (6)$$

where w is the load in pounds per linear inch at any point on the shaft, and x is the distance in inches of that point from the unsupported end of the shaft.

Applying the same method as in Case 4:

$$s = \int w dx = \int 200\, x dx - \int 400\, dx$$
$$= 100x^2 - 400x + c_1$$

When $x = 0$, — $s = 0$ and therefore $c_1 = 0$

Then,

$$s = 100x^2 - 400x \qquad (7)$$

Again,

$$M = \int s dx = \int 100\, x^2 dx - \int 400\, x dx$$
$$= \frac{100}{3} x^3 - 200x^2 + c_2$$

When $x = 0$, — $M = 0$, and therefore $c_2 = 0$

$$\text{Consequently } M = \frac{100x^3}{3} - 200x^2 \qquad (8)$$

Shear and moment diagrams can now be constructed from equations (7) and (8).

The reader may find it profitable to compare Figs. 7, 8 and 9 as well as equations (1), (3), (5), (6), (7), and (8), and draw a few conclusions of his own.

The shear and moment diagrams can be also constructed by the "area" method as outlined in Case 4; care, however, must be exercised in interpreting the results and assigning to them the proper signs, positive or negative.

In finding areas of parabolas or portions of them, the following will be of assistance: In Fig. 11, ODB is a parabola with vertex at O.

Area $ODBCO = 2/3ab$

Area $AODBA = 1/3ab$

Area $EDBE = 1/3ab - AE \times ED - 1/3\ OF \times FD$

Area $DBGD = 2/3ab - GC \times CH - 2/3\ OH \times DH$

Fig. 9 represents the bending moment diagram constructed from equation (8). It will be observed that the maximum moment amounts to only 1066.6 inch-pounds, as against 3600 inch-pounds in Case 4. (See Fig. 7.) As this reduction is considerable, it is of practical value, and a further investigation might disclose an offset which is accompanied by a further decrease of the bending moment. By selecting various offsets and obtaining maximum moments in each case by methods outlined in Case 5, two curves as in Fig. 10 may be plotted.

The line AB represents moments at the edge of the supporting wall, while the curve CD represents maximum negative moments on the shaft caused by varying load offsets. It might be added that these maximum negative moments do not occur at the same point on the shaft, but vary with the offsets.

By consulting Fig. 10, it will be observed that when the load is offset 2½ inches to the right of O, the moment at the wall is positive and is equal to 600 inch-pounds, while the negative moment amounts to 648 inch-pounds. The ideal offset is somewhat less than 2½ inches, but its exact value is of little practical use, since the ideal (*i. e.* the least) moment lies between 600 and 648 inch-pounds, and further investigation is not worth the trouble.

In conclusion the author wishes to state that there is a very prevalent notion among designers that by offsetting sprockets, gears, etc., so as to bring the plane of the load in the plane of support—the bending moment on the shaft is entirely eliminated, just as if the load were applied directly at the point of support. Time and again the author came across this idea, and it prompted him to look into the matter. He hopes he was successful in proving the utter fallacy of this idea and he further hopes that his investigation (based on accepted theories) reveals the fact that in "dishing" to attain the best results, the load need not necessarily come in the plane of support.

SOME INTERESTING MECHANISMS*

AS USED ON AUTOMATIC MACHINES FOR VARIOUS PURPOSES

By GEORGE W. ARMSTRONG†

The text of this article is, in the main, descriptive of cam applications, ratchet and star-wheel combinations, and reversing devices, illustrated by the accompanying line engravings. A heterogeneous collection of uncorrelated mechanical movements such as follows naturally cannot be classified, being garnered, as they are, from various sources in the hope that they may prove of interest and be instructive. As examples of inventive design—which term is used advisedly instead of machine design—these are presented for their suggestive value to the reader, rather than because they possess intrinsic value to other than those primarily interested. The writer's personal experience has been that knowledge gained by studying concrete examples of mechanisms or mechanical powers is vastly more beneficial toward a thorough understanding of the fundamental principles involved, than a much more extended study of abstract theories, with perhaps, finally an incomplete conception of the possibilities of combinations. The study, *in situ*, of a mechanical element of some complicated machine, in its functional relations to the organism as a whole, is undoubtedly most interesting and advantageous; but as such opportunities are seldom presented, a greater familiarity with the usage of the laws underlying applied mechanics may be gained from a perusal of the matter appearing from time to time in the technical press.

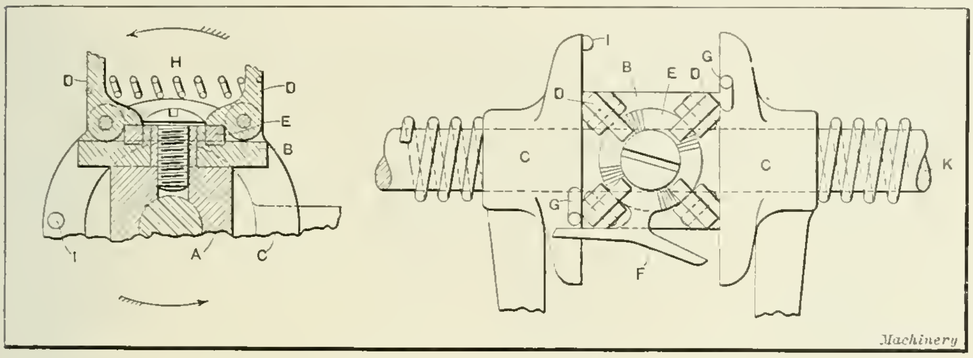

Fig. 1. Mechanism for Gripping and Turning a Piece of Work

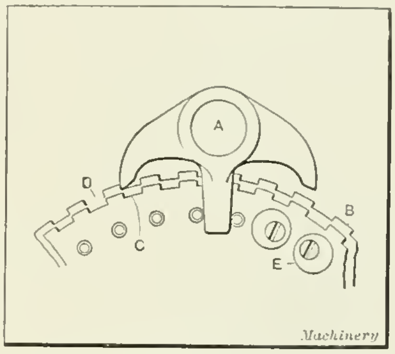

Fig. 2. Ratchet Reversing Mechanism

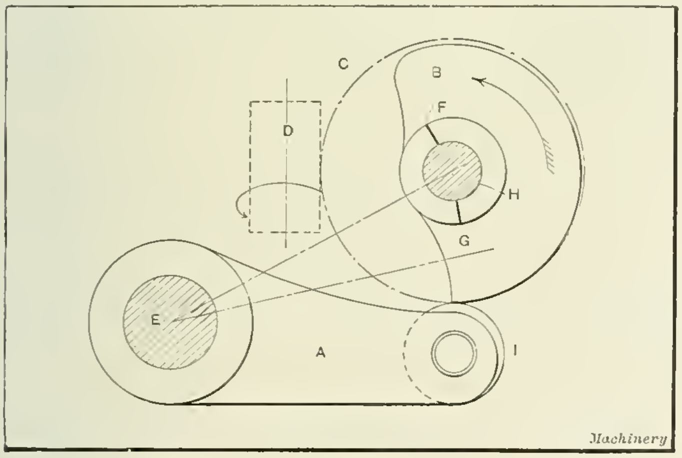

Fig. 3. Arrangement for Eliminating Chatter in Cam Mechanism

Mechanism for Gripping and Turning a Piece of Work

A piece of work operated upon in two positions within the machine producing it was required to be rotated 90 degrees between the operations. Fig. 1 illustrates a mechanism which successfully handled work from $1\frac{1}{2}$ down to $\frac{1}{4}$ inch diameter at from 30 to 60 revolutions per minute. Upon a double stud-block *A* are mounted two turn-tables (one seen at *B*), which are held in the same position, relative to each other, by the non-revolving collars *C*. These collars are free to slide along the shaft on which they are mounted, but are held up against the turn-tables by springs. As each turn-table approaches and recedes from the work, the toes of the grippers *D* are raised and lowered by the cam ring *E* (not unlike a universal chuck ring) which is provided with a double tappet *F*. This tappet, acted upon by pins *G*, provides means for gripping the work while the shaft *K* and the mechanism rotate. Continued rotation of the shaft brings *B* into engagement with projection *I*, thus turning the table *B* through an angle of 90 degrees, meanwhile forcing the collars *C* apart to permit the table to turn. Each table is returned to its former position while the other is indexing the work, thus avoiding the necessity of indexing to four positions. Spring *H* holds the toes of grippers *D* against cam *E*.

Ratchet Reversing Mechanism

An arrangement whereby a ratchet automatically reverses after making a predetermined number of revolutions was required, with the further condition that the time of reversal, or, what amounts to the same thing, the number of revolutions, might be varied at will through a wide range. Referring to Fig. 2, the double pawl *A* is carried by a reciprocating member (not shown) over the driving ratchet *B* and the controlling ratchet *C*, which latter is normally frictionally restrained from rotating. The larger diameter of *B* precludes the pawl engaging *C* except at such times as the deep notch *D* is reached. The two adjustable trip dogs *E* and the finger on the pawl accomplish the reversal, and the position of the former, together with the number of deep notches, determines the time for quicker reversals.

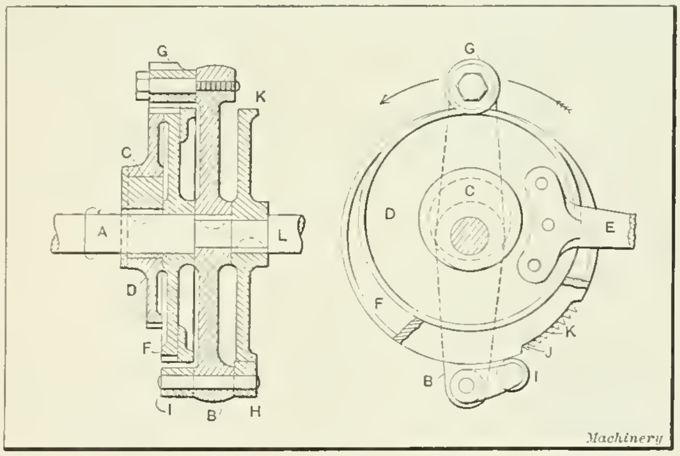

Fig. 4. An Intermittent Feed Mechanism

Arrangement for Eliminating Chatter in Cam Mechanism

An unforeseen difficulty and the expedient adopted to overcome it may be noted in Fig. 3. Here *A* is a stationary lever and *B* is a cam mounted upon the same shaft as worm-wheel *C*, which is driven by a triple-threaded worm *D*, the whole arrangement being pivoted on shaft *E*. The cam made from 25 to 100 revolutions per minute, and at the slower speeds its drop on the roller from the high to the low dwell was attended, with excessive chattering, the vibrations being disastrously magnified at a distant point, while the noise was decidedly objectionable. This was probably due to a slippage between the worm and gear while the drop of the cam was on the roll. In this position the thrust upon the worm was reversed, and this caused a tendency in the gear to gain on the worm by small jumps, so that a slight back-lash was exaggerated to a marked extent.

Various attempts to overcome this proved unsuccessful until the cam was left free upon the shaft and a clutch formed on the hubs of the cam and the worm-gear with the teeth *FG* and *FH*. A gap *GH* was left, slightly larger than necessitated by the time allowance for dropping, so that the cam was free to rotate ahead of the driving gear and give an instantaneous drop. A resulting advantage was a motionless low dwell.

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* See also MACHINERY, July, 1908: "Cam Applications."

† Superintendent, Lester & Wasley Co., Inc., Norwich, Conn.

An Intermittent Feed Mechanism

The solution of an interesting problem is indicated in Fig. 4. For every 1¼ revolution of a continuously rotating shaft, a second shaft in the same line must rotate intermittently with like velocity in the same direction through an angle of 30 degrees. Keyed to the driving shaft *A* are the double arm *B* and the eccentric bushing *C*. Loosely mounted on *C* is a 96-tooth gear *D* which is restrained from rotating by *E*, but whose pitch line, because of the eccentricity of *C*, is always tangent to that of the 120-tooth gear *F*, and to the planet pinion *G*. As the arm *B* carries the pinion around *D*, the gear *F* is revolved on *A* in the ratio of 120 to 96 or 1.25 to 1. The end of *B* opposite the pinion carries a link and roller *I*, which runs on a flange of gear *F* until a break *J* in the periphery allows it to drop and pawl *H* to engage ratchet *K* keyed to shaft *L*, thus turning the ratchet forward till the roll mounts the flange again. Since *F* advances one-fifth of a revolution per each revolution of the arm and pawl, and since 30 degrees equals one-twelfth of a revolution, the opening for the roll must be shortened 1/5 × 1/12 of 30 degrees, or to 29 1/2 degrees.

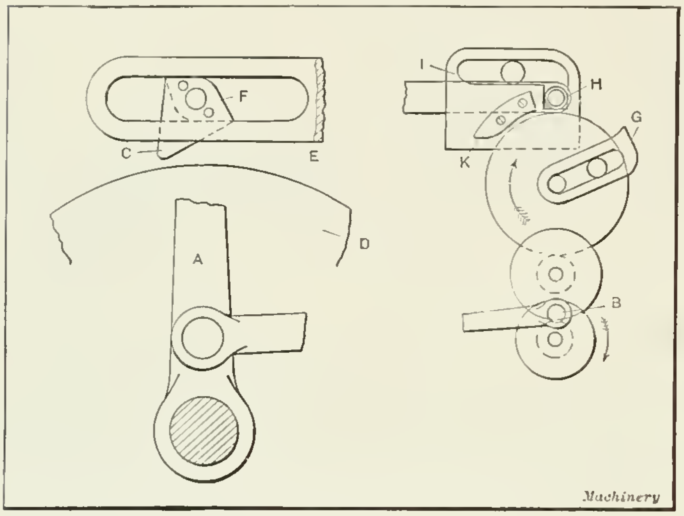

Fig. 5. Feed Mechanism with "Skipping" Device

Feed Mechanism with "Skipping" Device

The simple arrangement in Fig. 5 was devised to skip a feed in a ratchet according to any requirements. The arm *A*, oscillated by the pitman *B*, carries a stud on its free end upon which is pivoted a fiber pawl *C* engaging the smooth periphery of the disk *D*. The slotted bar *E* controls the pawl, which is made of two pieces screwed to opposite sides of the lozenge shaped piece *F*. The latter being within the slot and slightly thinner than the bar, causes the projecting parts of *C* to frictionally engage the lower side of the slot. The result of any motion of the arm *A* toward the right is to give the pawl the position shown, that is clear of the disk *D* for the return stroke, the shape of *F* limiting the back-lift of *C*. The reverse motion of *A* tends to reverse the position of *F*, the friction between *C* and *E* constraining the pawl to grip the disk and to rotate it, thereby feeding the required amount. The skipping of a feed is accomplished as follows: Through the train of change gears and the cam *G*, the pawl *H* is lifted clear of its seat and is free to slide horizontally, introducing no frictional resistance in the pawl and leaving it clear of the disk. Cam *G* is pushed in when it strikes dog *K*, and is suddenly thrown out by a spring after having passed the dog. Its release disengages *H*, which is reseated, upon the return of the bar *E*.

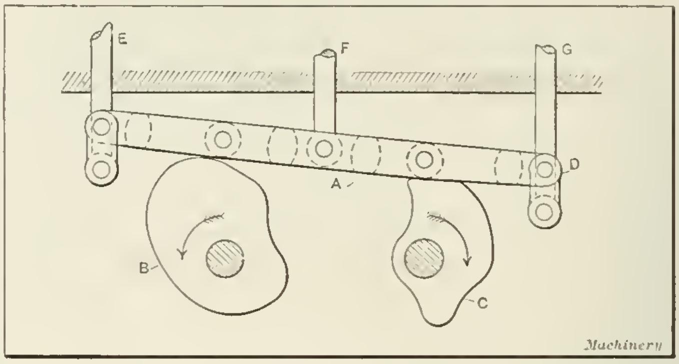

Fig. 6. An Interesting Cam and Lever Arrangement

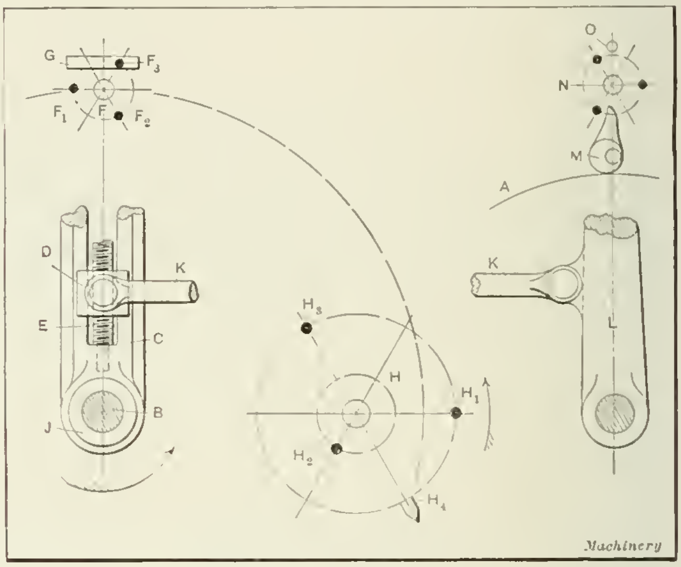

Fig. 7. A Complicated Feed Motion Device

An Interesting Cam and Lever Arrangement

In Fig. 6, lever *A* and two cams *B* and *C* are shown. This combination is a curious and rather paradoxical arrangement, introducing levers with two shifting fulcra. At times the lever is one of each of the three orders of levers, sometimes different pairs of the orders, and sometimes combines all three

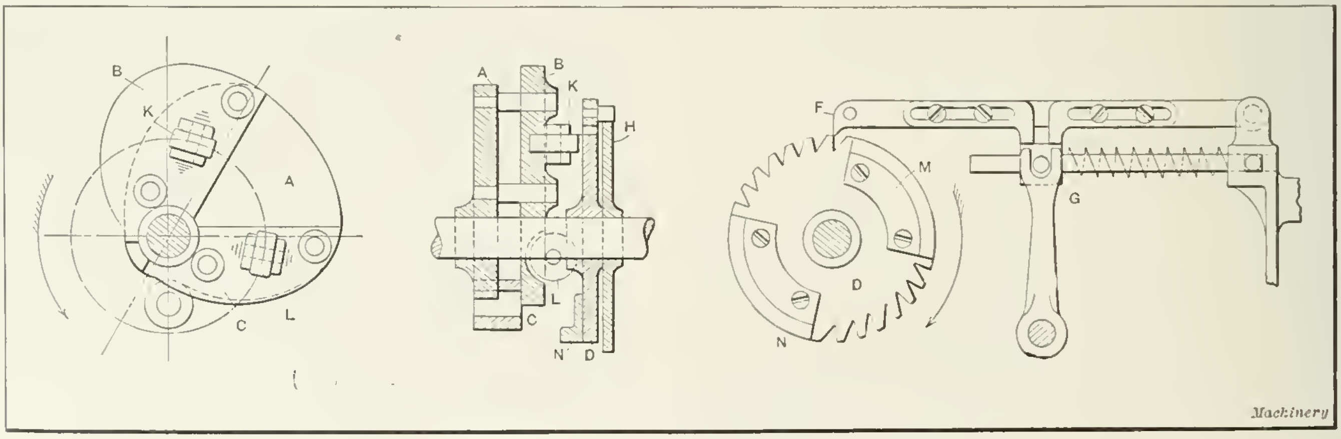

Fig. 8. An Automatically Adjustable Cam Mechanism

together; at times it is not a lever at all. Any kind of motion may be obtained for the outer rods, but if rod *F* is to remain motionless while *E* rises, cam *C* must follow the movement obtained from *B* in proper ratio. An analysis of the case shows an apparent paradox of a weight and fulcrum being at *D* and the power applied at *B* or *C*, or a fulcrum being at *C*, the power being applied at *B*. If both cams impart the same amount of motion to *A*, but in opposite directions, then the point where *F* is pivoted to the lever becomes the apparent fulcrum. During an equal simultaneous rise of both cams, *A* is not a lever in the ordinary meaning of the word.

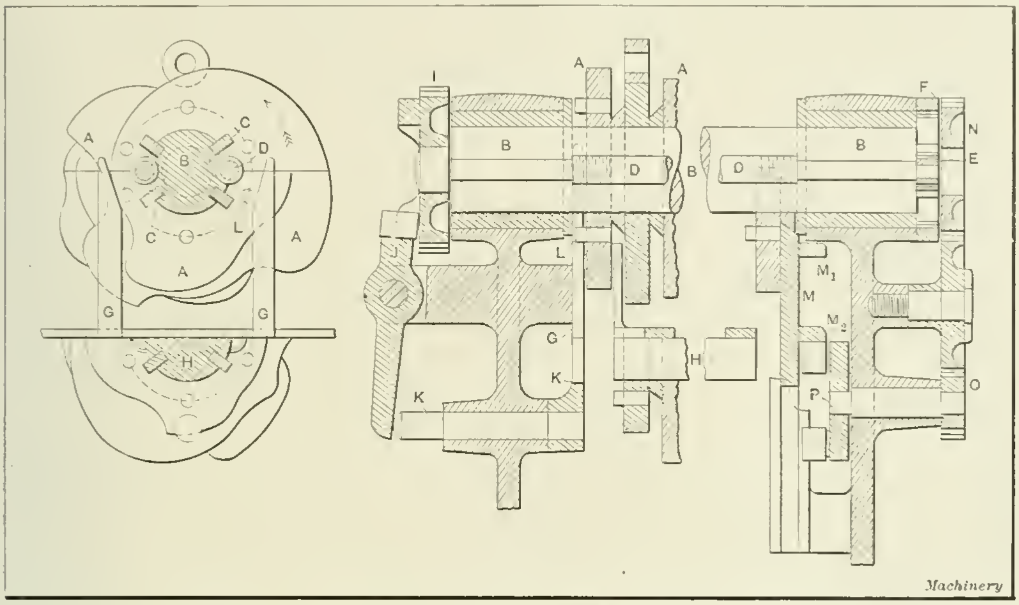

Fig. 9. Interchangeable Cam Mechanism

A Complicated Feed Motion Device

A somewhat complicated feed system was to be designed and it was desired to obtain the motion from a shaft running with twice the desired speed. The end in view was to rotate the ratchet *A*, Fig. 7, for every other revolution of shaft *B*, through a small arc which should increase by small increments until the maximum feed was reached, decreasing thereafter to the minimum, and then increasing again to the maximum, at which point the feed should instantly begin at the minimum again; that is, there should be two periods of increasing feed and one period of decreasing feed for every cycle.

In the partially diagrammatical view Fig. 7, *C* carries a sliding block *D*, connected to *L* by a pitman *K*. Block *D* is fed to or from the center of *B* by screw *E*, working in a divided nut. On the upper end of *C* are two intermittent motion star-wheels *F* and *G*, of six teeth each, with their planes at right angles. Wheel *F* is pivoted on the side of *C*, and *G* is fastened onto *E*. Wheel *F* has three projecting pins F_1, F_2, and F_3, placed on alternate teeth and denoted in the illustration by large black dots. Suppose star-wheel *F* is rotated one tooth (denoted by the straight lines). If that tooth is one of the three with the projecting pins on the side, wheel *G* and screw *E* will be rotated one-sixth of a revolution. Conversely, if the tooth on *F* has no projecting pin, *G* will not rotate. This scheme gives the alternating feed through *K* and *L*, as the arm *C* revolves about the center of *B*.

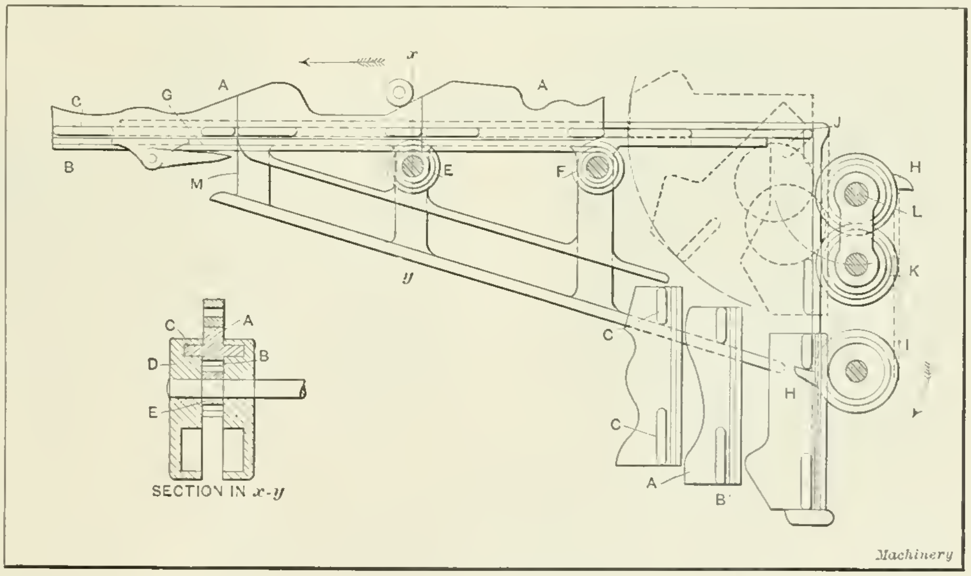

Fig. 10. Another Method of Obtaining Same Results as in Fig. 9

The center of *F* revolves about *B* in a path as shown by the broken line, which passes midway between the two circles at *H*. These circles represent the controlling star with six teeth or points (denoted by straight lines). A pin (not shown) upon the block *D* is caused to engage two teeth of *H*, on two successive revolutions before it is retracted. This is done only when the slide is at the upper end of its travel. Star-wheel *H* merely operates star *F*. Three projecting points (denoted by black dots) engage point after point of *F* as it comes around.

Suppose it is projections H_1 or H_3 that engage with *F*. Then by reason of their being on the outer side of the center of *F*, star-wheel *F* must revolve in an opposite direction to that in which it would revolve if H_2 was the projection engaging *F*, because H_2 is on the inner side of the center path of *F*.

From the description of the mechanism given it is now apparent that block *D* moves up (or down) through the action of *H* upon *F* and *F* upon *G*; and the motion takes place only for every other revolution of *B*. When block *D* reaches the outer limit, the pin upon the block is released as mentioned, which, in turn, revolves *H* two teeth before it is retracted, thereby engaging the opposite side of *F*, reversing the direction of rotation of *F* and *G* and returning *D* toward the center. Pin H_3 is here brought into action and *D* goes outward again to the extreme position. The controlling star is rotated as before, returning H_1 to position and bringing H_4 into action to open the split nut at screw *E*, which allows a spiral spring in *J* to return the block *D* and pitman *K* instantly to the center, thus completing one cycle.

Through link *K*, lever *L* and pawl *M*, ratchet *A* is rotated. A star *N* is carried by *L*, which is operated by the hinge tappet *O* and which is provided with three projecting pins to lift the eccentric pawl from the ratchet every alternate stroke of *L*.

An Automatically Adjustable Mechanism

A certain cam, normally has a 120-degree rise, 60-degree dwell, 90-degree drop, and 90-degree dwell. If, however, the pressure exerted in another part of the machine, during a dwell, exceeds a given limit, the rise must take place in 90 degrees; and the drop must be lengthened to 120 degrees, if the pressure decreases below that desired. Fig. 8 shows the mechanism used for accomplishing the object desired. Slidably mounted upon cam *A* are two auxiliaries *B* and *C*, of the proper angularity, each carrying a roller *K* and *L*. There is also a disk *D* with two sets of ratchet teeth and two side cams

M and N. A pawl F rests upon the block G until the increase or decrease of pressure outbalances the spring, at which time F drops into the ratchet. The latter then ceases to rotate, and M and N force cams B and C to the left, where they engage with the wide cam roller. Cam H returns pawl F to the neutral position.

Interchangeable Cam Mechanism

Two distinct methods of obtaining practically identical results were successfully evolved for a certain purpose, and as they exhibit great diversity of construction and are somewhat novel in design, they are illustrated in Figs. 9 and 10. The requirement in each case was a flexible cam system which could be readily changed with relation to any one movement by substituting another cam section, which would occupy less space than would a single large cam. One solution of this problem made use of rotary motion, while the other involved the use of rectilinear motion for the cam. Both mechanisms might properly be termed "magazine" cams, because the parts composing them were continually placed in action and then replaced by others in successive order. The cams in Fig. 9 are semicircular, as shown at A. The continuity of the cam surface is obtained by making each semicircular section in the form of a half turn of a spiral with close-fitting joints, the complete cam appearing like a worm. The sections are fed longitudinally along the shaft and successively under the lever roller at a rate of advance equaling the lead of the spiral. Four feathers C are provided to guide and retain the cams. The two screws D producing the longitudinal movement, are driven by pinions E meshing with an internal gear F, which is fastened to the bearing. As the feathers extend only to within the width of one cam from the left bearing, it follows that two sections drop from the shaft at every revolution, the dropping sections being guided by the guides G. The double cam upon the driving gear I, the lever J, and the carrier-slide K, provide the means for hanging the semicircular cams upon the magazine bar H. The slide K catches each piece by the pins L and, by pushing one, causes the further one to be slid onto the lifting slide M which engages its grooved hub. The gears N and O, in the ratio of 1 to 2, and disk P operate a slide for returning the cams to their shaft. The rollers on P successively engage the steps M_1 and M_2, thus raising the slide which drops back automatically.

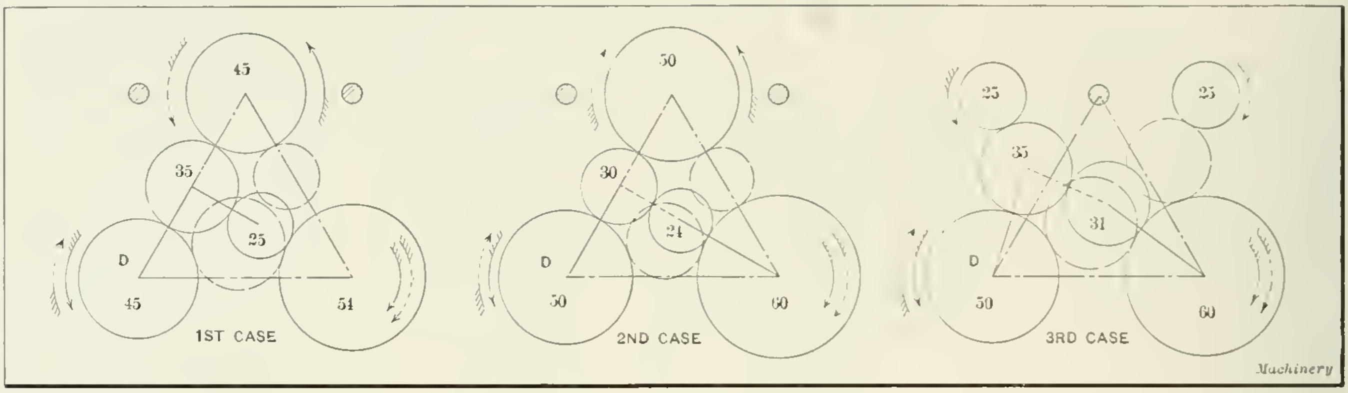

Fig. 11. Reversing Gearing Arrangements

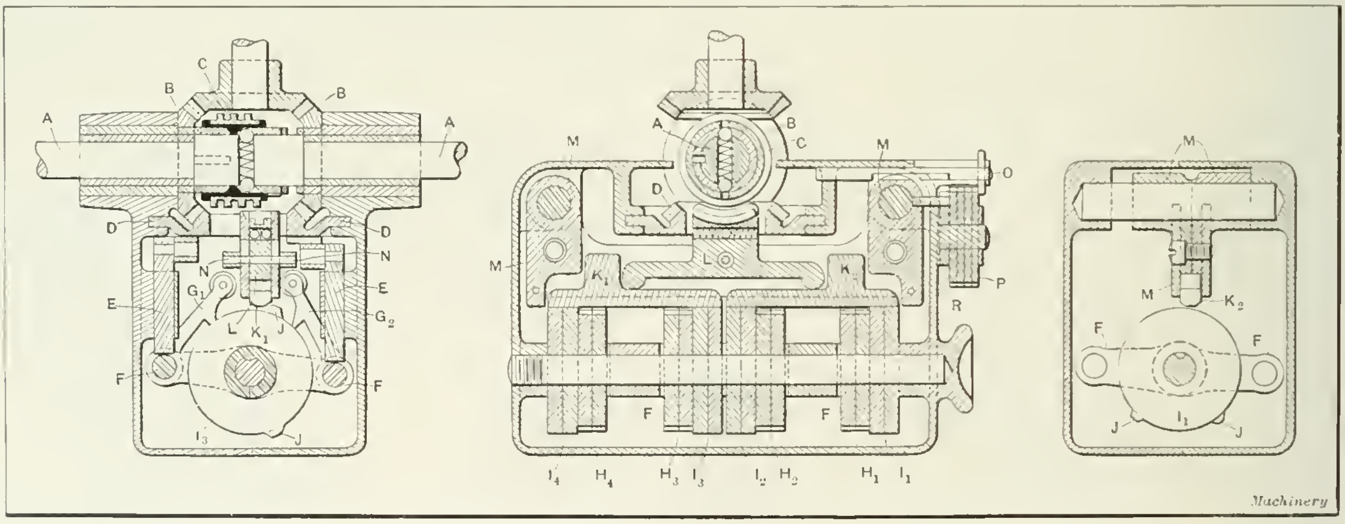

Fig. 12. A Mechanism that will reverse at any Predetermined Number of Revolutions between One and One Hundred Thousand

To facilitate engagement between the cam threads and the screws, the square threads of the latter are brought to a V at the entering ends, and to insure instantaneously positive locking of the cams to the shaft, the ends of the feathers recede into pockets and fly out by the action of springs. Any part of the system may be changed by placing the desired section in a holder and introducing it between the slide K and the magazine bar. The cam to be removed—the dropping cam—comes out upon an inclined runway of the holder.

The alternate design is the rectilinear cam system shown in Fig. 10. The mechanism consists of the cam section A, provided with rack teeth at B. Each section has four lugs C which act as guides in the ways D. A pinion E feeds the sections along beneath the lever roller, and the frictionally driven pinion F assembles them. When any section has passed beneath the roller, it is automatically hung upon the magazine chute. The forward lugs C are made slightly longer than the rear ones, to span the gap G; but the rear lugs enter the gap just as the forward lugs clear the ways. The sections are taken from the lower part of the ways in the magazine by spring-controlled forks H upon the chain I which engage the lugs and lift the cams until the smaller lugs abut at the corner J. The linked gear K meanwhile engages the rack, and as it swings about the center L, it lifts the cam up against the ways. Here the resistance offered to further motion of the links causes K to rotate about its own center and slide the cam into place. Substitute sections are introduced at M, and the replaced sections are lifted from the ways.

Reversing Mechanisms

Fig. 11 shows three diagrams of automatically reversing systems of gearing, employing self-operating tumblers; Fig. 12 shows the controlling elements of the combination. The requirements were (see Fig. 11): 1.—That a reversing gear should drive two others continuously in the same direction, but in opposite directions relative to each other. 2.—That a reversing gear should drive one of two gears continuously in the same direction and the other in the same direction as that of the reversing gear. 3.—That a reversing gear should drive one gear continuously in the same direction and should drive two others alternately in the same direction as itself.

The reversing driver is D. The full arrows and full circles should be read together, and likewise the broken lines. The full lines connecting centers indicate that those gears are linked, and the broken lines denote spring connections. The moment of the reversing driver and the friction of the links swing the idlers.

The means for accomplishing the reversal of the shaft automatically is of special interest; the shaft must reverse after completing the desired number of revolutions, which number may be anything below 100,000, and it must cease rotating when it shall have completed the required number of reversals, which may vary up to 10,000.

The reversing shaft seen at A, Fig. 12, is driven through the medium of the miter gears B and the sliding worm-clutch C. A miter gear D has a cam to engage the rollers on the upper ends of bars E, the lower ends of which oscillate the rockers F. These rockers carry two sets of pawls G_1 and G_2, each provided with a roller as shown. The set at the left is now in action upon the oppositely cut pairs of ratchets H_1, H_2, H_3, and H_4, which operate the disks I_1, I_2, I_3, and I_4, each of which is provided with a cam J. This system of cam disks and ratchets is the "combination." Each ratchet has twenty teeth with one deep cut. Each tooth of H_4 equals 8000 revolutions; of H_3, 400 revolutions; of H_2, 20 revolutions; and of H_1, one revolution. To set the combination for 49,763 revolutions, set H_4 at six, H_3 at four, H_2 at eight, and H_1 at three teeth. Each group of two ratchets and two disks are independently arranged, and the four units are then assembled.

Now, with the desired setting, the operation is as follows: G_1 drops into a deep notch of H_1 after a number of teeth, and allows the next pawl to turn H_2 one tooth; this is continued until eventually I_4 is brought to the position where its cam is at the top. This lifts the floating lever K_1 at the left end and the lever L one-half as much. When the other cam disks shall act upon K_1 and K_2 these and L are lifted the full amount and the spring balls in L throw it quickly into mesh with the worm C, the upper edge of L being formed as two threads. K_1, K_2 and L, being contained in carriage M, are all constrained to move to the left because of the action of C. This results in breaking the combination; that is, the floating levers are all removed from the cams, and must be reset for the next reversal. A further result is to throw out the set of pawls G_1 and to allow the idle set G_2 to come into action, thereby reversing the direction of rotation of the combination and starting another setting.

As soon as the travel of carriage M is completed (1½ revolution of the worm), the worm is constrained to act along the threads on L (1 revolution of the worm), until the feathers (shown in full black) over-ride the spring balls in shaft A. Immediately the clutch is thrown out of mesh on the left and into mesh on the right, thereby reversing the shaft. Just as the worm starts to jump, the cam on gear D engages one of the rollers N on L and throws the levers all down and the threads on L out of the worm.

With regard to the stopping of the mechanism after a predetermined number of reversals, the carriage M may be interrupted midway of its travel; the worm will then act upon L and withdraw the clutch until it is out of engagement on the left and cannot engage on the right. This is done by the pin O dropping into a groove in M, which it can only do when the four ratchets P (of 10 teeth) are properly aligned as regards the deep notch in each. The ratchets are operated consecutively by a four-fingered pawl on R, through the medium of a pin connection with M. The mechanism is encased and runs in oil.

* * *

Don't put even one pound more of metal into a piece of machinery than is absolutely necessary for practical purposes, because metal costs money, and you are working for the machine builder and not for the foundryman or the steel merchant.

GAS ENGINE DESIGN PROBLEMS[*]

By T. W. HOLLOWAY[†]

The following list of questions and answers relating to gas-engine and producer design may be of interest to some of the readers, for they are such as are constantly cropping up, having been collected from time to time by the writer in his daily work. The formulas and proportions presented have been found to give good results in practice.

Question 1.—When fitting the piston in the cylinder of a gas engine, how much smaller in diameter is it customary to make the piston than the diameter of the cylinder in order to give a proper working fit when hot?

Answer.—The diameter of a cast-iron piston may be made the same as the cylinder diameter less the sum of 0.0005 times the diameter of the cylinder bore and 0.005 inch. Therefore, a 10-inch cylinder would have a piston $10 - (0.0005 \times 10 + 0.005) = 10 - 0.01 = 9.99$ inches diameter. The diameter of a steel piston may be made equal to the diameter of the cylinder bore less the sum of 0.00075 times the diameter of the cylinder bore and 0.0075 inch, which is a little greater allowance than for cast-iron pistons. Therefore, if a steel piston is made for a 10-inch cylinder, the piston will be made $10 - (0.00075 \times 10 + 0.0075) = 10 - 0.015 = 9.985$ inches diameter.

Pistons for gas engines are sometimes made slightly smaller at the end next to the explosion than they are at the crank end in order to obtain a good working fit when the piston is hot; the end next to the explosion becomes hotter than the other end and, consequently, expands more. One reliable company makes the piston 0.997 times the cylinder diameter at the end next to the explosion, and 0.999 times the cylinder diameter at the other end.

Question 2.—What are some good formulas for proportioning both round and rectangular connecting-rods for stationary gas engines?

Answer.—When round connecting-rods are used on gas engines, they are usually turned with a straight taper from one end to the other. The amount of taper varies with different makers, but in the best practice it is about 0.08 to 0.09 inch per foot of length. Round connecting-rods are sometimes proportioned so that the diameter of the piston end is as small as 0.9 times the diameter at the middle, and the diameter at the crank end is as large as 1.1 times the middle diameter.

The diameter of a round connecting-rod at the middle may be found by the formula

$$D = F \sqrt[4]{PL}$$

in which

$D =$ diameter at the middle section of the rod, in inches;

$F =$ a factor varying from about 0.03 to 0.033 for ordinary stationary engines;

$P =$ the maximum load on the piston in pounds per square inch;

$L =$ length of connecting-rod in inches, the measurements being taken from the center of the piston-pin to the center of the crank-pin.

The diameter at the piston end should be checked by calculating the diameter of the neck of the rod for simple compression; a safe stress of about 8000 pounds per square inch should be used in making this calculation.

Most designers prefer to check these results, usually employing some column formula. A good formula for checking up a connecting-rod of either round or rectangular cross-section is

$$W = \frac{\pi^2 EI}{L^2}$$

in which

$W =$ load on rod in pounds;

$E =$ modulus of elasticity taken as 30 000,000 for steel;

$I =$ least moment of inertia of section of rod;

$L =$ length of connecting-rod in inches.

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[*] For additional information on this subject, see the following articles published in MACHINERY: "Suggestions in the Design of Combustion Engines," "Crankshafts for Internal Combustion Engines," "The Crank-case Problem," and "Commercial Ratings of Internal Combustion Engines," April, 1910; "To Determine Size of Gas and Oil Engine Cylinders," February, 1909; and "Formulas and Constants for Combustion Engine Design," February and October, 1906. See also MACHINERY'S Reference Book No. 65, "Formulas and Constants for Gas Engine Design."

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The factor of safety for a gas-engine connecting-rod should not be less than 9, and it generally ranges from 9 to 15. By dividing the load W, as found by the check formula, by the maximum load P on the piston, the factor of safety may be found. As an example, if the maximum explosion pressure in an 18 by 24-inch gas engine is 350 pounds per square inch, and the length of the rod is 2½ times the length of the stroke, what will be: (*a*) the diameter of the middle section of the rod; and (*b*) the diameter of the connecting-rod at the piston end?

(*a*) The total pressure P on the piston due to the explosion is $350 \times 0.7854 \times 18^2 = 89{,}064.36$ pounds. The length L of the rod is $2\frac{1}{2} \times 24 = 60$ inches. Taking F as 0.03, the diameter of the rod at the middle is

$$D = 0.03 \sqrt[4]{89{,}064.36 \times 60^2} = 4 \text{ inches}$$

The least moment of inertia I of a cylindrical section, as found from a table of moments of inertia, is $\frac{\pi D^4}{64}$, and for a 4-inch rod is therefore $\frac{3.1416 \times 4^4}{64} = 12.5664$. Using the check formula

$$W = \frac{10 \times 30{,}000{,}000 \times 12.5664}{60^2} = 1{,}047{,}200 \text{ pounds}$$

which gives the approximate factor of safety

$$\frac{W}{P} = \frac{1{,}047{,}200}{89{,}064.36} = 11.7$$

The calculation for the rod may be considered as satisfactory, as this factor of safety is well beyond the limit.

(*b*) In finding the diameter of the rod at the neck, use a taper of say 0.09 inch per foot. The taper from the middle will then be $\frac{60}{2 \times 12} \times 0.09 = 0.225$ inch. The diameter at the neck is $4 - 0.225 = 3.775$ inches. Checking by simple compression, the diameter of the rod at the neck should not be less than $89{,}064.36 \div 8000 = 11.133$ square inches. The diameter corresponding to this area is 3¾ inches. Therefore, the diameter of the neck found above is safe. The diameter may be taken as 3¾ inches. This will require a diameter of 4¼ inches at the crank end. The rod, therefore, has the following diameters: 4¼ inches at the crank end; 4 inches at the middle; and 3¾ inches at the neck.

Rectangular connecting-rods are much used on gas engines, especially on the better class of engines running at the higher speeds; the long side of the rectangle is always used in the plane of the motion. Considering the middle section of the rod, let X represent the breadth or shorter dimension of the rectangle and Y, the depth or longer dimension of the rectangle. The ratio of X to Y, which may be represented by K, varies in the best practice from 2 to 2½. After deciding on a value for K, the breadth or shorter dimeusion of the rectangular section of the rod may be found by the formula

$$X = F \sqrt[4]{\frac{PL^2}{K}}$$

in which X = breadth of rectangular section of rod in inches;
F = a factor varying from about 0.024 to 0.03 for ordinary stationary engines;
P = maximum pressure on the piston, in pounds per square inch;
L = length of rod, in inches, measured from center of piston-pin to center of crank-pin;
K = ratio of longer to shorter side of rectangular section of rod, varying from 2 to 2½.

The width or breadth of a rod of rectangular section is usually the same throughout the length of the rod, but the depth of the rod at the piston end is usually made less than it is at the crank end. The piston end may be made about 0.8 times the depth at the middle section, and the depth at the crank end may be made 1.2 times the depth at the middle section. The piston-end section should be checked by figuring for simple compression as in the case of the round rod. As an example, if the connecting-rod for the 18 by 24-inch gas engine mentioned above, is to be of rectangular section, (*a*), what are the dimensions at the middle and (*b*), what is the depth of the rod at the neck?

(*a*) Assume that the depth at the middle section of the rod is 2½ times the breadth; that is, the ratio of the longer to the shorter side of the rectangle is 2½. Taking a factor of, say, 0.025 for F, the breadth or shorter dimension may be found as follows:

$$X = 0.025 \sqrt[4]{\frac{89{,}064.36 \times 60^2}{2.5}} = 2\tfrac{5}{8} \text{ inches}$$

Since the ratio of depth to breadth is 2½, the depth of the rod is 2 1/2 × 2 5/8 = 6 9/16 inches. The moment of inertia for the rectangular section, found from a table of moments of inertia, considering failure to occur in the weakest direction, is $\frac{YX^3}{12}$. The moment of inertia for the above section is $\frac{6\,9/16 \times (2\,5/8)^3}{12} = 9.9$. Applying the column formula for checking

$$W = \frac{10 \times 30{,}000{,}000 \times 9.9}{60^2} = 825{,}000 \text{ pounds.}$$

The total maximum load on the piston being 89,064.36 pounds, the approximate factor of safety is

$$\frac{825{,}000}{89{,}064.36} = 9.26.$$

This value is above the lower limit for the factor of safety, but if it is desirable to have a greater margin, the factor F may be increased slightly, or the ratio of the depth to the width of the rod may be lessened, thus giving the rod greater stiffness in the direction of its width, which is the weaker direction when treated as a column.

(*b*) The depth of the rod at the piston end may be made 0.8 times the depth at the middle; that is, 0.8 ×6 9/16 = 5 1/4 inches. The area of the rod at the small end will then be 5¼ × 2⅝ = 13.7 square inches. Checking for simple compression, the area at the small end should not be less than $89{,}064.36 \div 8000 = 11.133$ square inches. Since this is less than the area found above, the dimension may be considered safe.

Question 3—In the case of suction producers, how is the size of the gas pipo leading from the producer to the scrubber, and from the scrubber to the engine, determined?

Answer—There does not seem to be any definite rule giving the size of the gas pipe for a suction producer, but practical experience has shown that in order to have the cross-sectional area of the pipe large enough to eliminate excessive resistance, the velocity of the gas in the pipe should not exceed about 30 feet per second. A rule-of-thumb method which has given good results in practice is to use a 3-inch pipe for producers of 10 horsepower or less, and to add ¾ inch for each additional 25 horsepower. For example, a 60-horsepower producer would have a gas pipe 3 + (¾ × 2) = 4½ inches in diameter.

Question 4—Is it good practice to use a receiver in the gas pipe, and, if so, where should it be placed and what should be its volume?

Answer—In the best practice, a receiver, or expansion box, is placed near the engine in the gas main so as to furnish a good volume of gas from which to fill the engine cylinder. The volume of the receiver will depend somewhat on the space available, but in no case should it be less than one-half the volume of the cylinder, and it should preferably be larger.

Question 5—How much smaller should the journals of a gas-engine shaft be made than the diameter of the bearings, in order to have a good running fit?

Answer—The allowance for a running fit will depend on the diameter of the shaft. Under ordinary conditions the diameter of the journal may be made 0.001 inch smaller than the diameter of the bearing for all sizes of shafts up to 5 inches in diameter; 0.002 inch smaller for shafts from 5 to 12 inches in diameter; 0.003 inch smaller for shafts from 12 to 18 incnes in diameter; and 0.004 inch smaller for all larger sizes.

* * *

There is no simple thing that will do more to take the gloomy haze off Monday morning than for every man about the shop to don clean overalls and jumpers.

THE EXTRUSION PROCESS*

METHODS, MACHINES AND ALLOYS

By E. F. LAKE†

The extrusion process for manufacturing metal shapes for various purposes is rapidly growing in favor. With it, intricate shapes can be made that would be impossible to roll and that would be very expensive to machine; and shapes that could be rolled can be produced more accurately to size by the extrusion process than by rolling, and they can be made from various kinds of metals. While the principle on which this process operates is a very old one, it was not a commercial success until the hydraulic press was enough developed to be used for this purpose. During the past two decades many improvements have been made that have enabled shapes to be made quicker and cheaper, and of metals that are stronger, harder and tougher than those formerly used. The great progress in metallurgy also has produced strong alloys that could be more easily extruded.

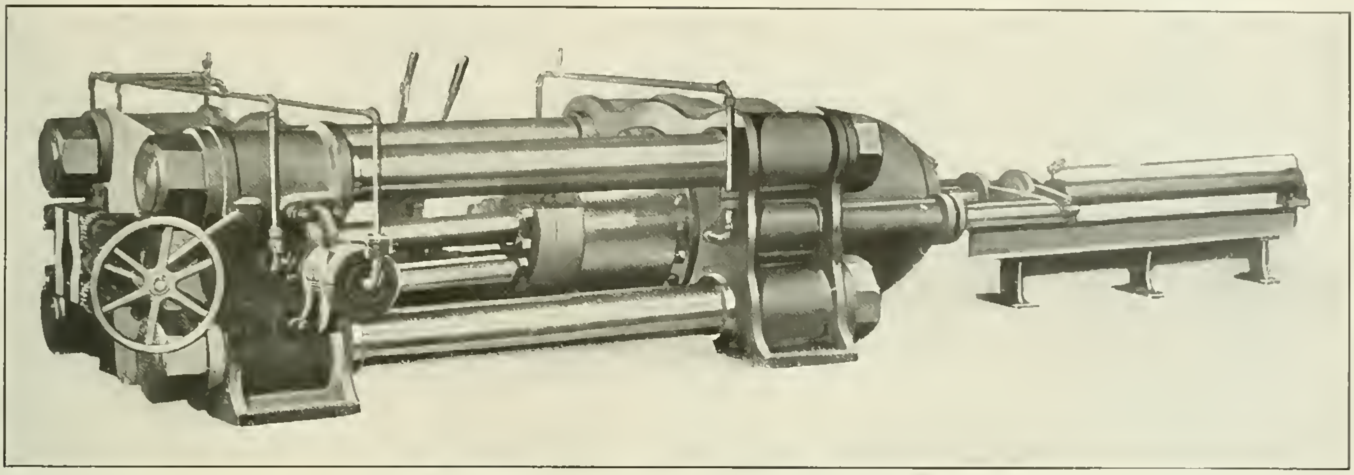
Fig. 1. Two-thousand-ton Hydraulic Extrusion Press, built by Watson-Stillman Co., New York

In Fig. 1 is shown one of the latest types of machines used for extruding or squirting solid metal alloys through metal dies into the required shapes. Like most other machines of the present day, the one shown has evolved, or gradually grown, from a crude, simple device. It has required the services of many engineers and mechanics and over a century of time, to develop it to its present state. The alloys and the methods of extruding them have also passed through the same evolution. Notwithstanding this, some manufacturers very zealously guard the methods employed in producing extruded shapes as secret processes. Like many other methods, however, they are secret in name only, and the details can always be obtained by those who make a study of this subject.

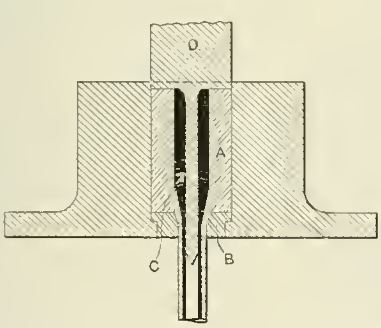

Fig. 2. Making Tin-lined Lead Pipe

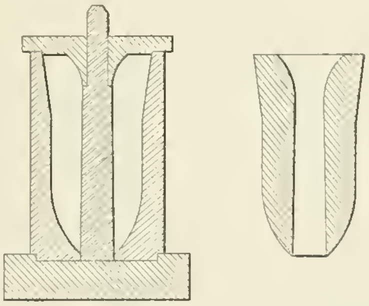
Fig. 3. Improved Ingot Mold and Lead Ingot

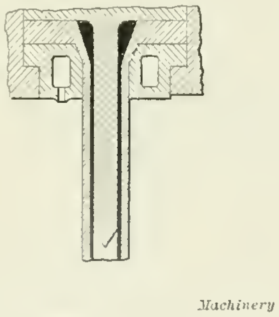

Fig. 4. Jacketed Die

Historical Review

The first patents on record were taken out in England in 1797. Like the die-casting process, the extrusion process started by using lead for the metal to be extruded. Lead-tin alloys were used later, and these developed into the lead-tin-antimony compositions that are used for type and anti-friction metals, and led the way to the copper-zinc alloys that may contain small percentages of aluminum, lead, nickel, iron or other ingredients.

One of the first forms of extrusion machines is shown in Fig. 5. In this the cylinder was packed full of lead and the whole heated so that the hand screw would squirt the lead out at the end in the form of a lead rod of the shape or size desired. The lead-tin alloys used for soldering were made into rods in a similar manner. The next step was to put a rod in the center of the plunger as shown in Fig. 6. This rod partly filled the opening through which the metal passed, so that the latter was extruded in the shape of a tube. This simple tool was enlarged and developed into a power-driven machine, and used in the manufacture of lead pipe. The machine, still further enlarged, was used for making very large lead pipe, which, after it left the machine, was split longitudinally and straightened out into lead sheets.

Later, special machines were designed for making lead sheets in a different manner. In 1847, J. Robertson designed the machine shown in Fig. 7. In this, the opening at *A* was filled with lead and plunger *B* was forced down into it, causing the lead to rise on both sides in thin sheets as shown at *C*. This machine was improved by making plunger *B* entirely fill opening *A* and cutting a slot at *D* to allow the lead sheet to come out at the bottom. Still later, the machine was made horizontal and dies inserted at *D*, so that the sheets could be more easily handled and sheets of different thicknesses made by inserting different dies.

In 1863 tin-lined pipe was made by placing a hollow ingot of tin inside of a hollow lead ingot and forcing both through the die as shown in Fig. 2. In this, *A* is the hollow lead ingot; *C*, the hollow tin ingot; *B*, the die; and *D*, the ram that forces the metal through the die. Previous to this, lead pipe was lined with tin by melting it inside of the pipe, but it was very difficult to make the tin cover the whole interior of the pipe, and it would be likely to form lumps and be unequal in thickness. While the new method overcame this trouble, it presented other difficulties due to the sharp corners in the cylinder. Therefore, the lead ingots were cast in a mold of the shape shown in Fig. 3, and the tin ingots were cast in another mold that would make them fit the inside of the lead ingot. Another difficulty encountered was due to the uneven heating of the dies, and they were jacketed as shown in Fig.

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* See MACHINERY, August, 1906: "Extruded Metal Sections."

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4, so that steam or water could be circulated through them. In this way the die could be heated up to the required temperature before starting to make pipe, and maintained at this temperature while running.

In 1869, A. H. Hamon of Paris, France, patented the hydraulic press shown in Fig. 8 for manufacturing tin-lined lead pipe. In this the lead ingot that surrounded the hollow tin ingot was placed in the cylinder at *A*, and ram *D* was operated to force the metal through the die at *C* and the opening at *B*, where it was coiled onto a reel. A blast of hot air or steam was sent through the ports *E* to bring the metal to the correct temperature for extrusion. This temperature was below the melting point of the tin, but high enough to make the mass pasty, so that it could easily be extruded through the die. This design is practically the same as that of the extrusion machines of the present day. Some details have been improved, however, and metals of a higher melting temperature can be extruded. Thus, some of the more plastic brasses are now made into commercial shapes.

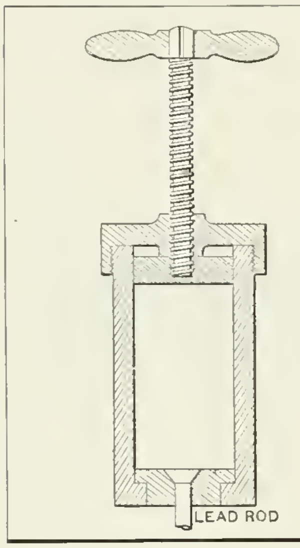


Fig. 5. Early Press for Making Lead Rods

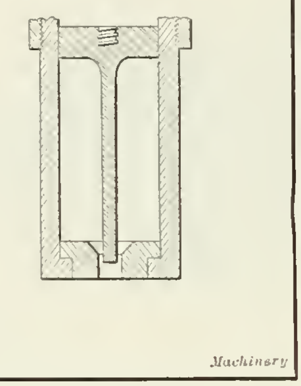


Fig. 6. Principle of Press for Making Lead Pipe

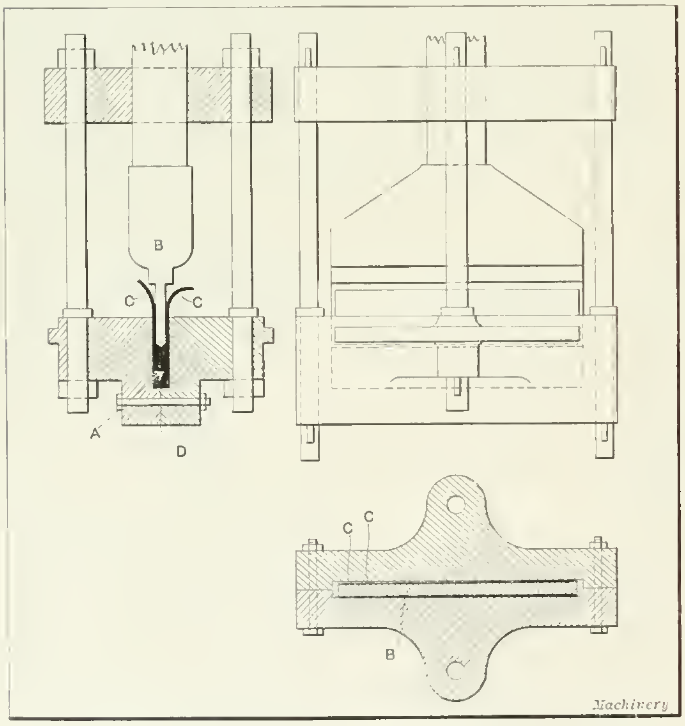


Fig. 7. Machine for Making Lead Sheets

In 1873, Robert Cunningham patented a device for making curved pipe for water traps, and a re-issue of this patent was granted in 1881. This device is shown in Fig. 9. It can be attached to any machine that contains hot lead and the required mechanism for squirting the lead through it. The diaphragm *A* moves back and forth through case *B*. Its center hole will thus, at times, be eccentric with the interior opening of the case, and, thereby, control the volume of metal that passes through this opening on different sides. When the hole in the diaphragm is central with the case, the volume of metal that passes through on all sides of core *C* will be equal, and the extruded pipe will be straight, as shown in the upper right-hand corner of the illustration. When the diaphragm is moved to the left, however, the largest volume of metal will pass on the left-hand side of core *C*, and the pipe will curve to the right, as shown in the lower left-hand view. When diaphragm *A* is pushed to the right, the volume of metal will be largest on the right-hand side, and the pipe will curve in the opposite direction. Thus, by pushing this diaphragm to the right and left the required distance, traps can be made as shown in the lower right-hand view, and these can be given any desired form.

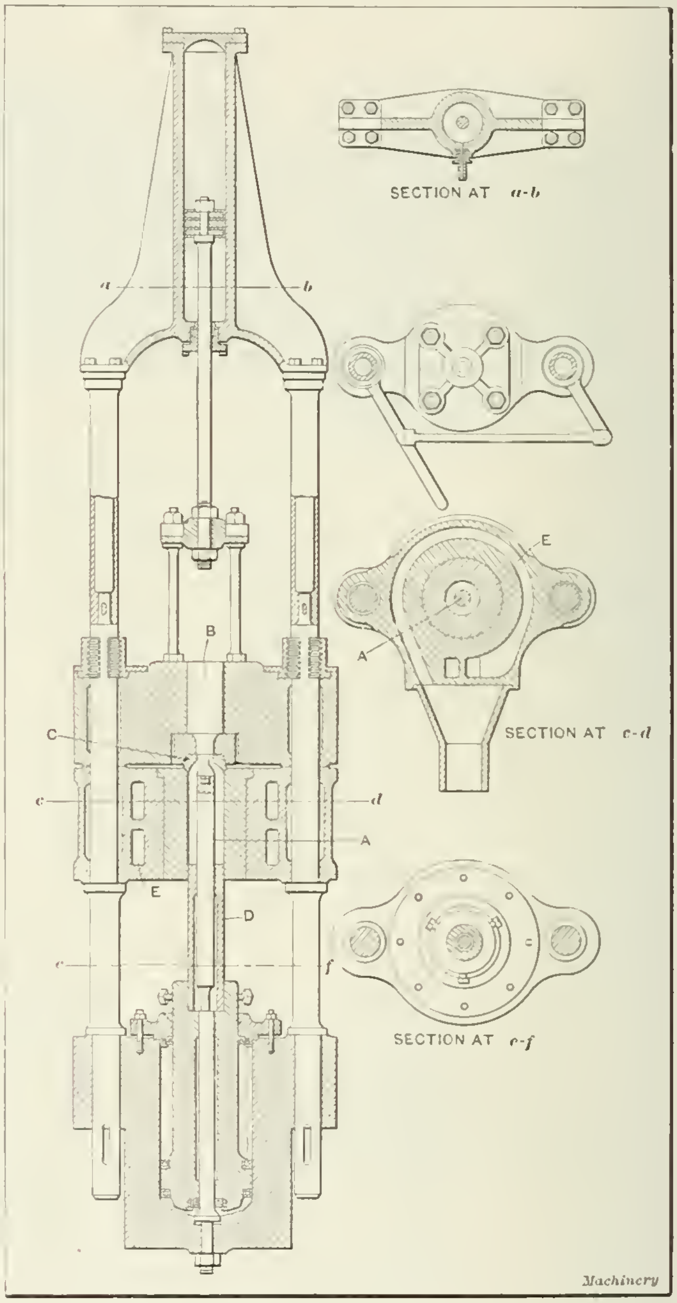


Fig 8. Hydraulic Press for Making Tin-lined Lead Pipe

Another method of accomplishing the same results is shown in Fig. 10. In this case the volume of metal on different sides of the core is controlled by two rams. When rams *A* and *B* are forced in at an equal speed, the metal coming out around core *C* will be equal in volume on all sides and the pipe will be straight. If ram *A* is made to travel faster than ram *B*, the volume of metal to the right of core *C* will be the greater, and the pipe will curve to the left. If ram *B* is made to travel faster than *A*, the volume of metal to the left of core *C* will be the greater, and the pipe will curve in the opposite direction.

In Fig. 11 is shown still another device that performs the same work. In this case ram *A* is made in two halves, each of which can be driven at a different speed. Hence, the metal on either side of partition *B* can be forced through the opening around core *C* in varying volumes. This causes the lead pipe to curve in either direction as much as desired, or extrudes it in a straight line.

The softer metals were also extruded in other shapes for various purposes, such as printers' leads, shapes for holding glass in leaded glass windows (as shown in Fig. 12), etc. Very thin metals used for metal foil were also produced. These latter were made from lead-tin alloys, and many different compositions were used to get stronger, tougher and better wearing metals than pure lead. Very thin tubes, such as are used for artists' paints and similar materials, were also made by a similar process. At *A* in Fig. 13 is shown a disk of metal with plunger *B* in position to be forced down into it. At *C*, the plunger is shown at the bottom of its stroke and the tube is completely formed. The grids or plates for secondary batteries were made by the extrusion process as much as twenty-five years ago. These consist of narrow strips of metal crossing each other, and joined at the intersections so as to form hollow squares. They often have more than one hundred squares in them. They were made by extruding a long cellular mass which was later cut up into thin grids.

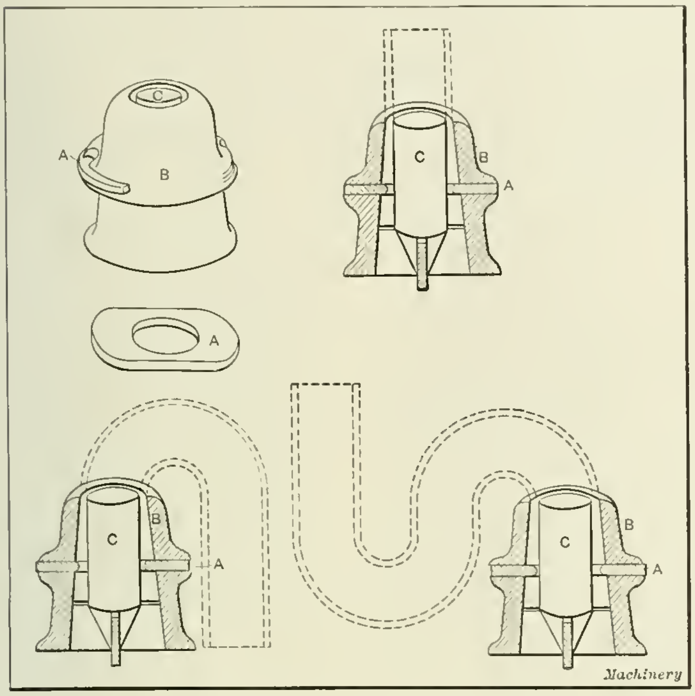
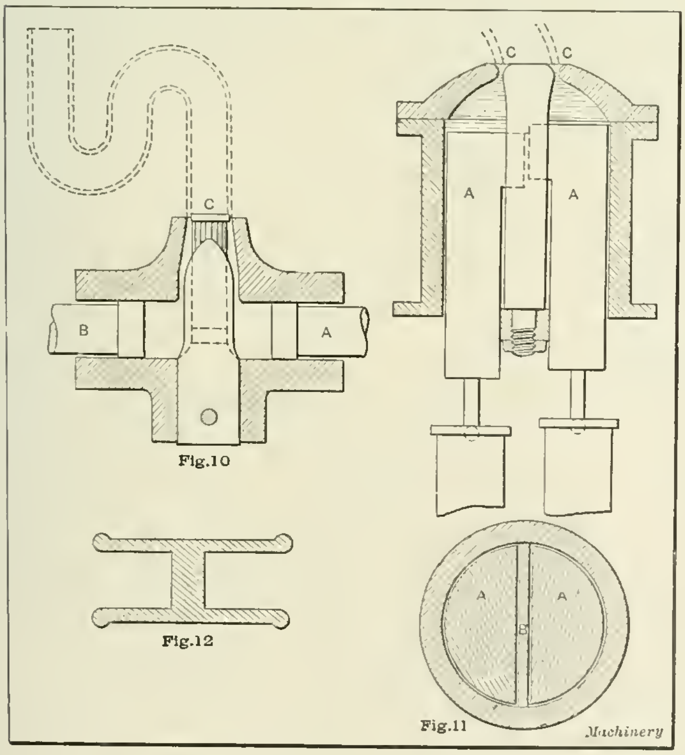


Fig. 9. Device for Making Lead Traps



Figs. 10 and 11. Other Devices for Making Curved Pipe. Fig. 12. Extruded Shape used for Leaded Glass Windows

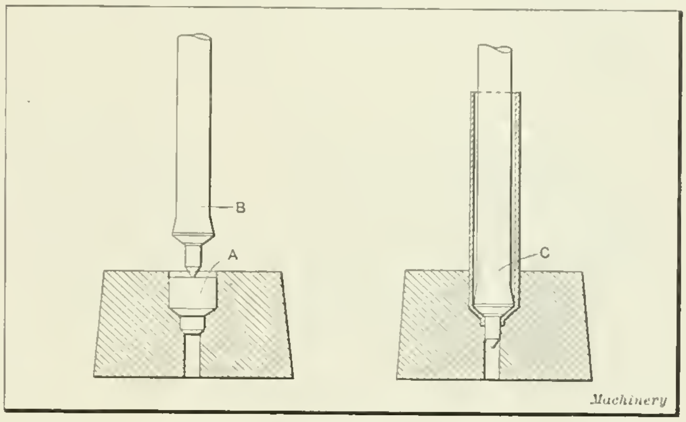


Fig. 13. Method of Tube Making

When metals or alloys with a higher melting temperature than the lead and tin first used were formed into various shapes by the extrusion process, several problems other than that of a powerful machine presented themselves. One of the greatest of these problems was that of the temperature. It was very desirable to be able to extrude brasses and bronzes, as they were much stronger than alloys with a lead or tin base. It was necessary to keep the temperature below the fusion point, as otherwise it would be difficult to cool the extruded shape to the solid state before it left the die. Also, if the metal was too soft when being extruded, it would not be subjected to the compression required to give it the additional strength that made the process really valuable. On the other hand, if the temperature was not high enough, the metal would not extrude through the die opening, and the billet would spread in the cylinder or container, grip the side walls, and thus become wedged in.

It was also difficult to find a metal for the dies that would withstand the strains produced by the hydraulic ram, or keep cool enough when the heated metal was being forced through. It was found, however, that tungsten steel would not soften enough to be pressed out of shape when brasses and bronze were extruded at a temperature just below the melting point. To maintain this temperature while the whole billet was being extruded was, however, difficult. This difficulty was finally overcome by designing special billet containers, and these are now a part of all extruding machines.

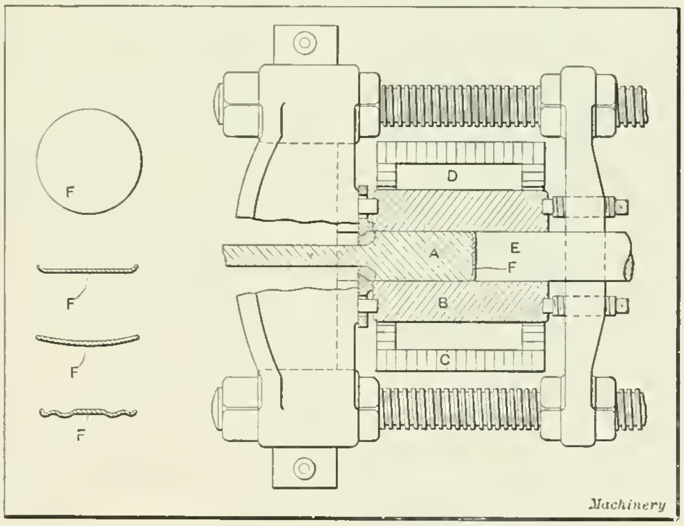


Fig. 14 Coke-fired Ingot Container

Billet Containers

One of the first designs of this type was patented by George A. Dick in England in 1893. This device is shown in Fig. 14, in which *A* is the billet of metal that is being extruded; *B*, the cylinder or billet container; *C*, a case built around the container; and *D*, a passage through which the flames from a coke or coal fire were passed. With this apparatus, copper and zinc alloys that were red hot and plastic at from 800 to 900 degrees F., were successfully extruded. When the billet was inserted in the container, a disk similar to those shown at *F* was placed over the end of the ram *E*. This disk will spread, fit the wall of the container tightly, and prevent the metal in the billet from squeezing back past the ram and wedging it. These disks were made from metal with a higher melting temperature and less plasticity than the metal being extruded.

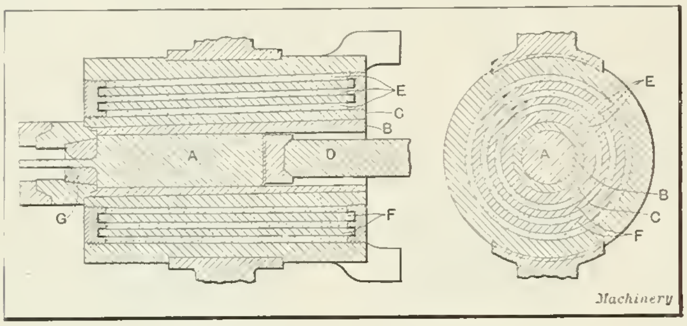


Fig. 15. Steel and Asbestos Container

While this device worked better than anything previously used, it was difficult to control the coke fire so as to maintain a uniform temperature. Another difficulty was met with in trying to conduct the heat away from the head, owing to the thickness of the metal that had to be used to withstand the pressure exerted by the hydraulic ram. As considerable heat was given out by the billet, and the penetration through the thick cylinder wall was slow, the exterior would be much cooler than the interior. This caused unequal expansion and contraction, and frequently resulted in cracks and fractures. Hence, a built-up head or billet container was designed, having alternate layers of steel and asbestos.

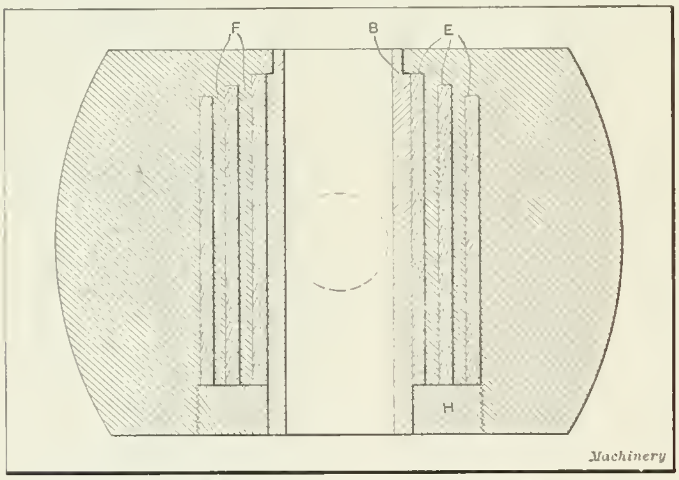


Fig. 16. Cast Container with Layers of Heat Insulating Materials

One of the first built-up containers is illustrated in Fig. 15. This also was designed by Mr. Dick in the same year as the coke-fired container. Most of those in use at the present time are built on this principle; *A* is the billet; *B*, the tapered container that fits into a tapered hole in the built-up cylinder; *D*, the ram; *E*, the openings between the steel rings *F*, which are packed full of asbestos; and *G*, the die through which the billet is extruded.

By surrounding the walls with several layers of refractory material, like asbestos, supported by steel rings, the heat was prevented from penetrating the cylinder walls. By thus keeping the cylinder at a lower temperature, it had greater power to resist the pressure from the ram; and by retaining the heat in the billet, its temperature was kept more uniform, and it could be more easily extruded. This design also greatly reduced the unequal expansion and contraction and the consequent cracking and breaking. These cylinders, or containers, enabled the extrusion process of manufacturing metal shapes to become much more of a commercial success, and to-day many parts are being manufactured more economically in this manner than they formerly were by casting in sand molds.

Following the Dick designs, many forms of billet containers have been designed. Fig. 16 shows one in which the outer case *A* and steel rings *F* were cast in one piece. After the billet container *B* had been put into position, the openings were packed with heat-insulating materials, and ring *H* was screwed into the case. In Fig. 17 cores were made from broken granite, soapstone, trap-rock or other suitable heat insulating materials, and these were located in the mold and the case cast solidly around them. Billet container *B*, however, was inserted as a separate piece, because this part wears and must be replaced, while the container proper may last indefinitely. It is not always possible to manufacture cylinders in this way, as the metal from which they are cast may shrink much more than the refractory material in the cores. This is almost sure to cause a fracture in the casting when it is solidifying. A style in which the cylinder is cast hollow is shown in Fig. 18. After the billet container *B* has been placed in position, the hollow space is filled with refractory materials like glass, sand, etc., by forcing these materials through valve *I*, with a force pump, as shown.

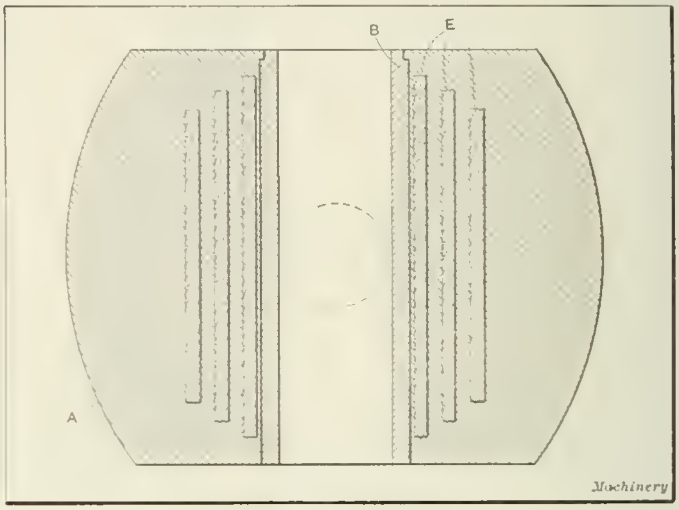


Fig 17. Another Type of Cast Container

In Fig. 19 lining *B* is wound with asbestos-covered flat wire and the cylinder clamped together over this with bolts. The form of wire shown at *J* is used, and the coils are separated by rings of asbestos. This retains the heat and strengthens lining *B* enough to prevent it from bulging or cracking under the pressure transmitted by the ram. The rings of asbestos

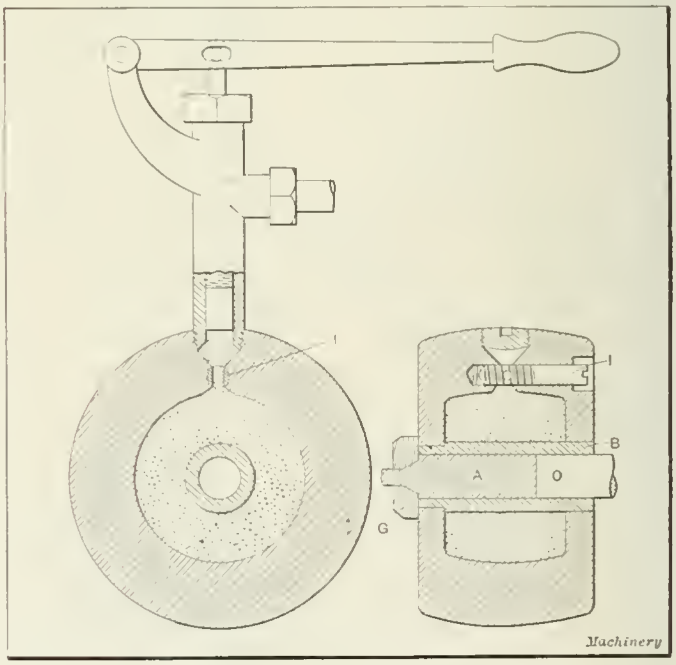


Fig. 18. Heat Insulation forced into Place by Pump

may be left out, and the covered wire wound in solid, or it may be wound alternately with strips of asbestos of the same size, staggered. A sectional view would then present the appearance of a checker board.

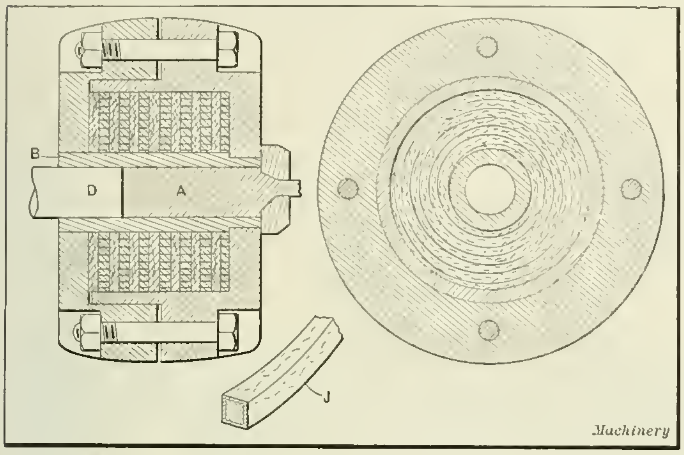


Fig. 19. Container wound with Wire and Asbestos Insulation

Electrically-heated Container

One of the latest types of cylinders is arranged so that the ingot to be extruded can be electrically heated. Not only the cylinder, but the die block and the end of the ram also can be similarly heated. This is shown in Fig. 20. Here *A* is the ingot that is being extruded; *B*, the billet container; *C*, the cylinder; *D*, the ram or plunger; and *E*, the winding of metallic tape which has enough resistance to impede the current and generate the heat. A section of this tape is shown at *X*. It is usually made of copper and covered with some insulating material. Insulating material that confines the electric current and prevents it from entering other parts of the machine is shown at *F*; *G* is the die, and *H* the die block, which may also be electrically heated by constructing it as shown at *Y*. The end of the ram *D* may be electrically heated by constructing it as shown at *Z*. This would entirely surround the billet with electric heating apparatus.

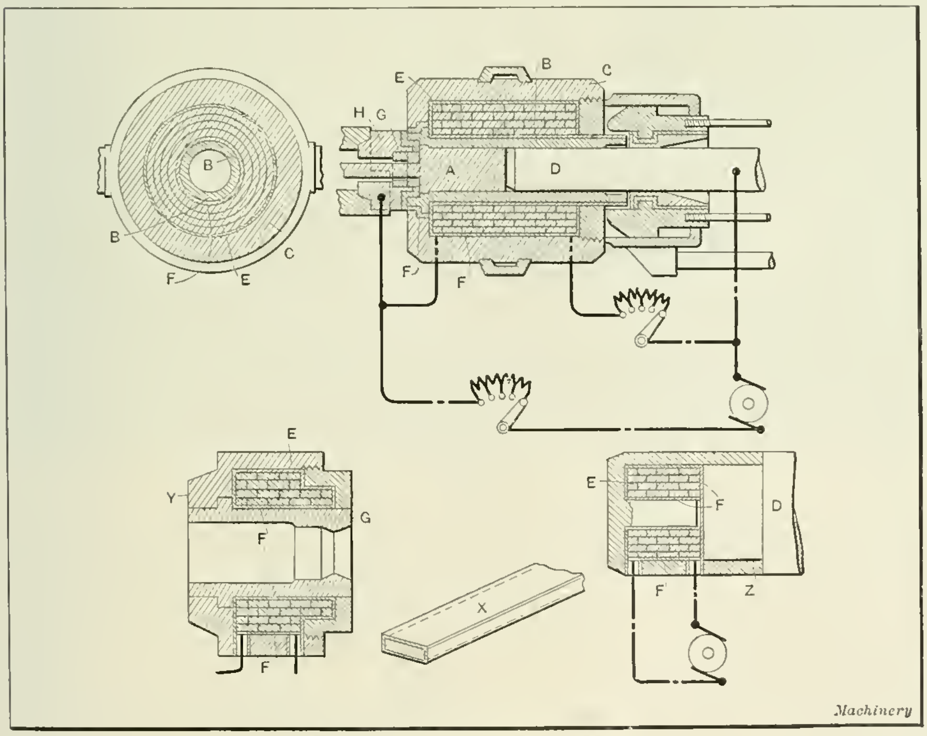


Fig. 20. Electrically-heated Container

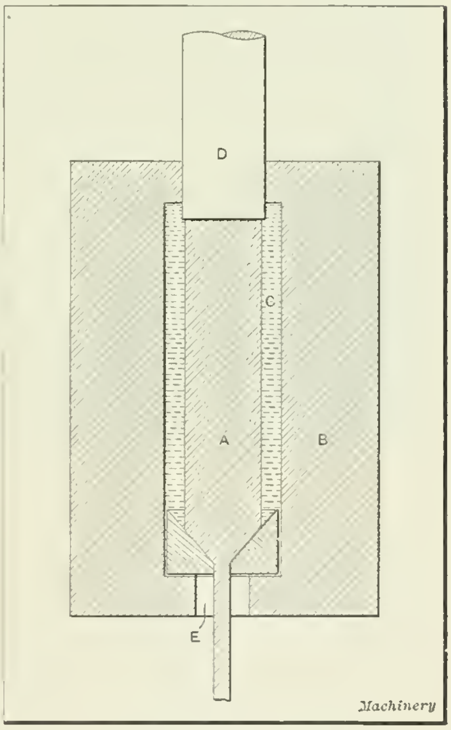


Fig. 21. Liquid-surrounded Ingot

In extruding machines or processes, the billet is heated to the proper temperature before it is placed in the cylinder, and hence the only thing required is a maintenance of this temperature until the metal has been extruded. If, therefore, the cylinder were electrically heated, it might be all that would be required. The ram would seldom require heating, and it would weaken it to place a resistance in the end of the ram. For metals with higher melting temperatures, however, it might be desirable to heat the die-block electrically, and this could readily be done as shown. The electric current is by far the best means of heating the metal and maintaining it at a steady temperature. With rheostats, the current can be easily controlled, and, consequently, the amount of heat required to maintain an alloy at a certain temperature is easily regulated to within a few degrees.

Special Forms of Containers

An attempt was made to abolish the troubles caused by billets adhering to the container walls as shown by the design in Fig. 21. Here billet *A* is much smaller in diameter than container *B* and is surrounded with some kind of liquid at *C*. Thus, when ram *D* forces the metal through die *E*, liquid *C* is supposed to keep the ingot from gripping the walls of the container and wedging therein. It is claimed for this method that aluminum or metals of similar ductility can be extruded at atmospheric temperature, this being due to the fact that the billets can be made much smaller in diameter than the interior of the containers; that the ram *D* need only be a tight fit at the extreme end of the container; and that the liquid acts as a lubricant, and the adhesive force is thus entirely overcome. Thus a greater power can be applied to the ram, and the extruded metal be made more dense. The heat can also be done away with, except that which is caused by friction when the metal passes through die *E*. The liquid *C* can be oil when metals are extruded cold, and this will lubricate the apparatus and aid in overcoming the friction as it passes through the die. Water also might be used. Metals of a higher melting temperature could be extruded, and consequently greater strengths obtained. When it became necessary to heat metals for extrusion, fused caustic potash or other materials might be used.

In attempting to press cold metals through a contracted hole like the die of an extrusion press, the billet spreads under the compression and grips the side walls. To overcome this adhesive force and make it less than the forward pressure of the ram, billets are softened and made plastic by raising their temperature. This also reduces the strain against the die. If the extruding metal is heated too high it will be too soft, and its grain will be coarsened. The design of cylinders requires that the ram or plunger shall fit the billet container so tight that no metal from the billet can force its way between the ram and the container wall. At the same time it must be loose enough not to score the sides of the container. These requirements also put a limit upon the pressure which can be employed. This limit is not very high, owing to the fact that the die spreads in proportion to the strain put upon it. The higher the temperature to which it is heated, the more will it give way to this strain.

When metals are extruded at atmospheric temperature, a higher pressure must be used. The metal is condensed more and the grain greatly refined. This adds strength, hardness, and toughness to the metals to a degree that it is impossible to attain in other ways. One illustration of the pressures required is shown by the fact that to extrude aluminum at 600 degrees F. only requires one-fifth of the pressure that is required at 70 degrees.

A Modern Extrusion Press

The principal parts of a complete modern extrusion machine are shown in detail in Fig. 22. Nearly all of the hand labor is done away with in this machine: It heats the billets to the proper temperature, inserts them in the container by hydraulic pressure, and extrudes them by the same pressure. Four gas heated furnaces are located around a central shaft under the extruding press so that their tops come a little above the floor line. Three of the furnaces when they are in the positions *A*, *B* and *C* are covered with a disk screen *E*, that has an opening over each furnace. When starting the operations, the cold billet is inserted in the furnace located at *A*; cover *F*, containing a vent-hole, is placed over it, and the furnace revolved to the position at *B*. It is next revolved to the position at *C*, and while in the positions *B* and *C*, other billets are being extruded. After this, it is turned to the position at *D*.

The cylinder is then revolved on trunnions to the position shown at *G*; cover *H* is placed over it, and billet *I* is pushed up into it by hydraulic piston *J* raising loose block *K* from the bottom of the furnace where billet *I* rests on it. The gas for heating the furnaces enters the hollow shaft on which they revolve, and passes out through ports and piping to each of the four furnaces. The air passes through ports surrounding this hollow central shaft and then through pipes to the different furnaces. After the billet is in the cylinder, this is again revolved on its trunnions to the extruding position; projection *L*, on disk cover *E*, prevents the billet from falling out while the cylinder is being revolved.

With the extrusion cylinder in position, fluid is admitted under pressure to the hydraulic cylinder through port *M*. This moves the hollow piston *N* forward and first transmits power to the device *O* and rod *P* and causes part *Q* to butt against extrusion cylinder *G* and hold it firmly in its seat

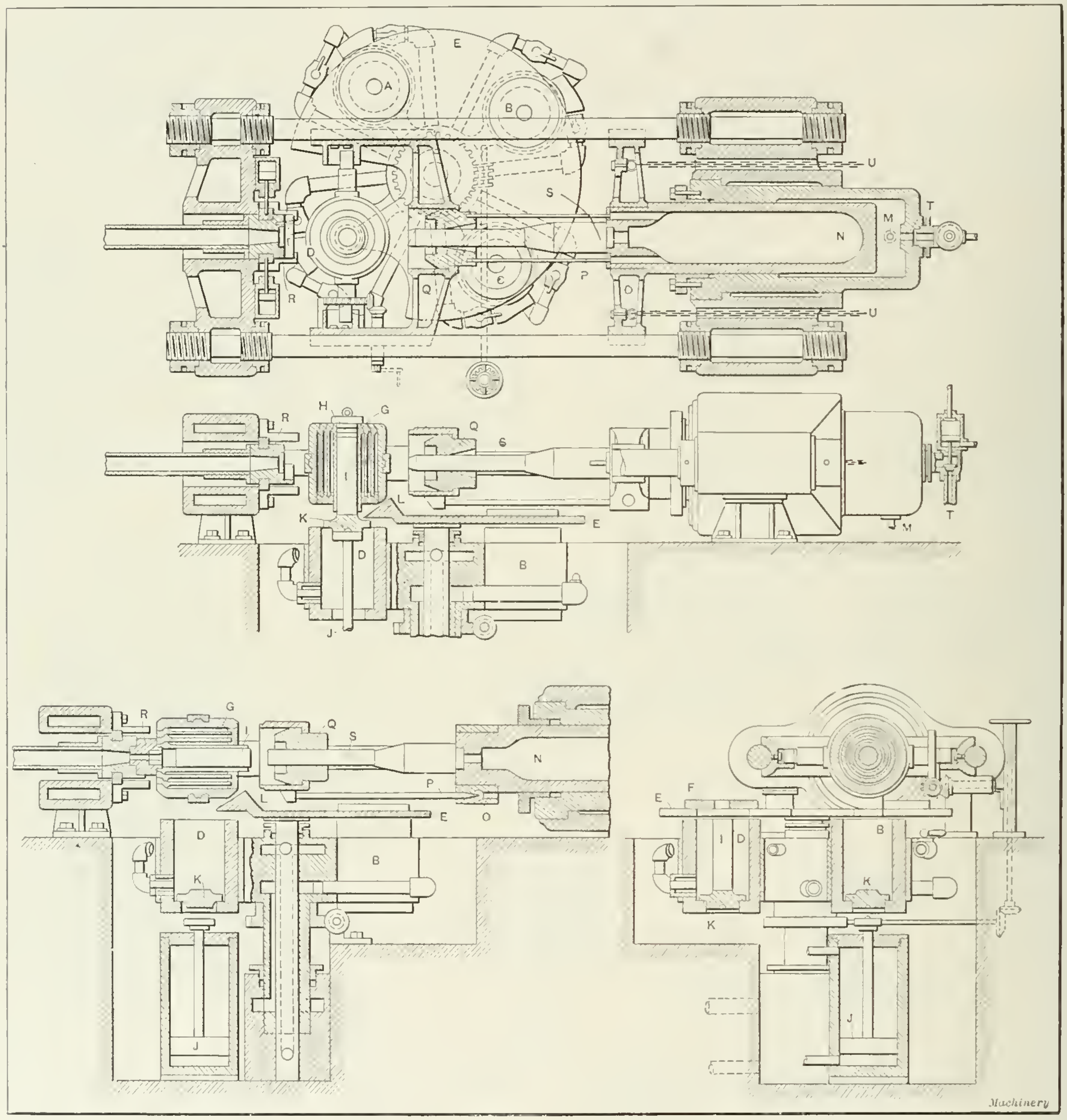


Fig. 22. Main Features of a Modern Extrusion Machine

against the die and die-holder *R*. Container cover *H* has, of course, been removed. Now, ram *S* acts on billet *I* and extrudes it through die *R*. When the ram has reached the end of its stroke, the fluid is allowed to escape through port *T* and with the other mechanism attached, the ram is brought back to the starting position by weights attached to chains *U*.

In this machine, as well as in others, a small end of the billet cannot be extruded. This part often sticks in the cylinder, but it is easily removed by turning the cylinder over the furnace at *D* and turning on the gas, so as to melt it out. With this machine many alloys can be extruded that could not be used with the cruder and simpler machines formerly employed.

Metals and Metal Alloys used in the Extrusion Process

In the extrusion of metals it is natural that lead should have been the one first used, as this is the most plastic of metals. Lead in the form of filings can be compressed into solid metal with 13 tons pressure to the square inch. It will flow through all the cracks of the apparatus, like liquid, when a pressure of 32 tons per square inch is applied to it. Its plasticity as compared with that of other metals is shown by the fact that powdered tin can be made into solid metal with a pressure of 19 tons per square inch; copper, with 33 tons; zinc, antimony, aluminum and bismuth with 38 tons, while other metals require considerably greater pressure than this. Tin would flow through the cracks of the apparatus like liquid at a pressure of 47 tons per square inch, and the other metals at a considerably higher pressure. Lead and tin, or any alloys that might be made from them, however, have very little strength and thus their use has been limited.

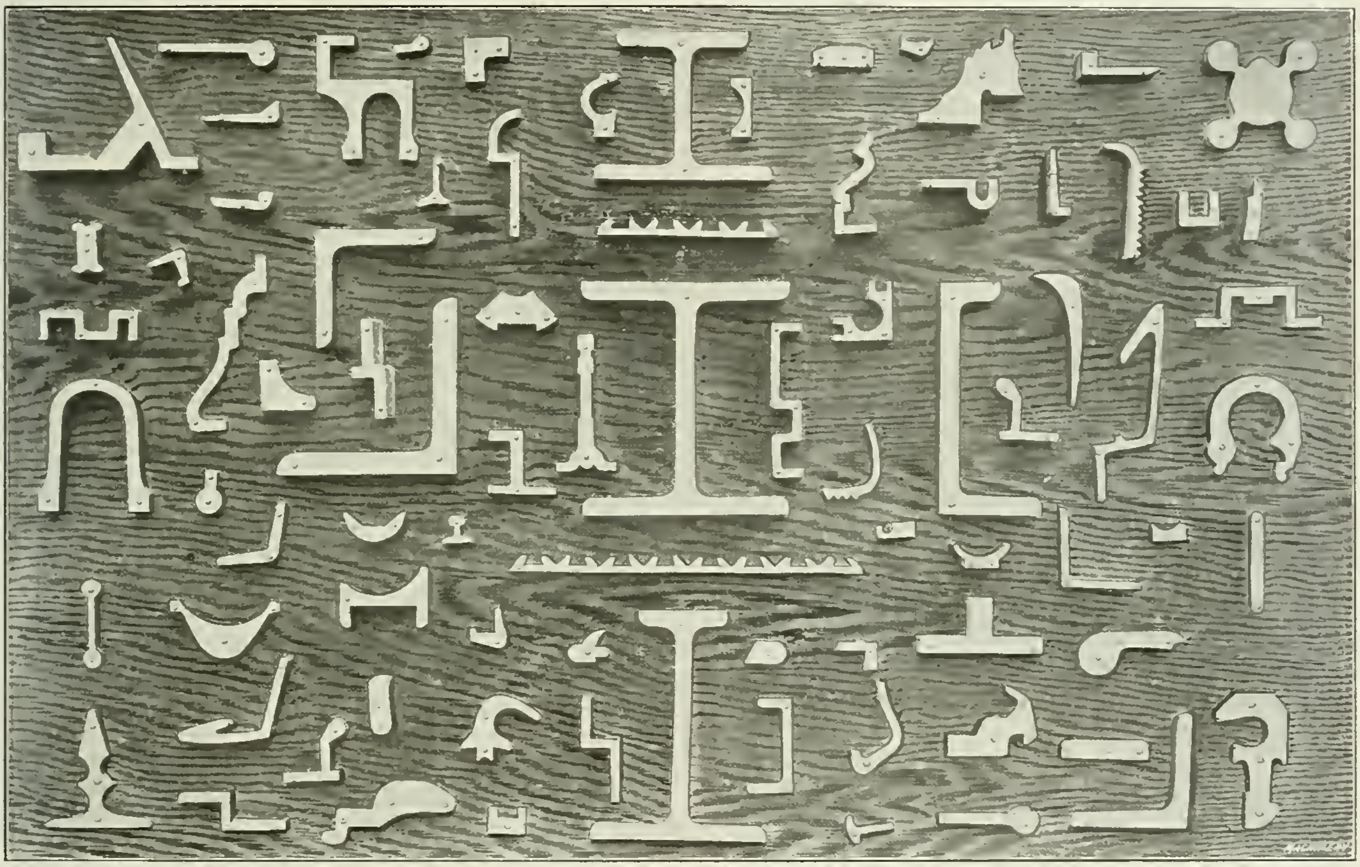


Fig. 23. Examples of Extruded Metal Shapes produced by the Coe Brass Mfg. Co.

While copper is very malleable, ductile and tough, and consequently would flow freely through a die under pressure, it has but limited strength, and, consequently, cannot be used for very many purposes. As lead, bismuth or antimony have an injurious action on copper and make it hard brittle and cold short, these elements cannot be alloyed with it for extrusion purposes, except in very small quantities. When more than 0.5 per cent lead is added to copper it makes it both hot and cold short, and it cannot be worked hot; 0.2 per cent lead, however, may be present without impairing the tenacity of copper. Tin in small quantities does not appear to affect the working properties of copper, except to make it somewhat harder. Larger percentages of tin, however, would render copper too hard for extrusion purposes, and would give it a flaky grain that weakens the metal. When zinc is alloyed with copper, 1 per cent zinc will make the copper hard and red short, but 20 per cent zinc alloyed with 80 per cent copper will produce an exceedingly malleable alloy. Small percentages of zinc do not alter the character of copper in other ways. The zinc also produces a greater tensile strength.

An alloy composed of 55 per cent copper and 45 per cent zinc was the first comparatively strong metal that was used for extrusion purposes. This is also one of the most common alloys used at the present time. The brasses that contain from 50 to 60 per cent copper and 40 to 50 per cent zinc are the most plastic, and hence are the alloys most frequently used for extruded metals. The brasses containing from 75 to 85 per cent copper are malleable while hot, but are rather too hard to extrude easily, while the brasses containing from 62 to 70 per cent copper are not malleable at a red heat and hence are difficult to extrude.

Small quantities of iron add strength to the brasses and do not make them difficult to extrude; hence Delta metal, manganese bronze and similar alloys can be used in the extrusion process. Aluminum, when used in small percentages, makes copper harder than when 8 to 10 per cent is used, and hence the aluminum bronzes with from 8 to 10 per cent of aluminum are the most easily extruded. An alloy containing 90 per cent copper and 10 per cent aluminum, or one with 85 per cent copper, 10 per cent zinc, and 5 per cent aluminum is used for the extrusion process, but ordinarily the copper content is kept lower than this. With these aluminum bronzes, however, a tensile strength of from 65,000 to 85,000 pounds per square inch is obtained, with an elastic limit of from 40,000 to 60,000 pounds, an elongation in 8 inches of about 18 per cent, and a reduction of area of about 20 per cent. Some tests on extruded shapes made for the Government have shown even better results than this.

Pure zinc can be greatly strengthened by an extrusion process conducted in the proper way. If the area of the die opening in relation to the area of the zinc billet to be extruded is in the ratio of 1 to 15, the temperature of the metal is kept between 85 and 180 degrees F., and the extruded metal is submitted to a pressure of not less than 90,000 pounds per square inch, the coarse crystalline structure of the ordinary zinc is transformed into a fine grain, and the zinc assumes the properties of brass. A tensile strength of 29,000 pounds per square inch can be obtained in this way and an elongation of from 26 to 70 per cent. For comparison, ordinary zinc only has a tensile strength of 5000 pounds per square inch and almost no percentage of elongation. Zinc in the extruded condition can also be readily worked with machine tools and it is quite malleable and flexible.

Examples of Work Produced by the Extrusion Process

In Figs. 23 and 24 some of the shapes that are manufactured by the extrusion process are shown. The half-tone illustration Fig. 23 shows sections made by the Coe Brass Mfg. Co., Ansonia, Conn., the well-known maker of extruded shapes. Various special forms of angles are made in this way. Gears, ratchet wheels, gear racks, padlock hasps, and other special shapes are turned out in long bars which are afterwards sawed up to give the pieces their required thickness. Moldings have also been made for the Navy Department. An extruded angle that was made for the Navy had a tensile strength of 85,000 pounds per square inch, an elastic limit of 33,800 pounds per square inch, an elongation in 8 inches of 18.1 per cent, and a reduction of area of 20 per cent. Some quite intricate shapes have been made.

Where parts, such as flat lock keys, can be made in the punch press, they can be made cheaper this way than by the extrusion process. Such parts as the hasp on padocks, however, are made more economically by the extrusion process, as they would be difficult to punch out owing to their thickness. There are also numerous other lock parts that are cheaply made from extruded metal. The extruded shapes can be made to within 0.0005 inch of the correct size. This makes the process very useful for parts that would otherwise have to be machined.

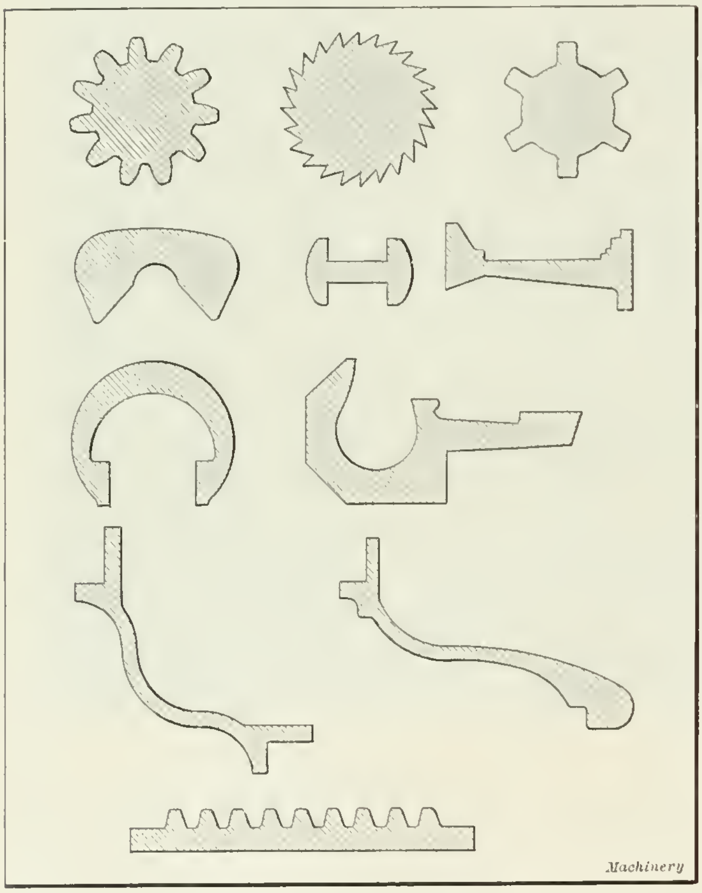


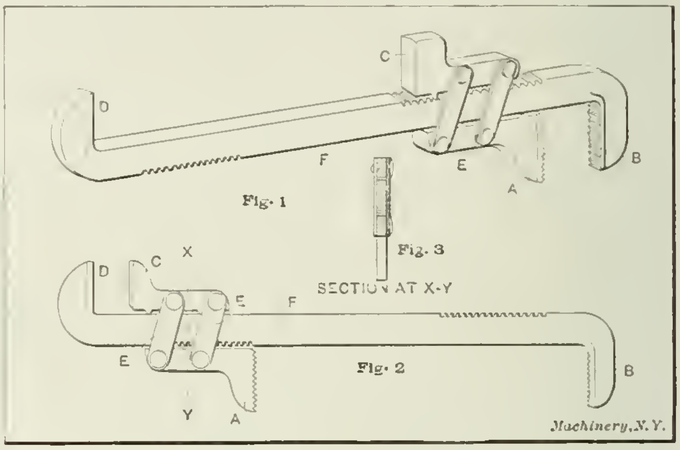
Fig. 24. A Collection of Shapes produced by the Extrusion Process

[The foregoing review of the art of extruding metals shows its state as recorded in the patent office and gives an idea of its commercial importance and future. The extrusion process is of extraordinary interest to engineers because of the inherent mechanical difficulties and the larger possibilities that may be realized when metals or materials of greater strength and heat-resisting power have been discovered and more minds are working on the problems. It is said that the process saves about one cent a pound in the manufacture of certain brass or bronze shapes as compared with drawing. Readers who can contribute authoritative articles treating of the details of dies, hydraulic clamping devices, rate of production, etc., are requested to communicate with the editorial department.—EDITOR.]

* * *

COMBINED NUT AND PIPE WRENCH

The nut and pipe wrench shown in the accompanying illustration is the subject of patent No. 994,364 granted to George R. Blair, Bellevue, Pottawatomie, Kans. Fig. 1 is a perspective view of the device arranged as a pipe wrench, Fig. 2 shows the device arranged as a nut wrench, and Fig. 3 is a cross-section taken on the line *X-Y*. This wrench consists essentially of a shank with both ends bent in opposite directions at right angles to the shank, and two movable jaws, one on each side, connected by links. The jaw *A* and end *B* of the wrench are provided with teeth, this part of the device being used as a pipe wrench, while the jaw *C* and end *D* are plain, and are used as a nut wrench. The connecting-links *E* are fastened to the jaws *A* and *C* by rivets, as shown, but they are not riveted tightly, so that the jaws may be moved to put the links in a position at right angles to the shank, this being necessary to move the jaws along the shank. Teeth forming a rack are cut in the shank *F*, on each end, in which two teeth formed on the jaws mesh when the wrench is in position for gripping the nut or pipe.



Figs. 1 to 3. Side, Perspective and Sectional Views of Combined Nut and Pipe Wrench

In using this device, either one movable jaw or the other, as desired, is moved along the shank to engage the work with the complemental fixed jaw. The opposite jaw is then pushed forward so as to cause the links *E* to assume an oblique position relative to the shank, the teeth on the jaws being engaged in the teeth in the rack. It will thus be seen that any tendency of the jaws to open will be effectively resisted by the canting effect, and the interlocking engagement of the two teeth of the jaw with those in the rack.

* * *

The Hungarian government has decided to take charge of the tremendous natural gas resources discovered at Kissarmas in Transylvania, of which the daily yield is said to amount to 26,000,000 cubic feet. This is the most important source of gas, so far discovered, in the world. This natural gas supply promises to become a source of wealth for the whole country, now that the government has decided to control the output. This is the true object and method of conservation—that the natural resources of a country are being used for the benefit of the whole people.

* * *

Ancient iron furnaces consisting of cavities or holes set with stone and having a hard burned bottom of clay mixed with slag, have recently been discovered in Hedesunda in Sweden. It is claimed that this kind of primitive furnace was used for the production of iron earlier in Sweden than in any other country. Those found at Hedesunda are the largest known; it is estimated that they were in use more than two thousand years ago.

CHAIN HARDENING BY THE TON

By CHESTER L. LUCAS*

To harden three tons of steel chain per day, and perform this feat day after day, sounds like a stupendous job of hardening for four laborers, especially when it is added that the time spent in actual hardening is but two hours of the day's work. Indeed this is a creditable performance, but the way in which the Bridgeport Metal Treating Co., of Bridgeport, Conn., handles this branch of its work is so systematic that it seems to receive no more attention than any of the other work. Through the courtesy of Mr. Wm. T. Gibson, general manager of the above company, the details of the chain-hardening process, and a description of the general hardening equipment used in the regular work of the company, are here presented.

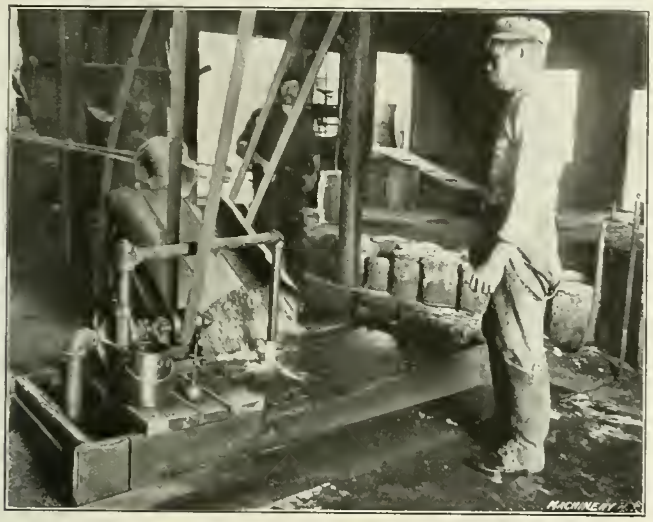


Fig. 1. Tank used for Hardening, and Boxes packed with Chain

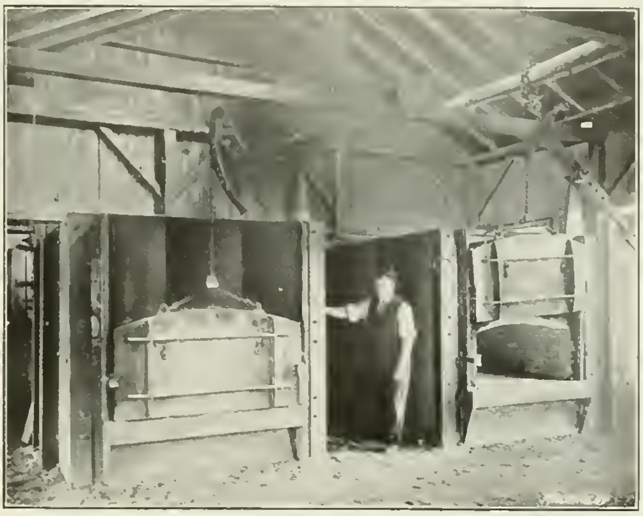


Fig. 2. The Carbonizing Furnaces

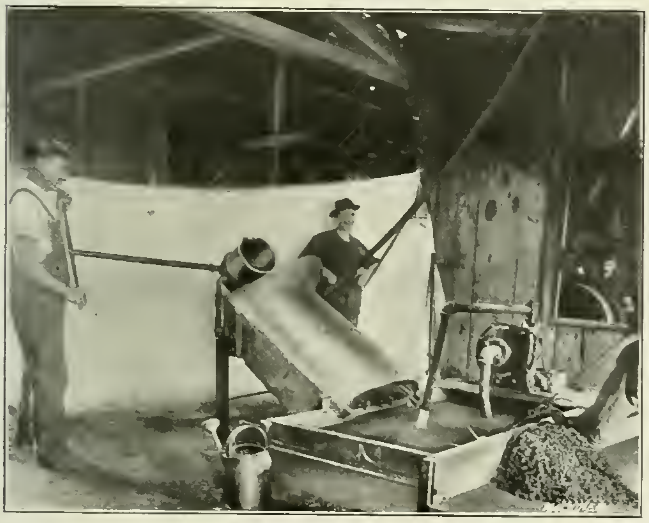


Fig. 3. Ready to harden a Box of Chain

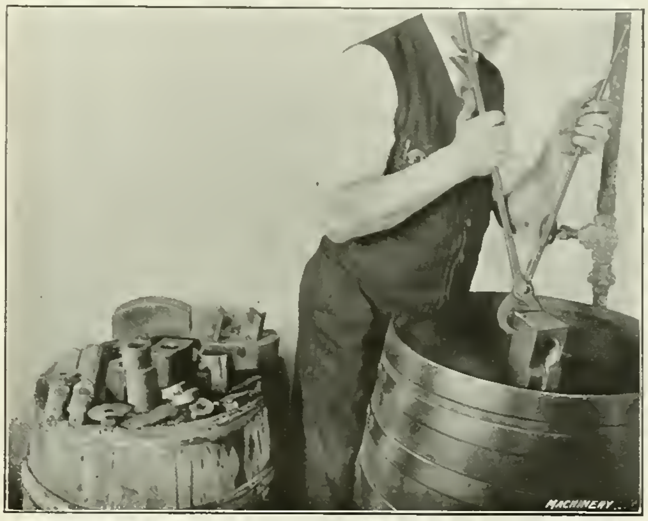


Fig. 4. Hardening an Embossing Die for Silver Spoons

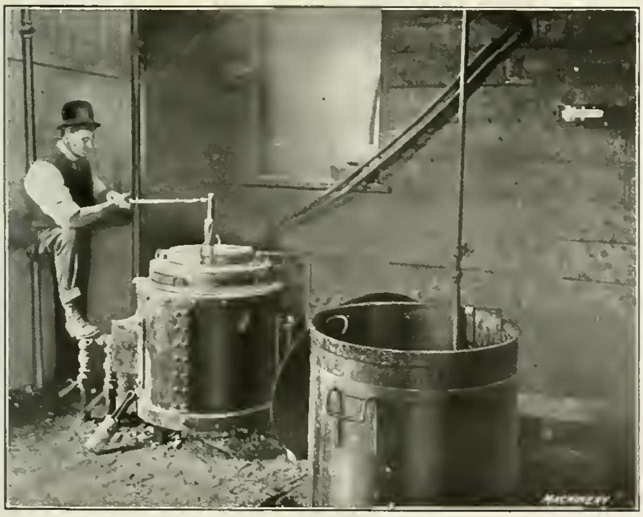


Fig. 5. High-speed Steel Furnace, illustrating the use of the Pyrometer

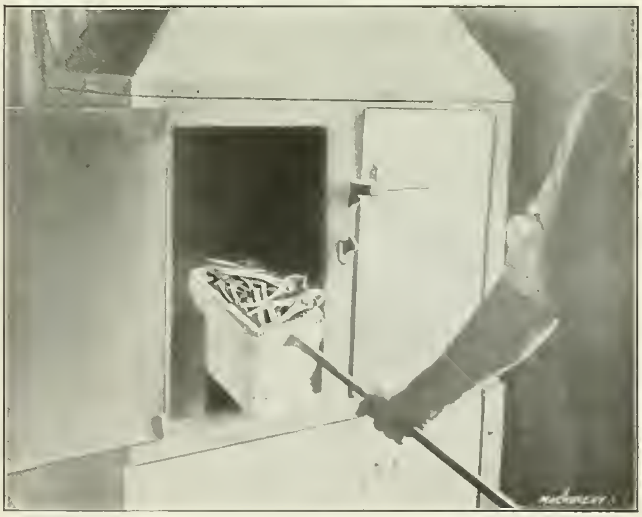


Fig. 6. Hardening Pliers by the Basketful in the Soda Ash Bath

The chain itself is composed of one-inch links, made in short lengths ranging from ten to eighteen inches, and is used in large quantities by manufacturers of automobile accessories. The material is low-carbon steel, so that carbonizing is necessary before the chain can be hardened. For this purpose the chain is packed in iron boxes with granulated raw bone and is heated for several hours to carbonize the chain to a sufficient depth. As the chain is not subjected to any great strain, the principal reason for the hardening is to secure a surface that will wear well. In packing the chain in the iron boxes, the raw bone is first mixed with spent bone so as to give the mixture more body, for clear raw bone would supply more carbon than necessary, and only result in a waste of the material. In the background of Fig. 1 may be seen a number of the boxes of chain packed and ready for the carbonizing furnaces.

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* Associate Editor of MACHINERY.

The Carbonizing Furnaces

Fig. 2 shows two of the carbonizing furnaces in which the boxes of chain are heated for hardening. They are of the well-known Rockwell make, being of the over-fired type. These furnaces have displaced the old-style under-fired furnaces that were previously used in this shop. The old-style furnaces burned on an average of 60 gallons of oil per day of ten hours, while the over-fired furnaces consume but 40 gallons of oil in the same time, and give a more uniform heat. As shown in the illustration, the oil and air supply is at the rear. The furnace at the right shows the interior of the heating chamber.

In order to make clear the construction of the Rockwell over-fired type of furnace, the line-engraving Fig. 8 is shown. At the extreme top of the furnace is the combustion chamber, from which the products of combustion are distributed through the perforated arch into the working chamber below. The spent gases are discharged through the outlets at the sides and pass through the space beneath the floor of the working chamber. Fig. 8 also shows the pyrometer arrangement employed with this style of furnace. The pyrometer plays an important part in hardening operations as practiced in the up-to-date shop. In using this type of furnace, pyrometer readings are obtained by passing the thermo-nipple through a small opening in the side wall, near the rear of the furnace. From the extension piece shown, the leads are connected with the instrument that is kept in a more convenient location. Pyrometer readings show that the over-fired furnace is far superior to the under-fired furnace in maintaining even heats.

The Hardening Apparatus

The chain-hardening apparatus, shown in Fig. 1, consists of a tank with a pump attached, so as to insure a good supply of cold brine, and a "shaker" or screen that is agitated to screen the bone from the chain while being turned into the hardening tank. The tank is made of wood, four feet deep, four feet wide and eight feet long, and is kept filled with natural brine from the ocean nearby. The supply of brine is insured by the pump, shown at one end of the tank. The overflow at the other end permits the warm water to run off; thus the water in the tank is always cold.

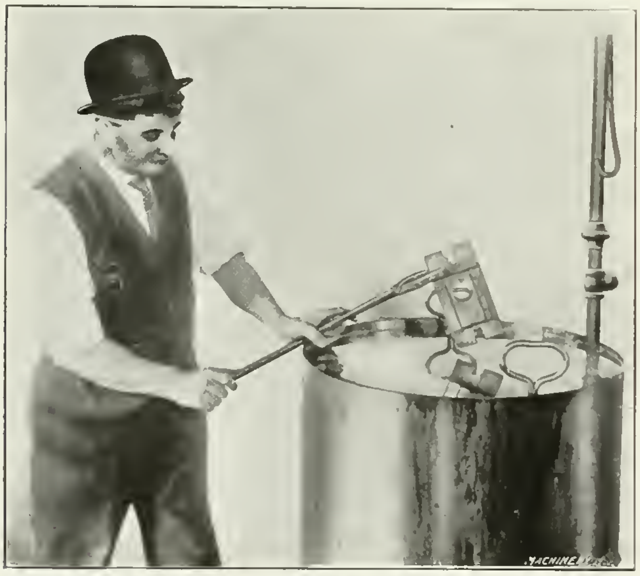

Fig. 7. Quenching a Blanking Die

The shaker, which is the novel feature of this hardening apparatus, consists of an inclined screen that is automatically shaken by a simple crank movement. In Fig. 3 the screen may be seen just below the guard. This illustration also shows the tank and pump.

Hardening the Chain

Fig. 3 shows the hardening apparatus with a box of chain about to be hardened, while Fig. 1 illustrates the actual hardening of the chain. In this latter illustration the guard has been partly removed to better show the chain. The heavy boxes of chain are taken from the fire by one of the men, and immediately two other men grasp the boxes with the special tongs shown, and take them to the hardening tank but a few steps away. The pump and screen are kept in operation and the contents of the boxes are dumped onto the moving screen. The action of the screen rapidly separates the bone from the chain, permitting the bone to drop into a box under the screen, while the clean chain slides into the tank of brine. The separating of the bone from the chain not only saves time, but also prevents an unnecessary amount of heat from going into the hardening tank. Another advantage of the screening is the manner in which the chain is spread out and slid into the tank, allowing the brine to get at each link quickly.

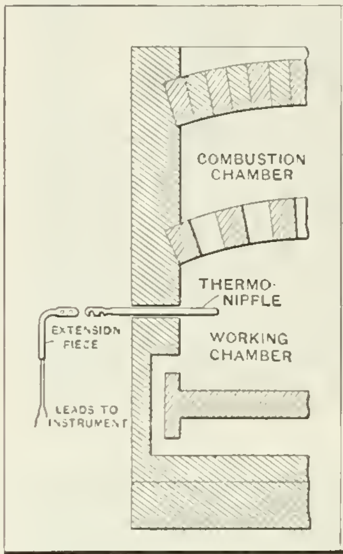

Fig. 8. Section of Rockwell Over-fired Furnace, showing Pyrometer Setting

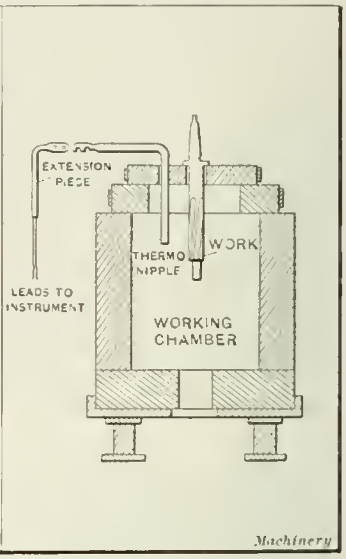

Fig. 9. Section of High-speed Steel Heating Furnace, illustrating Pyrometer Setting

Tool-hardening Department

The success that the Bridgeport Metal Treating Co. has had in hardening dies and other fine tools has resulted in the establishment of a business in hardening work from shops that either do not have the hardening facilities necessary, or that do not wish to risk the chance of losing their work in hardening. Fig. 4 illustrates some of this high-grade tool work—embossing dies for silverware, thread tools, special arbors and engraved hobs used in sinking spoon dies. This illustration also shows the foreman of the hardening room in the act of hardening one of the embossing dies that is to be used in striking up spoons.

Previous to heating, the face of the die is covered with a paste of plumbago for the purpose of preventing the formation of scale and to protect the fine engraved lines of the design. After the die has reached the hardening heat, this covering is quickly brushed off, and the die quenched in the tank in the manner shown in Fig. 4. The hardening tank is made from a large hogshead, and, of course, is provided with a generous inlet pipe that discharges upward from a point in the center of the barrel, about twelve inches from the surface of the water. The overflow pipe is set at the opposite side of the barrel.

The high-speed steel furnace shown in Fig. 5 and in section in Fig. 9, is used for hardening high-speed steel cutters, reamers, lathe and planer tools. The halftone also shows the pyrometer. The instrument is suspended upon the wall to the right of the illustration whence connections are made to the thermo-nipple in the furnace. Fig. 9 shows the method of attaching the pyrometer to the high-speed steel furnace. In this illustration the heating details have been omitted. The thermo-nipple in this case is of a bent form, being suspended through the top of the furnace. In the foreground in Fig. 5 is the oil tank for hardening high-speed steel.

The method of heating pliers in quantity is shown in the illustration Fig. 6 in which the hardener is putting a basketful of pliers into the heating bath. The heating bath is composed of soda-ash, a substance much the same as barium chloride, although it has a lower melting point.

Fig. 7 illustrates the hardening-room foreman in the act of quenching a blanking die in one of the hardening tanks. This tank is made of sheet iron. The two handles at the sides are for raising the sieve that is placed in the tank to catch work left there to cool. It will be noticed that in hardening these dies, the hardener dips them into the tank, end first, and not face down. To the experienced hardener, this point is self-evident, but the apprentice usually attempts to harden a die "face down," irrespective of its dimensions.

In addition to the chain and tool hardening, this company does a great deal of hardening of a general nature, and specializes in the heat treatment of gears and similar work.

* * *

"GALVANIT" OR PLATING POWDER PROCESS

The new and much-discussed English "galvanit" process for producing metallic coatings (see MACHINERY, engineering edition, April, 1910, page 605) was described by Arthur D. Little, Inc., of Boston, in their recent annual report as official chemists to the American Brass Founders' Association. The details of this method as shown by the two patents recently taken out in London are substantially as follows:

A wet rag dipped in the plating powder mixture is rubbed on the surface to be coated. If this surface is metallic, or at least electrically conductive, electrolytic action is set up in the wet mixture which is rubbed on, and the desired metal is deposited on the surface. A suitable mixture for nickel plating is stated to be: 60 parts nickel ammonium sulphate; 3 parts metallic magnesium; 30 parts chalk; 7 parts talc powder.

The nickel ammonium sulphate dissolves when the powder is wet, forming the electrolyte; the magnesium being highly electro-positive, forms the anode, while the surface to be coated forms the cathode. There are therefore produced a number of short-circuited electrolytic cells with particles of magnesium as anodes and the surface as cathodes, with the result that nickel is deposited on the surface. The ammonical salt is stated to be specially advantageous when the surface to be plated is greasy and the reaction tends to dissolve the grease and facilitate the plating. The talc powder and chalk serve both as abrasives for polishing the coating and to prevent the ammonium sulphate from acting on the other ingredients by absorption of moisture from the atmosphere. A mixture of the following composition for plating zinc on iron or copper is suggested: 45 parts zinc dust; 15 parts ammonium sulphate; 3 parts magnesium; 30 parts chalk; 7 parts talc.

* * *

COW'S-HORN CUP PACKING FOR DEEP-WELL PUMPS

Most of the petroleum produced in the United States is pumped from the wells, as few oil wells flow after the first year or two. Fitting up oil-well pumping rigs and pumping wells are two of the chief occupations in an old oil field. The pumps are especially designed for high pressure, having a small bore and a long stroke. The hydraulic pressure under which they operate is often as high as 1000 pounds per square inch, and is commonly 500 pounds or more. The common design of plunger provides four cup leathers in series. The material used for the cup leathers comprises a variety of materials, including ordinary leather, vulcanized fabric and cow's horns. The cow's-horn cups are made from sections of horn turned and bored to the common packing leather shape, and are given a treatment which increases their durability. But the value of cow's-horn cups seems to lie chiefly in their expansion without causing undue friction. As the cup wears it expands to fit the bore of the cylinder, but the hydraulic pressure is not transmitted through the cup rim to the cylinder walls in the same degree as with leather cups, and the cow's horn wears about twice as long as the best leather cup under average conditions. They are made about 1¾ inch in diameter, being confined in size, of course, to the diameter of the average horn near its base.

* * *

When men get cold feet on concrete floors it is a literal and not a figurative case.

THREADING CHASER TROUBLES AND REMEDIES[*]

By O. G. H.

The troubles encountered by the toolmaker and toolgrinder in keeping up a very large assortment of thread chasers of various designs for cutting soft steel, tool steel, malleable iron, and especially brass, are many. There are also numerous methods advanced for overcoming the various troubles encountered, but they, like many of the theories regarding the manufacture and re-grinding of threading chasers, do not always prove satisfactory when put into practice.

Owing to the large number of thread pitches used on different diameters there are, of course, many angles to contend with. This fact makes it impossible to control a cutter of the chaser class, as we do the single-pointed lathe tool for brass, which is a tool used principally by brass finishers and machinists. This tool is ground with very little side clearance and with usually no top rake. We know that if the brass threading tool is not made in this manner, it is likely to run ahead of the feed, and produce a rough and uneven finish. This is the trouble which is also encountered with threading chasers held in a die-head, where they are required to make their own lead; they run ahead of the pitch, sometimes, to such an extent as to cut the thread entirely off the piece. In other cases where the chasers are more correctly ground, they leave the back side of the thread rough, as shown at *A* in Fig. 1, which indicates that the die is leading ahead too fast. Sometimes just the opposite condition exists, that is, the front side of the thread is rough, as shown at *B*, in Fig. 1. This is caused by the die not leading fast enough.

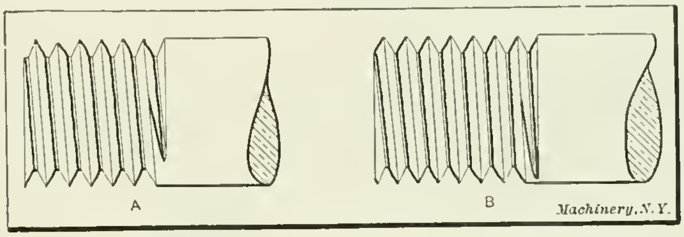

Fig. 1. Conditions of Thread which denote how the Chasers are leading

The condition of the thread produced on both the front and rear sides should always be noted, as this is a guide which can be used to correct the trouble. Where it is necessary for the thread to fit sufficiently close to make a watertight joint, it is desirable that the threads should be correctly formed. The ideal way to govern the leading of the die, is to grind more or less relief in the throat of the die, as the case demands, similar to that shown at *A*, Fig. 2. The more relief given to the die, the faster it will lead, and the less relief the slower it will lead. Unfortunately it is seldom possible to have a very long throat in the dies, especially on small brass work, where it is necessary to cut the thread up to a shoulder. This condition makes it impossible to entirely control the free cutting of the chasers by the amount of relief in the throat.

Where a set of chasers is to be used for cutting up close to a shoulder, instead of grinding the throat of the dies back, as shown at *A* in Fig. 2, the first two or three teeth in the chasers are lapped with a strip made of sheet brass, as shown at *B*, Fig. 2. This strip is charged with carborundum and oil, and is moved across the first two or three threads by hand. It should be held at the angle required to give the thread more or less side clearance as desired. The side of the thread to lap depends upon whether it is desired to make the die lead faster or slower. If the angle of the thread *a* shown at *C* in Fig. 2 is reduced, the dies will lead slower. The working edge of the lap should be made with an angle of about 50 degrees, so that it will be possible to get to the bottom of a 60-degree thread, and touch only the side desired. When lapping a set of chasers in this manner, they should be tried out occasionally on a piece of work to see whether they are producing the desired results. A very slight change on the first two threads will generally be sufficient, leaving the rest of the cutting edges perfect, and free cutting.

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[*] For additional information on this subject, published in MACHINERY, see "Threading Chasers—Dimensions," January, 1908; "Circular Chasers for Internal Threading," May, 1908, engineering edition; "Grinding Threading Chasers for Brass Work," November, 1908; "Grinding Threading Die Chasers," November, 1907; "Recutting Thread Chasers," October, 1904.

Chasers should be sharpened frequently and the lightest possible grinding cut should be taken from them. The chasers should not be allowed to become so dull that it will be necessary for the grinder to remove so much material that the previous corrections on the chasers by lapping are entirely removed. The writer has seen some mechanics correct chasers with a three-cornered file, by filing the threads clear across the chasers instead of lapping the first two or three threads. Filing can be used sometimes for making the corrections, but unless the file is handled with a certain amount of dexterity, the results are not always gratifying. Frequently a chaser in a set is not so sharp as the opposite one, which results in the stock being forced over the sharper chasers. This only aggravates the condition, and makes it more difficult to find which chaser is producing poor results. Filing the chasers also causes them to burnish the thread instead of cutting, which puts an excessive strain on the die-heads, and when of the opening variety they frequently refuse to trip. Excessive heating of the work being threaded is also caused by the friction, which results in unequal expansion, and makes it difficult to assemble the parts, if they are to fit at all closely.

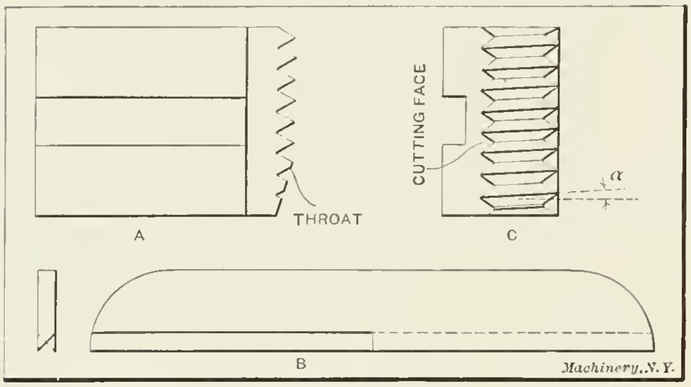

Fig. 2. Showing how the Throat of the Chaser is relieved—Tool for Lapping the Sides of the Thread

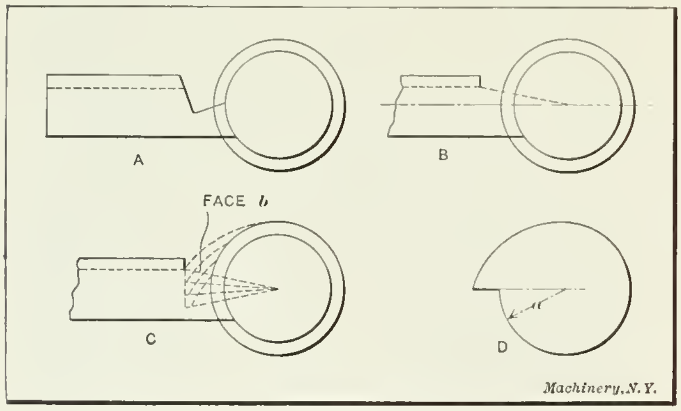

Fig. 3. Templet and Method of Grinding Threading Chasers for Cutting Different Materials

The angle of the cutting face or top rake of the chaser is another point about which there is a considerable difference of opinion. In deciding on this angle, the material to be cut is the governing feature. When cutting machine steel, tool steel, or yellow brass, considerable top rake is necessary, as shown at *A*, Fig. 3. The idea of giving the top rake to the chaser is to produce a curling chip, so that the metal can be removed without undue friction. On cast brass the conditions are quite different, according to the alloy used. In most cases it is advisable to grind the cutting face radial as shown at *B* in Fig. 3.

A point which has caused considerable confusion in the minds of mechanics is the constantly changing appearance of the cutting face of the chasers, after they have been resharpened a number of times. Referring to *C*, Fig. 3, it will be seen that in order to maintain the top-rake, the angle, if taken with reference to the chaser itself, and not with reference to its position in the die-head and the center of the work, seems to be greater as the chaser is ground away. This the writer believes is the reason that a difference of opinion exists regarding to the grinding of the chasers. It is important, however, that the cutting face of the chaser should always bear the same relation to the work, and for this reason it is desirable to have a templet to grind the chaser to. The templet shown at *D* in Fig. 3 has been found very useful for grinding thread chasers for cast brass. This templet is made of thin sheet steel and is held in the bottom of the thread. The radius *a* is made one-half the diameter of the work on which the chasers are to be used. The projection on the templet is ground to a radial line. By holding this templet in the bottom of the thread in the chaser, and grinding the face *b* to the projection on the gage, the cutting edge will always pass through the center of the work.

The writer has found by experience that chasers which gave satisfactory results in one die-head did not work at all when put in another die-head. However, it was found after considerable experimenting, that the relief in the throat of the chaser should be controlled very closely; in fact, a difference of from 0.002 to 0.003 inch more throat relief would sometimes cause the thread to strip badly. This led to an investigation, and a comparison of all the releasing die-heads revealed a wide variation in the width of the slots. This accounted for the chasers working correctly in one die-head and poorly in another, as the change in the width of the slots would allow the chasers to tip more or less, thereby changing the throat relief.

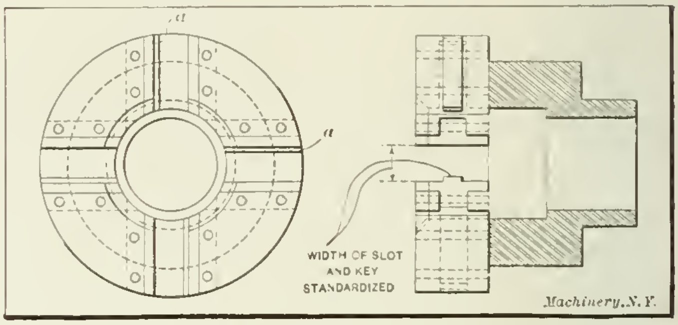

Fig. 4. Method of repairing a Geometric Tool Co.'s Die-head, so that the Chasers can be interchanged

In order to make a chart showing the exact position of the chaser in the throat grinding machine, so that it could be duplicated and used in any head when ground, it was found necessary to cut out the slots in the die-heads and insert hardened and ground tool-steel blocks *a*, shown in Fig. 4, in such a manner that they could be removed when worn and new ones put in their place. This permits keeping the slots in the die-head in good condition, and also facilitates making the chasers interchangeable. When a set of chasers of, say, 1 inch in diameter and 14-inch pitch, for example, is found by experiment to be correctly ground, the position they occupy in the throat grinding machine is marked on the chart so that it is possible to duplicate the grinding. Chasers which are made slightly taper, say about ¼ inch to the foot, have been found to work much better on some jobs on account of good clearance conditions. It has been found that five times as many pieces can be threaded with such dies before resharpening, as can be done with ordinary straight ones.

* * *

What is believed to be the largest ingot ever produced was lately cast by Cammell, Laird & Co., Grimesthorpe Works, Sheffield. This ingot weighed 130 tons and was over 15 feet long, about 9 feet wide, and 5 feet thick. From it a plate was rolled 18 feet, 6 inches long by 10 feet, 9 inches wide, the thickness of which was 25 inches. This plate weighed approximately 90 tons.

SPECIAL TOOLS AND FIXTURES

By JAMES H. CARVER*

The accompanying illustrations show special tools and fixtures which the writer believes will be new to many. The fixture shown in Fig. 1 is a small tool-holder to be bolted to the clapper of a shaper or small planer, and which, with the round tool inserted as shown, makes a very handy and efficient rig for machining small blanking or trimming dies to shape, or for any other job for which a projecting tool is required. Anyone who has experienced dressing a tool of this sort many times to suit different jobs will appreciate the value of this device. The plate *A* is bolted and doweled to the clapper as shown, the bolt and round nut, occupying the hole generally filled by the toolpost. The inserted tool is made from round stock, and, when of small size, the split bushing is used as shown, the larger size filling the hole in *A*. When a cheaper tool is needed, that shown in Fig. 2 is satisfactory. This is formed from an ordinary piece of tool steel, into which is fitted the tool, made from round stock, and having a taper of about ¼ inch to the foot. It can be knocked out with a hammer blow, when the point is to be shifted or another style of tool inserted.

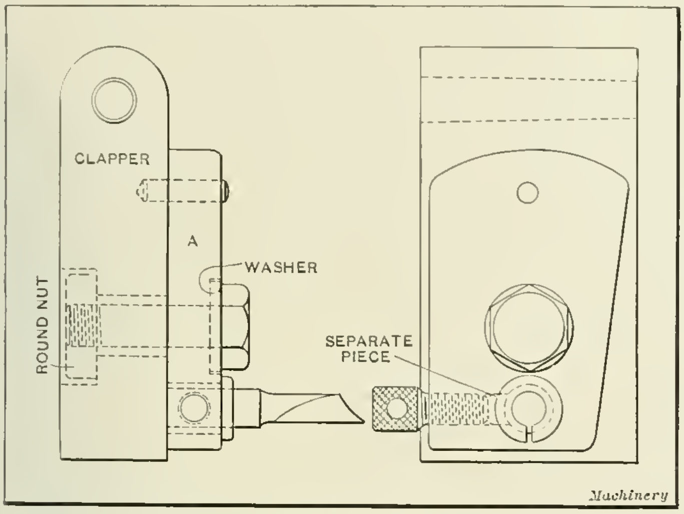

Fig 1. Fixture to be attached to Planer or Shaper Clapper Box, for Use in Machining Small Blanking or Trimming Dies

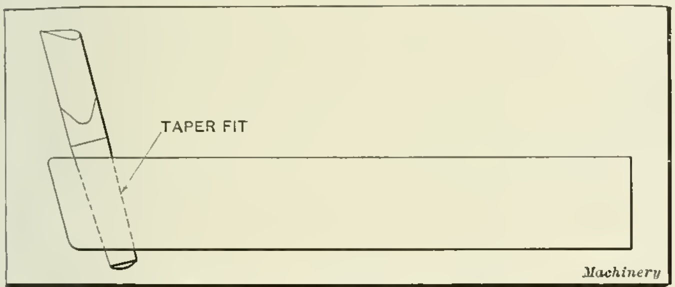

Fig. 2. Simpler Adaptation of the Tool shown in Fig. 1

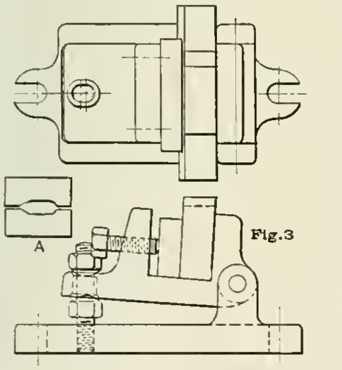

Fig. 3. Vise for Holding Blanking Dies in Shaper, to give Clearance

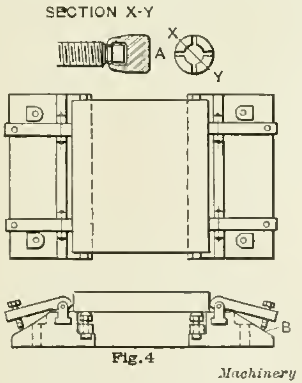

Fig. 4. Vise for Holding down Work in the Planer

The fixture shown in Fig. 3 is for use on a shaper when forming blanking or trimming dies, such as the one shown at *A*. Two bolts are used in the fixed jaw, for holding the work. If the fixture is large, cast iron may be used, steel being employed for the smaller sizes. In Fig. 4 is illustrated a fixture for holding down work on the planer. In one case in mind, it was found very useful while planing die-holders. One pattern, of course, does for both sides of the fixture. The tip *A* may be used on the bolts at *B*. The castings can be either bolted to the planer at the bolt holes shown, or pinned down by the adjustable pins shown in Fig. 5, which are made of cold-rolled steel; the pointed pin may be made from an ordinary set-screw. Adjustable blocks used in connection with bolts and U-straps are shown in Fig. 6. On the slotter these will be found invaluable, but on the planer and shaper, their heights will probably make them useless. Parts *A* and *B* can be sawed from rectangular cold-rolled stock, the lower part of *A* being turned round to fit a drilled hole in *B*.

In Fig. 7 is illustrated a chuck much used in connection with drop-forge dies, where an impression requiring lathe work is necessary. When an impression is used on both top and bottom dies, this fixture insures a correct line-up in one direction, the test-indicator of course making it correct in the other. When many bolt-header dies requiring lathe work are being made, the fixture illustrated in Fig. 8 is well worth making, a test-indicator being used to true up the job.

Fig. 9 shows a good substitute for a commercial chuck and is meant for use on large or small boring-mills. The four pieces forming the rectangle are made from rectangular cold-rolled stock, and have a screw tapped into each jaw. The square-threaded screws and collars at *A* are made in one piece, with a separate pinned collar on the other side. The four cold-rolled pieces are held by fillister-head screws, tapped into the table. A jig for drilling holes in a circle, on rather large work, is shown in Fig. 10. This is used on a radial drill, but may be used to advantage on other style drills, if the size of the table will permit. The round bar *A*, which is fitted into *B*, may be adjusted to any radius for drilling holes in a circle. Any number of slots may be machined in movable plate *C*, the divisions being divisible by the number of holes most likely to be used. The work is held by a lathe chuck, which is bolted to dividing plate *C*. Latch *D* is lifted as each hole is drilled, and the movement made for the next hole.

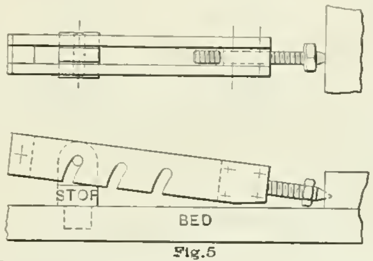

Fig. 5. Adjustable Pins for Securing Flat Work on Planer Table

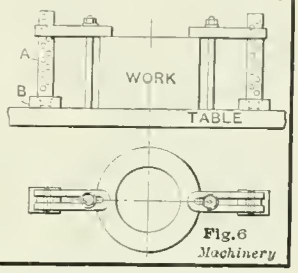

Fig. 6. Adjustable Blocks for Use with U-straps

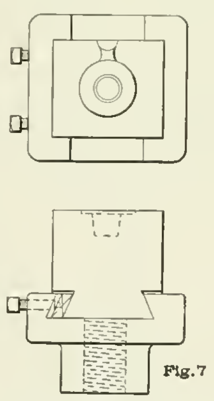

Fig. 7. Chuck for Holding Drop-forged Dies

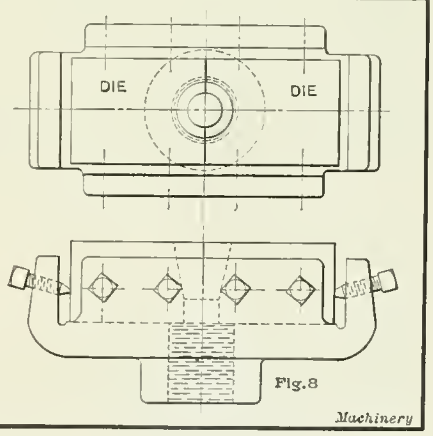

Fig. 8. Another Type of Chuck for Securing Bolt-header Dies

Fig. 11 shows a jig for use on a radial drill, whereby a job of the nature suggested by the small figure shown at *A*, may be drilled. The stop at *B* is of the same design as that used in Fig. 10. The bushing holder at *C* may be made adjustable, if necessary, making it possible to drill holes in circles of different diameters.

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A tool used in the drill press for cutting circular plates from sheet metal is shown in Fig. 12. The bar *A* and tool *B* are both made adjustable. The cutting tool is made from round stock, having a flat surface for the set-screw seat. When plates are cut singly, a hard-wood board is generally placed between the work and the machine table; when not cut in this manner, the number of plates cut at one time is limited by the design of fixture. In Fig. 13 is shown a fixture for cutting circular pieces of emery paper, for use on disk grinders. The paper is furnished by the manufacturers in rolls, of widths, 19 inches, 21 inches, etc., and is cut into circular sheets just a little larger than the diameter of the disk on the grinder. A 16-inch disk would have, say, a 16½-inch diameter disk of paper, which would be trimmed to the size of the disk after being mounted. A square wooden block is laid on the drill-press table; this block has a thin sheathing of copper fixed to the top surface, by means of wood-screws. The paper is fed from the roll, between the circular wooden block *A* and the copper sheet; the drill spindle is lowered, which holds the paper firmly, by means of the block and spring. The downward movement is continued, when the circular cutting tool comes in contact with the paper, cutting the circular piece to a size depending on the adjustment of bar *B*. The parts in line with the drill spindle are the body *C*, which is made in one piece, the spring securing plate, fiber washer and circular wooden block. The securing plate is held on the block *A* by means of wood-screws, and is split to allow the parts to be assembled. When cutting the paper, block *A* is, of course, stationary, body *C* turning in it.

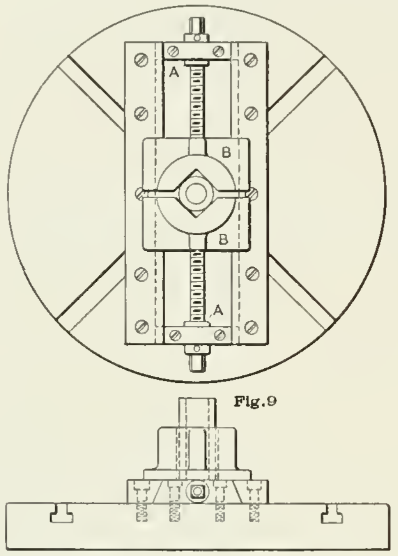

Fig.9

Fig. 9. Substitute for the Commercial Chuck for Use on the Boring Mill

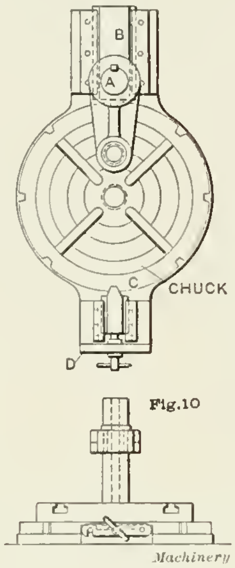

Fig.10

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Fig. 10. Jig for Drilling Holes in a Circle

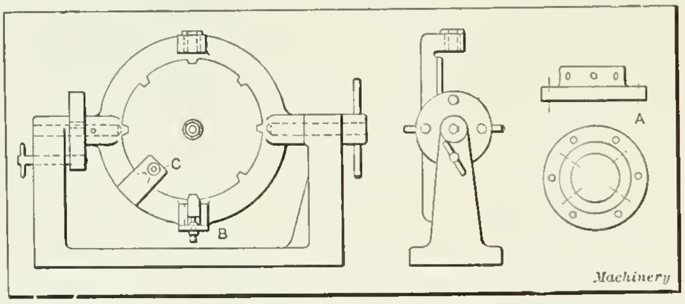

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Fig. 11. Drill Jig for equidistantly Spacing Holes in such a Piece as that shown at A

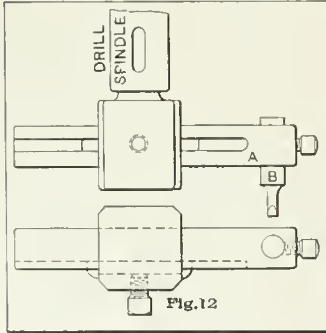


Fig.12

Fig. 12. Tool for Cutting out Circular Metal Plate

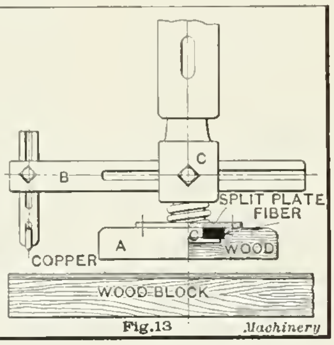


Fig.13

Machinery

Fig 13. Similar Tool used for Cutting Abrasive Disks

* * *

REMARKS BY THE ON-LOOKER

In looking over Machinery for August, I got to thinking of what an amount of information is given therein for twenty cents. While the object of business is to make money, I think there are two kinds of business which embody something more—the idea of brotherly love or philanthropy. One of these is life insurance and the other journalism. In your case, you give out each month, not a mere outline of your individual views, but those of others also, allowing them to be weighed by the readers.

I am not quite able to make up my mind which is the more interesting portion of your publication (I think it certainly could be called a magazine), the advertisements or the reading matter.

You mention small shops and their equipment in one of your editorials, and on that particular point I have a whole lot to say, but not just now; I want to advise anyone about to start a small shop to cut loose from the past and not consider that a shaper, planer, drill press and lathe, with perhaps an emery wheel, is about all that is necessary to begin with—and to keep on with. In a small machine shop, to those who really know machine shop work, the tools outlined are all right, but the world advances and new methods come up. Take, for instance, the surface finishing machine; it would be perhaps a wiser investment than a shaper. In other words, in starting a machine shop to-day a proprietor has to remember that what he used to have, or what his father had, while in many cases all right at the time, must be added to. A close scrutiny of the advertising pages of Machinery will give a pretty good idea of what to add.

In your editorial you speak of the necessity of awakening some people to their own capabilities by a good hard jolt. Permit me to say that there is a whole sermon in this. In my personal experience I have often seen much good come out of what was apparently a misfortune, in developing human character.

In the practical articles you show an illustration of the leveling of a lineshaft by means of a suspended straightedge. This is something I hardly see the use of; why not lay the leveler on the shaft itself?

The welded joint shown is a practical example of what can be done with the oxy-acetylene system, and it seems to present the solution of many leak troubles. It is now proposed to weld flues in locomotive boilers by this system. I have my doubts about its value there, but certainly the uses of this valuable process are not yet half worked up.

In the planer-rail elevating device, the author fails to mention one very decided advantage which it has, or can have; that is, by elongating the holes in the half of the coupling which is not tapped, the two elevating screws can be readily timed. This is a decided point of advantage in the arrangement.

Mr. Hamilton's article on rolling threads will save those who are interested in the subject an immense amount of guess-work. Here, again, the price of twenty cents for the magazine seems absurdly small.

The question of die-casting is one that is becoming daily more interesting. In the Veeder products, its value is most clearly brought out, but are we any more than just starting in this matter? I think not. As time goes on I look to the foundry to effect great savings for us. I suggested and put into practical use the idea of having certain surfaces on machines, which had heretofore been tooled, so cast by reducing their area, that they came out practically perfect, that is nearly enough perfect for the particular job, and I believe this idea can be carried much further.

There is no country in the world, save the United States, where such detailed explanations of methods and ways would be given in a journal as those given by you in relation to press work and die making. I cannot imagine the publication of such articles in any foreign country being possible. They would lose the writer his job, and wild horses could hardly wrest the information from him if he were a proprietor.

Many years' living abroad gives me the right to speak of cast iron. (I mean by "living," making my living as an engineer in foreign countries.) Therefore I speak out of knowledge in the matter of soft or hard iron. I do not take the view that the softer material absorbs a lubricant advantageously. Of course oil will run into a hole under proper conditions, but it is hardly obliging enough to run out again, and in comparing hard and soft iron I should be very wary in accepting the value of one over the other until I knew that the care given to both was just the same.

It is sad to find the name of Beale among those who have "washed up" for the last time and gone home forever. Truly his existence has been of great value in the mechanical world. What more can a mechanic ask than an epitaph which reads: "What he did he did well," and this can be said of him.

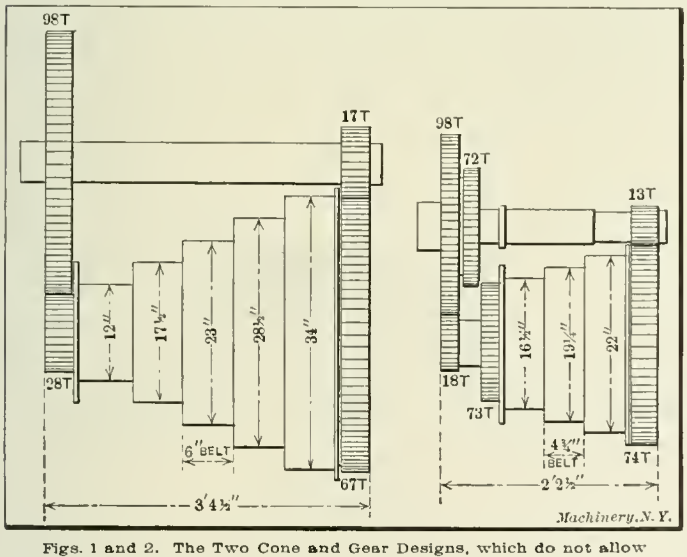
W. D. F.

* * *

DOUBLE BACK-GEARS

By T. BARTON*

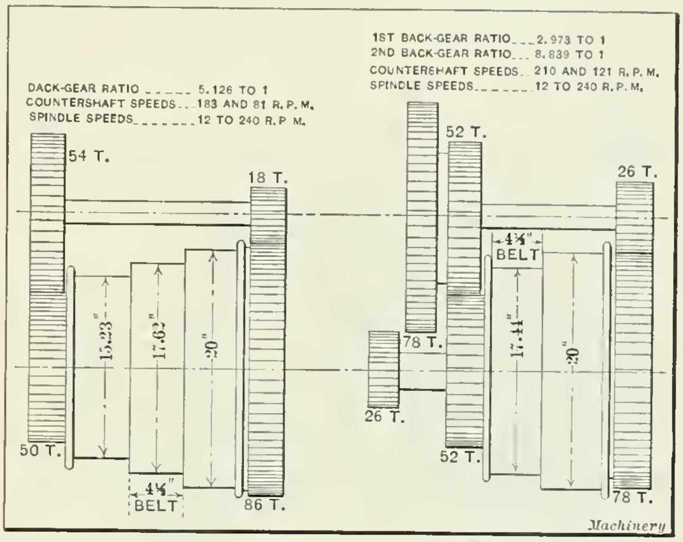
In the March number of MACHINERY "Racquet" draws attention to the increased driving power obtained by the use of double back-gearing. It is only natural that the double back-gear should give more power, as with this arrangement two-thirds of the speeds are obtained through gearing, against one-half with the ordinary single back-gear. The two examples given by "Racquet" to show the superiority of the double back-gear, see Figs. 1 and 2, are not very well selected, because the two cone pulleys are of different designs, one being a "flat" cone, and the other a "steep" cone. By this is meant that for the double back-gear, Fig. 2, the belt is shifted over the whole range of the cone before changing the countershaft speed, while for the single back-gear, Fig. 1, the countershaft speed is changed each time the belt is shifted, the two countershaft speeds being used consecutively on each step of the cone.



Figs. 1 and 2. The Two Cone and Gear Designs, which do not allow a Fair Comparison

"Racquet" is only comparing double with single back-gears, and not criticizing cone-pulley design; therefore, for a fair comparison, it is hardly correct to show the double back-gear with a cone which gives a much higher average horsepower than it would if designed in the same way as the cone in Fig. 1. If this large cone were designed in the same way as the small one, it would be found, taking average horsepower, that instead of the small cone being 12 per cent more powerful than the large one, the large cone would be 27 per cent more powerful than the small one. Thus a large part of the advantage is due, not to double back-gears, but to different designs of cone pulleys.

It would appear that but little consideration is given to the matter, if cone pulley drives are compared by their average driving power. The horsepower put into a machine is governed by the number of square inches of belt passing over the pulley per minute. This is at its maximum in a cone drive at the point where it is usually least needed, that is, at the highest spindle speed, on work of small diameter, and at its minimum on the lowest spindle speed, on work of large diameter. Therefore the lowest spindle speed is the weak point in the speed range, and comparisons should be made relative to this. To take the average power is misleading, and is as sensible as it would be to take a chain having links of varying strengths, and find the strength of the chain by taking the average. "A chain is no stronger than its weakest link," and the same principle applies equally to machine tools.


DACK-GEAR RATIO ..... 5.126 TO 1
COUNTERSHAFT SPEEDS...183 AND 81 R.P.M.
SPINDLE SPEEDS.......12 TO 240 R.P M.
1ST BACK-GEAR RATIO...2.973 TO 1
2ND BACK-GEAR RATIO...8.839 TO 1
COUNTERSHAFT SPEEDS..210 AND 121 R.P.M.
SPINDLE SPEEDS.......12 TO 240 R.P.M.
54 T.
18 T.
15.23"
17.62"
20"
50 T.
4¼" BELT
86 T.
52 T.
26 T.
4¼" BELT
78 T.
17.41"
20"
26 T.
52 T.
78 T.
Machinery

Figs. 3 and 4. Designs which permit of a Fair Comparison

Would not the best way of making a comparison of the relative power obtained from single and double back-gearing be to fix on a certain speed ratio and number of speeds, and then design a cone and gearing to give these speeds according to each method? This has been done in Figs. 3 and 4. A speed ratio of 20 to 1 is assumed, with twelve speeds. The countershaft speeds specified give 12 to 240 R. P. M. Twelve speeds are used because this number can be obtained under the same conditions, that is, using two countershaft changes with each headstock, etc. The large step of the cone, and width of step is the same in each case. On the lowest spindle speed, the double back-gearing shows an advantage of 73 per cent. This advantage would naturally be greater with a higher speed ratio and less with a smaller one. As the space occupied by each arrangement does not vary greatly, this increase in power would seem to warrant its adoption where possible.

The "flat" design of cone, as shown in Fig. 2, is generally spoken of as being the nearest approach to the single-pulley drive. It may be, as regards appearance, but it is not so in point of power delivered. The advantage of a single-pulley drive is that the power is constant. With any of the usual types of cone drives the power varies, but the variation is much less when the unfashionable "steep" cone is used than when the "flat" cone is used. The factors which generally determine the employment of the "flat" cone are: ease of belt shifting, and appearance, the "flat" cone looking much more impressive and powerful on a machine than the "steep" cone. This latter reason probably carries the most weight.

* * *

The close interdependence of the various activities in modern life was well illustrated during the recent labor strike in London. The dock workers' strike had an immediate and paralyzing effect upon the means of communication within the city. This was due to the shortage in the supply of fuel for motor omnibuses and taxi-cabs. The difficulties in obtaining coal also had a serious effect on the electric generating stations, and had the strike not been so quickly settled, it would have tied up practically all the urban railways and street car lines in London, although none of these were directly involved in the labor strikes.

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* Address: 22 Augustus Road, Coventry, England.

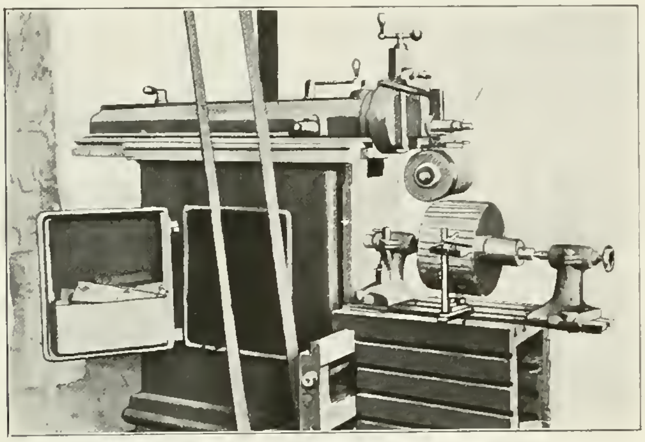
LETTERS ON PRACTICAL SUBJECTS

We pay only for articles published exclusively in MACHINERY.

SHARPENING A HOB IN A SHAPER

A small shop recently had occasion to sharpen a hob which was larger in diameter than could be accommodated by the tool-room grinder. The accompanying illustration shows the ingenious method devised to overcome this difficulty. The center heads were removed from the grinder and placed on the shaper, as shown. As the hob arbor was considerably longer than the shaper, a parallel strip was fastened to the table and the center head attached to it. An electrically driven center grinder with a wheel formed to the desired shape was set up in the tool-holder of the shaper, and tne ram adjusted to give a feed of about 30 feet per minute. As the flutes in the hob had been cut and milled with an index-head, a "snap stop" was fastened to a bracket and located in the flutes, as shown. This stop was sufficient to insure the accurate indexing of the work, the hob being revolved by hand.

Myerstown, Pa. E. J. CARLSON



Method of Sharpening Hob Larger in Diameter than the Capacity of the Grinder

PRESS TOOLS FOR ALUMINUM SHELL

The spoked aluminum shell shown in Fig. 1 is about four inches in diameter and one inch deep. It has four spokes, or arms, radiating from a hub in which a shaft hole and four rivet holes are punched. These holes are used for attaching the aluminum shell to the bearings of the hub on which it is used. Stiffening "lips" around the openings and spokes are formed, and the ribs or spokes themselves are embossed to add to the strength of the shell. Four rivet holes punched through the rim of the shell serve to attach it to an exterior band.

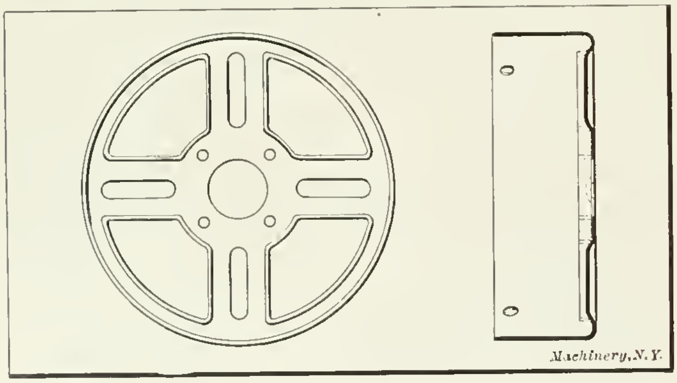


Fig. 1. Aluminum Shell to be made

This shell was made in the following manner and with excellent results: The blanking, drawing and embossing is done in one operation in a double-action press, using the die shown in Fig. 2. The blank-holder *A* is made of cast iron, and a hardened tool-steel blanking die *D* is fastened to it, which not only acts as a die, but also serves to hold the blank in position while the drawing operation is taking place. *B* is the cast-iron drawing punch, to which is attached a hardened steel face *K*. This face *K* contains the embossing recess for the spokes, into which the metal is forced by the embossing punch *H* held to the lower member. The punch *H* also acts as an ejector after the drawing and embossing operations have been completed, and is actuated by the stem *J* and the knock-out mechanism of the press.

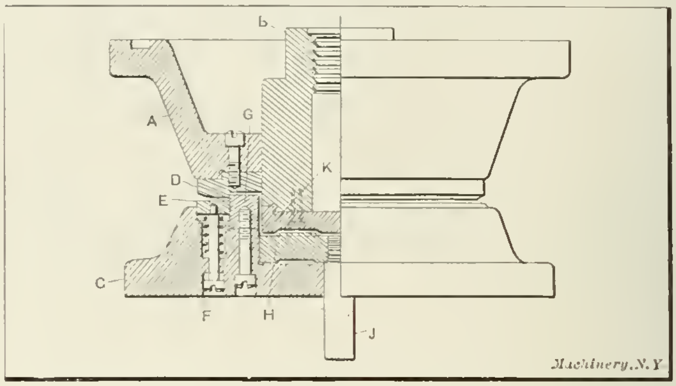


Fig. 2 Combination Blanking, Drawing and Embossing Die for the Shell

The die-shoe *C* is made of cast iron, and is bored out to receive the blanking punch *G* over the inner edge of which the shell is drawn after blanking. The stripper ring *E*, which is made of soft steel and passes around the periphery of the die *G*, is limited in its travel by the shouldered screws *F*, and acted upon by six helical springs. There are several vent holes in the drawing punch and through the plate *H* and the base of the die-shoe, the purpose of which is to allow the air to escape while drawing, and enter while stripping and ejecting the shell. The shell is drawn entirely into the ring *G*, and of course, must be trimmed afterward. This is performed in a trimming lathe, although similar shells are sometimes drawn to the depth required, and a flange left on them, so that they may be trimmed off by a simple blanking die. However, the method of handling this operation lies entirely with the designer, although it should be governed to some extent by the requirements of the shell.

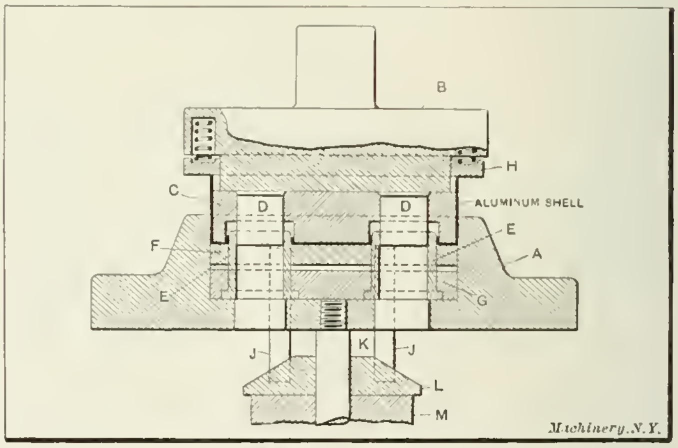


Fig. 3. Combination Piercing and Ribbing Die

After the shell is drawn into cup form, the next operation is to pierce the openings to form the spokes, and turn up the "lips" around these openings. Both these operations are performed in the die shown in Fig. 3, which is held in a single-action press. The die-shoe *A* and the punch-holder *B*, respectively, are made of cast iron, the die-shoe being bored out to receive the soft-steel die carrier *G*, and the ejector plate *F*, which is also made of soft steel and is actuated by four studs *J* resting on a cast-iron plate *L*. This cast-iron plate *L* is pressed upward by a rubber pad *M* which slides on stud *K*. The die-bushings *E* are flanged on the bottom, as shown, and are held in the carrier plate in the usual manner. They serve not only as dies for piercing, but also as drawing punches to draw the stiffening "lips" on the shell. The drawing die *C* is held on the punch-holder *B*, and carries the piercing punches *D*, which are set ahead of the drawing die so that they will pierce the stock before the die begins to draw the "lips." A stripper ring *H*, actuated by coil springs as shown, is limited in its travel by the drawing die *C* upon which it comes to rest on the upstroke of the ram. All the screws and dowel pins used for holding the various members in their respective holders are omitted for the sake of clearness.

The shell is now ready to have the holes around the rim and the small holes in the bottom pierced. These operations are accomplished in the die shown in Fig. 4 which is held in a single-action press. A circular disk *B* of cast iron serves as a base for the die, and to it is attached the die-anvil *K*, of soft machine steel. Die-bushings *L* and *M* are driven into the anvil *K* for piercing the holes in the rim and in the bottom of the shell. Recesses are cut in the block *K* to receive the "lips" around the spoke openings. The cast-iron punch-holder *A* carries two flat springs *J*, which serve to hold the shell on the anvil when the holes are being pierced. The punch-holder *A* also carries four studs *F* (only two of which are shown) that operate the piercing punches *G*. These piercing punches *G* fit in blocks *H* held to the die-bolster, and are retained in the blocks *H* by the small studs *N* working in elongated holes in the block. These small studs or pins *N* also serve to prevent the punches *G* from turning around, so that their beveled ends are always presented properly to the studs *F*. The punches *G* are withdrawn when the ram of the press ascends, by coil springs, as shown. The punches *O* and *P*, for piercing the holes in the bottom of the shell, are held in a machine-steel block *C*, which is backed up with a hardened tool-steel block *D* inserted in the punch-holder *A*. These blocks *C* and *D* are doweled together and held to the punch-holder.

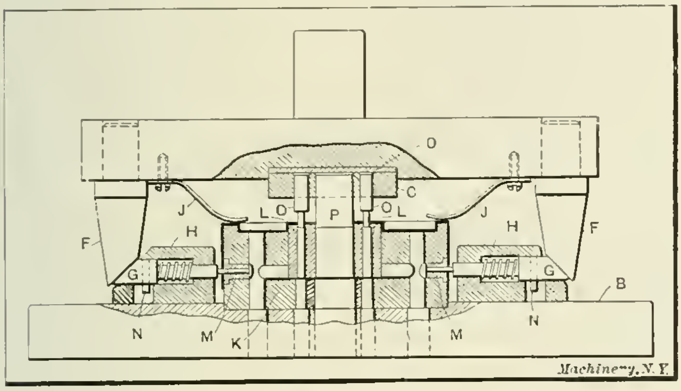


Fig. 4. Punch and Die for Piercing the Holes in the Sides and Bottom of the Shell

Making this aluminum shell in the manner described, gives a uniform product, and the tools are of such a character that they are easily repaired and are not very costly. While these tools are of a special character, a number of the features incorporated in them could be used for a variety of purposes.

Detroit, Mich. ARON LAWRENCE

MAKING AN IRREGULAR HARDENED PUNCH

The accompanying illustrations show a punch and die for cutting out two pieces at the same time, these pieces being of different lengths, as shown in Fig. 1. The factory using these pieces had too much work on hand in the tool-room to make the punch and die, so they let out the contract to an outside firm doing such work. In due time the punch and die was delivered, and judging from its appearance the firm had done a very good job, especially on the punch, which was drawn to a dark straw color. The fact that the punch was so nicely drawn caused no little surprise, for it was of a difficult shape to harden, as will be seen by referring to Fig. 2. The punch had been ordered long, so as to provide for sufficient grinding. The blades *A*, which had been worked out from a solid piece of steel, were quite long and thin, and it became a matter of speculation as to how the punch had been hardened without bending or warping.

The more interesting feature of this punch became known when, after testing it with a file, it was found that the punch had not been hardened at all. It appears that the maker, having realized that the blades would warp, and having spent considerable time in making the punch, thought he would take a chance, so he polished the punch and drew it to a dark straw color, and incidentally lost his reputation. The stock to be punched would not permit the use of a soft punch, so it was necessary to make a new punch, the construction of which is shown in Fig. 3. The general design of this punch is somewhat similar to that shown in Fig. 2, except that the blades are made separate, and fastened to the main body of the punch. These blades are made 1/32 inch thicker than the finished size and then drilled, after which they are hardened and ground to the finished size. The blade *B* is inserted in a slot in the punch base, and the blade *F* is held to the side of the punch base.

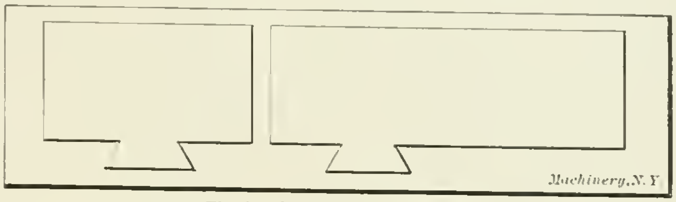


Fig. 1. The Pieces to be made

In order to hold the blade *B* in place, two reinforced pieces *C* are fastened to the body of the punch by screws *D*, while screws *E* pass through these pieces, clamping the blade between them. The blade *F* is made to extend down past the punch base to the holder *G*, and is held in place by two pieces *H* and *I*; the piece *I* is located on top of the base of the punch, while the piece *H* is held to the base by a screw *J*, and two screws *K* passing through the blade hold piece *I* firmly to piece *H*. In this way the blade is held rigidly, as the pieces *H* and *I* are made long, thus supporting the blades. After repeated grinding, the pieces *C*, *H* and *I* can be taken off and ground down to the lines *L*, thus allowing the punch to be used to within ¾ inch of the base.

The die which is used for cutting out the pieces shown in Fig. 1, is shown in Fig. 4; an unusual feature of this die is that instead of the blanks being forced through the die, the scrap is forced through instead. The die is set up in an inclined press, so that the blanks slide off the die into a box. In the illustration, *A* is the stripper-plate and *B* the stock, the latter being of the same width as the pieces shown in Fig. 1. The stripper *A* is attached to the die by three screws, as shown; a block *C* is also attached to the die-block by two screws, and acts as a guide for the strip. *D* is a stop for the stock, and *E* is a stationary guide, as the stripper at this point is cut away to allow the blanks to drop out. Spring pins *F* act as guides for the strip and are held in the die-bolster. These pins are formed with a shoulder, as shown, which rests against a stud *H*, screwed into the webs *I*. Pressing against the shoulders on the pins, are two coil springs *G*, which are held in the die-bolster by two screws *J*. These spring pins are forced down into the die as the punch

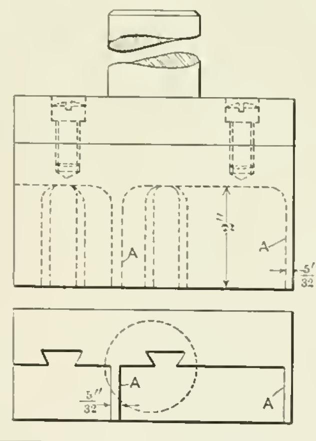


Fig. 2. The Unhardened Punch

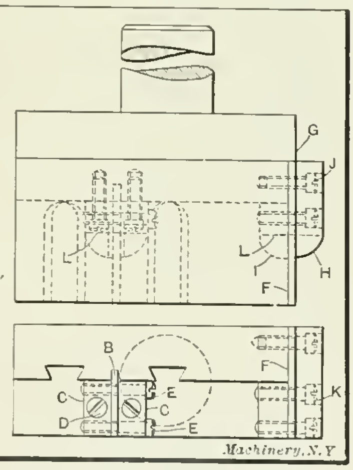


Fig. 3. The Successful Punch

descends, and are returned by the springs *G* when the punch retreats.

The punch is made to overlap the stock; that is, it extends past the face *L* of the stock, so that it removes the burrs thrown up at the corners of the dovetails. As the stock does not vary in width to any extent, very few of the pieces would be shaved, and by having the punch fit in this way all objectionable burrs are removed. The outline of the punch is clearly shown in the lower view in Fig. 3. The reason for making the die of this construction was merely to save material, there only being waste in the center and at the sides of the dovetail, as the strips were of stock size. This was found to be the most economical method of making these pieces.

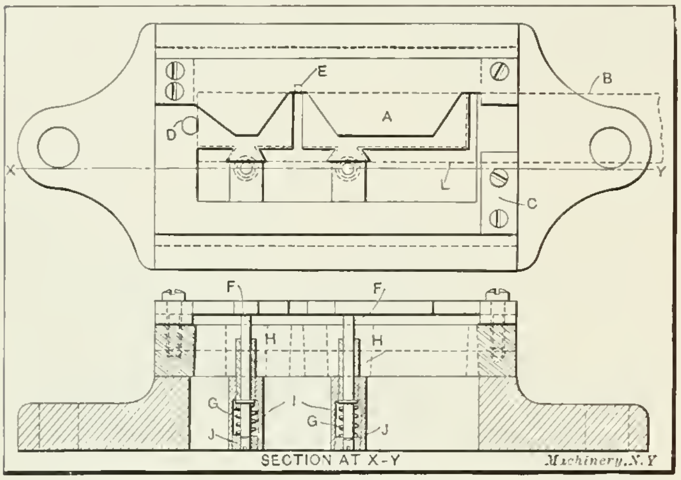


Fig. 4 Die used for Blanking the Pieces

Bayonne, N. J. J. A. Luther

HOOK-FLUTED TAPS

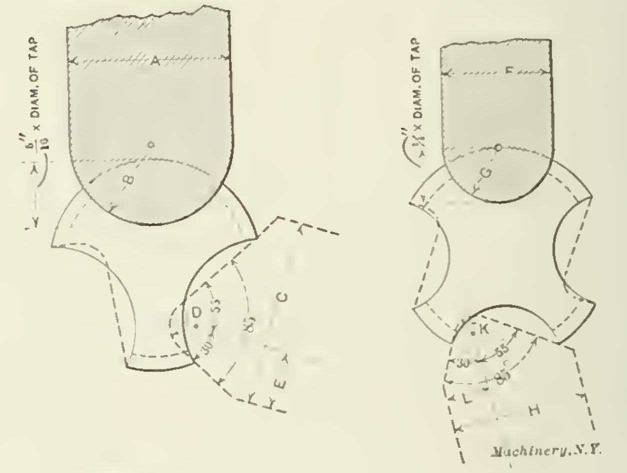
The advantage of the so-called "hook-flute" on taps is that it is possible with taps thus fluted to cut the threads in nuts with less power than otherwise, or in other words, the tap cuts with greater freedom. In the case of nuts made of steel of tough composition, taps fluted in this way are practically the only ones that will give satisfactory results. Hook-fluted taps have an under-cut cutting edge; that is they are provided with a positive rake. They are the very best taps to use for tapping steel and similar materials, but cannot be used to advantage for tapping brass, bronze, cast iron, and similar materials, as in this case a positive rake at the cutting edge is not permissible, a negative rake being, in fact, preferable. These general principles as applied to tap making are, of course, well known, but until recently very few taps have been made regularly for the market with a hook-flute.

In most cases the hook-flute on taps has been produced by using a convex cutter, as shown by the full lines in the engraving above the accompanying table. This kind of cutter is, however, not always satisfactory on account of the limited positive rake obtainable and the weak section of the lands of the tap that is a necessary consequence of its use. Taps fluted with cutters of this kind are more liable to break, but there are certain cases when the convex cutter must nevertheless be used, regardless of its disadvantages. When taps, for example, have to be backed out of a hole, the convex cutter is the best one to use for fluting them, because, on account of the form of the flute, the chips are not liable to get in between the teeth of the tap and the threads in the nut being tapped, when backing out. The difficulty due to chips getting in between the teeth of the tap and the threads in the nut, thus spoiling the thread and often breaking the tap, is frequently met with when a fluting cutter of the shape shown by the dotted lines in the engraving above the accompanying table, is used. This kind of fluting cutter, however, is the best one to use for fluting hook-fluted taps which will not have to be backed out, such, for example, as tapper taps. The tap is not weakened as much by a flute of this kind, and any amount of positive rake at the cutting edge can be obtained. This can be easily seen by studying the engraving.

An important point in favor of a cutter of the shape shown by the dotted lines is that it is much easier to keep sharp. It is nothing but an ordinary angular cutter which can always be sharpened by grinding the top of the teeth, and the required clearance can easily be obtained. The convex cutter, on the other hand, is almost always made of the formed eccentrically relieved type, and when sharpened is ground on the face of the teeth only. As these latter cutters, of necessity, have little or no clearance on the sides, they do not cut freely, but leave heavy burrs in the threads of the taps, which will break off when polishing the flutes after hardening and produce "ragged" teeth or cutting edges in the tap.

It might be said that convex cutters do not necessarily need to be made of the eccentrically relieved type, but that cutters of the regular milling cutter type might be used, the teeth of which can be ground on the top by means of special fixtures of a type similar to those described in Machinery, October, 1908. In that case any required clearance could be obtained on the top of the teeth. However, a cutter so made would have a very short life, as it would be reduced in width by the very first grinding, and would not apply for any length of time to the particular size of tap for which it had been made. It could, of course, be applied to smaller sizes.

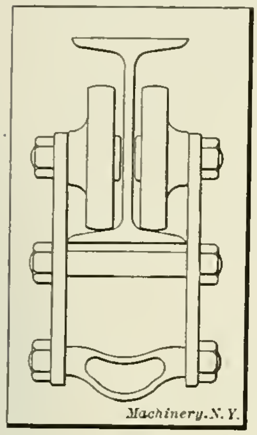
TABLE OF TAP FLUTING CUTTERS



Diameter of Tap	Three Flutes					Four Flutes				
	Convex Fluting Cutter		Angular Fluting Cutter			Convex Fluting Cutter		Angular Fluting Cutter		
	Width A	Rad. B.	Width C	Rad. D	From Side to Cent'r of Arc E	Width F	Rad. G	Width H	Rad. K	From Side to Cent'r of Arc L
1/8	3/32	3/64	3/8	1/64	1/8	1/16	1/32	3/8	1/64	1/8
1/4	3/16	3/32	3/8	1/32	1/8	1/8	1/16	3/8	1/32	1/8
1/2	3/8	3/16	1/2	1/16	5/32	1/4	1/8	1/2	3/64	5/32
3/4	9/16	9/32	3/4	3/32	7/32	3/8	3/16	5/8	1/16	7/32
1	3/4	3/8	7/8	1/8	5/16	1/2	1/4	3/4	3/32	1/4
1 1/4	15/16	15/32	1 1/4	5/32	3/8	5/8	5/16	7/8	1/8	5/16
1 1/2	1 1/8	9/16	1 1/4	3/16	7/16	3/4	3/8	1	1/8	3/8
1 3/4	1 5/16	21/32	1 3/4	7/32	9/16	7/8	7/16	1 1/8	5/32	3/8
2	1 1/2	3/4	1 3/4	1/4	9/16	1	1/2	1 1/4	3/16	7/16
2 1/4	1 11/16	27/32	2	9/32	11/16	1 1/8	9/16	1 3/8	7/32	7/16
2 1/2	1 7/8	15/16	2 1/4	5/16	3/4	1 1/4	5/8	1 5/8	1/4	1/2
2 3/4	2 1/16	1 1/32	2 3/8	11/32	3/4	1 3/8	11/16	1 3/4	9/32	1/2
3	2 1/4	1 1/8	2 5/8	3/8	7/8	1 1/2	3/4	1 7/8	5/16	5/8

The accompanying table gives dimensions for fluting cutters of both kinds for taps of varying diameters. The size of the hole in the cutter and the outside diameter are not given, as these dimensions must be made to conform to the machines in which the cutters are to be used. It will be noticed that when fluting with convex cutters the center line of the cutter coincides with the center line of the tap, whereas when angular cutters are used the point of the cutter is set off center. The table gives dimensions for both kinds of cutters for both three- and four-fluted taps. Correspondent

I-BEAM TROLLEY DESIGN



I-Beam Trolley of Practical Design

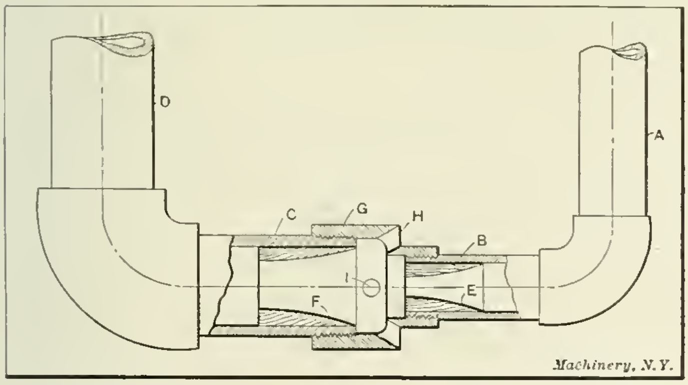
Referring to the article on I-beam trolley design which appeared in the January issue of MACHINERY, it seems to the writer that this is a question very similar to that of perpetual motion, for it is constantly appearing from time to time in all the mechanical papers, but no definite conclusions are arrived at. Your correspondent points out two objections to the first design with which the writer agrees.

To overcome these defects a compromise is made, such as shown in the trolley design herewith illustrated. This engraving is self-explanatory. The writer has a great many of these in use which have been running for several years, and can confidently say that they operate very easily and require no attention whatever, with the exception of an occasional drop of oil. P. H.

A HOME-MADE SIPHON

A siphon of simple construction which can be easily and quickly made is shown in the accompanying illustration. This siphon is made entirely of pipe fittings. *A* is the feed pipe 1/2 inch in diameter; *B* is a nipple about 2 inches long made from ½-inch pipe; *C* is a 1-inch nipple about 2½ inches long; and *D* the discharge pipe 1 inch in diameter. Wooden plugs *E* and *F* are driven in the nipples *B* and *C*, respectively, and are flared as shown. The reducing coupling *G* is provided with seven ¼-inch holes *H*, equally spaced and drilled through the shoulder, all "meeting" at a common center. Seven additional ¼-inch holes *I* are bored through the circumference, equally spaced and are staggered in relation to the holes *H*, bored through the shoulder of the coupling.

In application, the siphon is lowered into the liquid, which is to be pumped out, and in pumping out a cellar a hole should be dug so that the siphon will be located deeper than the lowest surface of the water. Steam, air, or water may be used for power; this flows through the feed pipe *A* and produces a strong suction, drawing the water through the holes *H* and *I* and discharging it through the pipe *D*. The writer constructed such a siphon in about one hour's time, and pumped three inches of water out of a basement measuring 40 feet square in about five hours. The water was lifted about 6 feet, and water having a pressure of about 40 pounds per square inch was used as power for creating a suction.



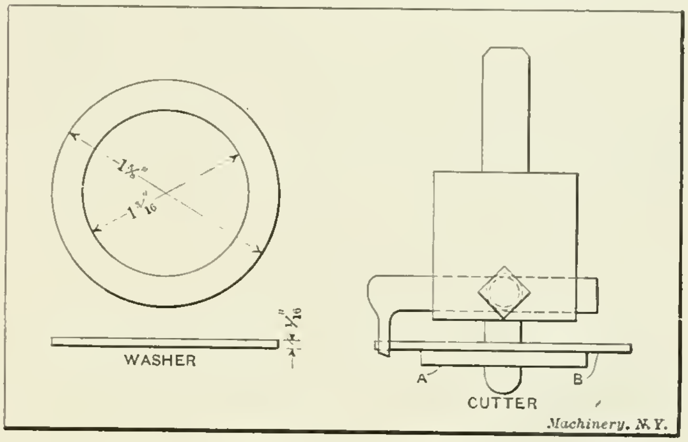
A Home-made Siphon which can be cheaply and quickly made

Oaklyn, N. J. CHARLES R. ENGEL

CUTTER FOR SMALL FIBER WASHERS

The fiber washer cutter which is described in the following, and illustrated in the accompanying engraving, is a kink that will be appreciated by all those who have ever had occasion to cut a few washers. Recently, the writer was presented with the task of making several hundred fiber washers such as the one shown to the left in the illustration. The fiber was first cut into strips two inches wide, and then laid out, centered and drilled with a ¼-inch drill. The cutter was then set to a diameter of 1 3/16 inch to cut out the central opening of the washer.

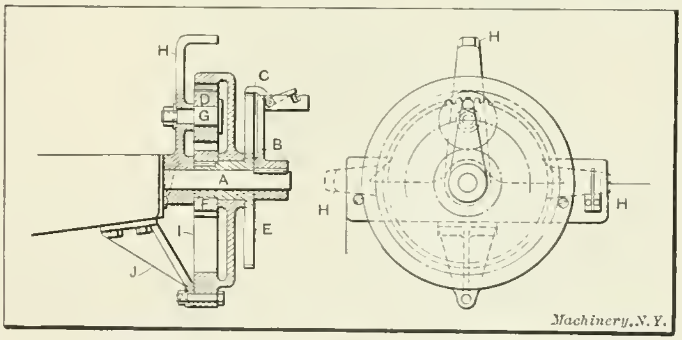
After all the strips were put through these first operations, the more difficult task of cutting out the washer was presented. For this purpose, the washer *A*, 1 3/16 inch diameter and 3/32 inch thick was turned out of sheet brass, and soldered on the pilot in such a position that the cutter could only cut down half way through the fiber blank. One half was first cut, the blank turned over and the other half cut through. It was in this latter operation that difficulties were encountered, for the fiber, when nearly parted, had a tendency to tear, forming a ragged parting. This matter was corrected in a simple manner by soldering a brass disk *B* to the upper surface of the disk *A*. (Disk *B* is made 1½ inch in diameter so that the fiber washer can be removed while the cutter revolves.) This prevented the cutter digging in beyond the half-way limit, which was the cause of the tearing. By this method, the washers were turned out in good condition, leaving only a slight fin which could be readily removed with a sharp knife or a fine file. W. F. H.



Small Fiber Washer and Cutter for Producing it

A DIFFERENTIAL QUICK-WITHDRAW MECHANISM

The accompanying illustration shows a quick-withdraw device which can be attached to the lathe cross-slide when the construction of the cross-slide screw is such that it is impossible to move it bodily in a direction parallel with its axis. In the illustration, *A* is the cross-slide feed-screw, to which is keyed a handle *B*, fitted with a catch or finger *C*, which can be engaged in teeth cut in the index-plate *E*. This index-plate is not keyed to screw *A*, but rotates freely on it, and is keyed to the gear *F*, which, in turn, meshes with the gear *D* held on stud *G*. The stud *G*, on which gear *D* fits loosely, is held to a handle *H* as shown, this handle rotating freely on the screw *A*. Gear *D* meshes with an internal gear *I*, the latter being held to the cross-slide by a bracket *J*.



A Differential Quick-withdraw Mechanism for the Lathe

When the tool-slide is to be adjusted, the catch *C* is released by a pressure of the hand, thus disengaging it from index-plate *E*. Screw *A* can now be rotated by means of the handle *B*, independently of the regular withdrawing mechanism. The setting for the depth of cut is facilitated by notches in plate *E*. While this device could be used in a number of cases for different classes of work, its chief value is for cutting screw threads, as it takes the place of the micrometer stop or collar used on most lathes for this purpose. For the quick withdrawing of the tool-slide, handle *H* is turned one-half revolution into the positions shown by the dotted lines (in right-hand view), and as the internal gear *I* is stationary, the movement of the handle causes gear *D* to rotate, driving gear *F*, which is keyed to shaft *A*. Thus, by turning the handle *H* a quick motion is given to the feed-screw, withdrawing the tool from the work.

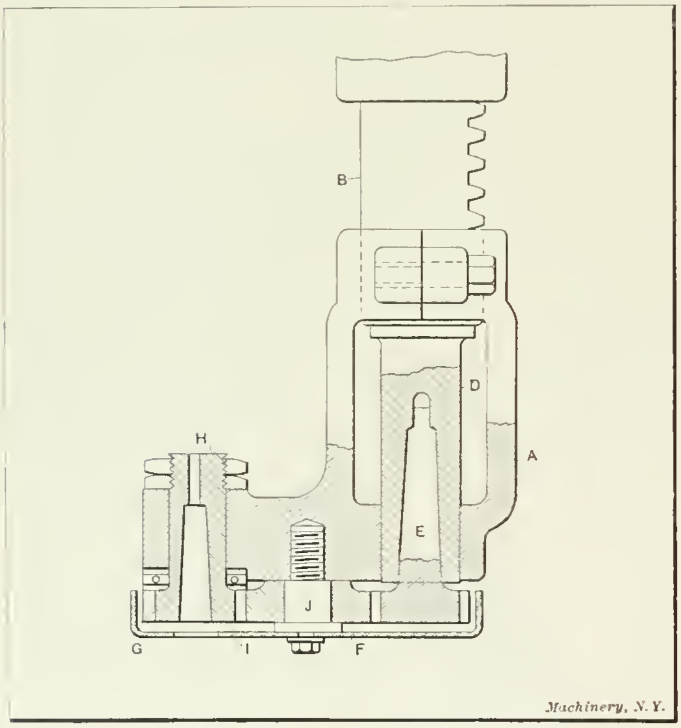
When catch *C* is in contact with plate *E*, and handle *B* is rotated, the index-plate *E* also rotates, but when the catch is disconnected, of course no motion will be imparted to plate *E*, handle *H* only being moved. It will thus be seen that the tool-slide can be withdrawn without changing the position of handle *B* and plate *E*, so that when *H* is revolved to its former position, the tool will then be in the same position that it previously occupied. By moving handle *B* relative to the notches in plate *E*, the threading tool can be set in to the depth required for the next cut. The internal gear *I* has 60 teeth and the gears *D* and *F* each have 20 teeth; therefore, one-half revolution of the handle *H* will revolve gear *F* twice, and consequently impart the same number of revolutions to the screw *A*. The pitch of screw *A* equals ½ inch, so that the tool is withdrawn 1 inch for one-half revolution of handle *H*.

X. Y.

OFFSET DRILLING ATTACHMENT

Having a considerable number of holes to drill under a projecting part of a piece of work, we designed the attachment shown in the accompanying illustration. This device consists of a cast-iron frame *A*, which is clamped to the sliding sleeve *B* of the drill press, while the lower end of the frame is bored out to receive the "live" spindle *D* of the drill press. A small gear with a shank *E* fits into the live spindle and meshes with an intermediate gear *F* held to the bracket. Gear *F* drives gear *G*, which is made integral with the vertical spindle *H*. A guard *I* is located on the stud *J* and protects the gears. This arrangement might not be applicable for heavy work, but for very light drilling, it has proved satisfactory.

W. A.

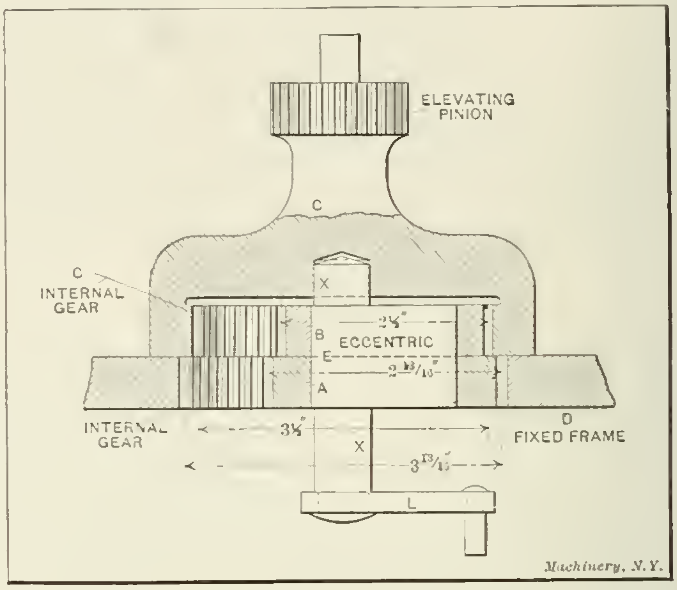


Efficient Offset Drilling Attachment for Light Duty

ANALYSIS OF SPEED-REDUCING MECHANISM

The analysis of a gear train is always an interesting problem, and in addition, it is instructive to a high degree; it develops the habits of inspection and thoroughness in a man. This is especially true because no one rule can be made to cover all cases; consequently, different problems offer different ideas and solutions. One of the nicest problems along this line that the writer has come across for some time is the finding of the speed ratio between the crank and elevating pinion in the mechanism shown in the accompanying engraving. This train is used as a sort of hand-operated elevator and the multiplication of power is considerable; the speed reduction is so great that the device is self-locking with any ordinary load—a requisite feature of an elevating system.

The construction of the mechanism is as follows: An eccentric *E* is driven by the crank *L* and is free to turn in the gears *A* and *B*, the stud *X* being free to turn in the casting *C*. The gear *A* meshes with the internal gear of the fixed frame *D* and is bolted to gear *B* which, in turn, meshes with the internal gear *C* which is an integral part of the elevating pinion. As the eccentric is turned by the crank *L*, gear *A* is moved around inside of *D* and carries *B* with it rolling inside of *C*. Since the diameter of *A* is a little more than that of *B*, *C* is revolved slowly in the same direction as *L*. *A* has 45 teeth, 16 pitch; *B*, 45 teeth, 18 pitch; *C*, 63 teeth, 18 pitch; and *D*, 61 teeth, 16 pitch.



Epicyclic Gear Train used in a Speed Reducing Mechanism

The following analysis of the problem showing the speed ratio between *L* and *C* is perhaps the most satisfactory solution for such problems that has been devised. First consider all of the wheels locked together and imagine the entire combination as being turned to the right one turn. Then since the internal gear *D* is fixed it must be turned back one turn in order to bring it to its original position. While performing the last operation consider *E* as being held stationary and then calculate the total turns made by *C* during the entire proceeding; the result is the number of turns made by *C* for one turn of *E* or *L*. With *E* held stationary and *D* turned -1 times, *A* and *B* will each turn $-\frac{61}{45}$ times. *C* will make $-(\frac{61}{45} \times \frac{45}{63})$ turns in the same direction as *B*.

Tabulating the results obtained from these calculations gives the following number of revolutions and portions of revolutions for each of the gears:

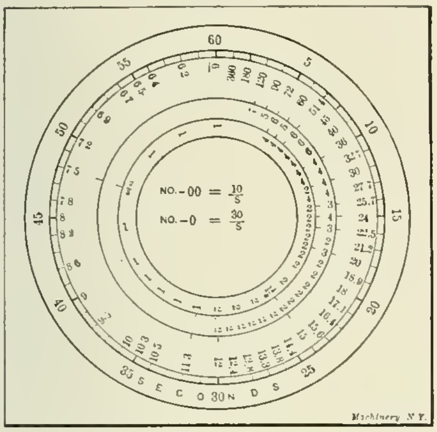
	E	*A*	*B*	*C*	*D*
Wheels locked ..	$+1$	$+1$	$+1$	$+1$	$+1$
E stationary.....	0	$-\frac{61}{45}$	$-\frac{61}{45}$	$-(\frac{61}{45} \times \frac{45}{63})$	-1
	$+1$	$-\frac{16}{45}$	$-\frac{16}{45}$	$+\frac{2}{63}$	0

From the above, for one turn of the crank right-handed, *A* and *B* each make $\frac{16}{45}$ turns left-handed and *C* makes $\frac{2}{63}$ turns right-handed. The speed ratio is then $1 \div \frac{2}{63}$ or 31.5 : 1, that is, for 31.5 turns of L the elevating pinion makes one turn.

This method of analysis may be used with any gear train no matter how complicated, the chief requirement being to follow the combination through carefully, noting the result of turning each gear.

Scranton, Pa. S. Hurley

A PRODUCTION CHART FOR SCREW MACHINES



Production Chart for Screw Machine Use

The accompanying illustration shows a chart which the writer designed for screw machine use, but it can also be used in every department of the shop. This chart is of such a size that it can be cut out and placed in the back of a watch. Its purpose is to enable the foreman, speed boss or engineer, to calculate the number of parts made in ten hours, when the number of seconds required to make a piece is known, or *vice versa.*

A few illustrations of the value of this chart may be of interest. First, in setting piece-work prices, when the day rate is known, the operator is timed, and the number of seconds required to make one piece is found; then the gross product for one day of ten hours will be found directly opposite the seconds on the chart. It is thus possible to figure the price per hundred without pencil and paper. The figures opposite the seconds represent the number of hundreds of pieces made, as, for instance, 19 seconds for one piece would be 1890 parts in ten hours. Without this chart it would be necessary to divide 19 seconds into 36,000, with the likelihood of making a mistake.

Again, suppose a foreman is placing a job on a machine, and in order to keep up with the factory output, he must obtain 1500 parts a day; he glances at his watch and sees that it will take 24 seconds to make one piece. What the writer wishes to make clear is that these problems come up many times during the day, and that the production of any machine can be determined by means of the watch alone. A screw machine foreman finds it very handy, because he can gear his machines up, on occasion, to hurry the parts through; this sometimes means more tool-cost but is often necessary. The reason all the productions are not given is that the chart was made for screw machine use, and the productions corresponding with the gears alone are given.

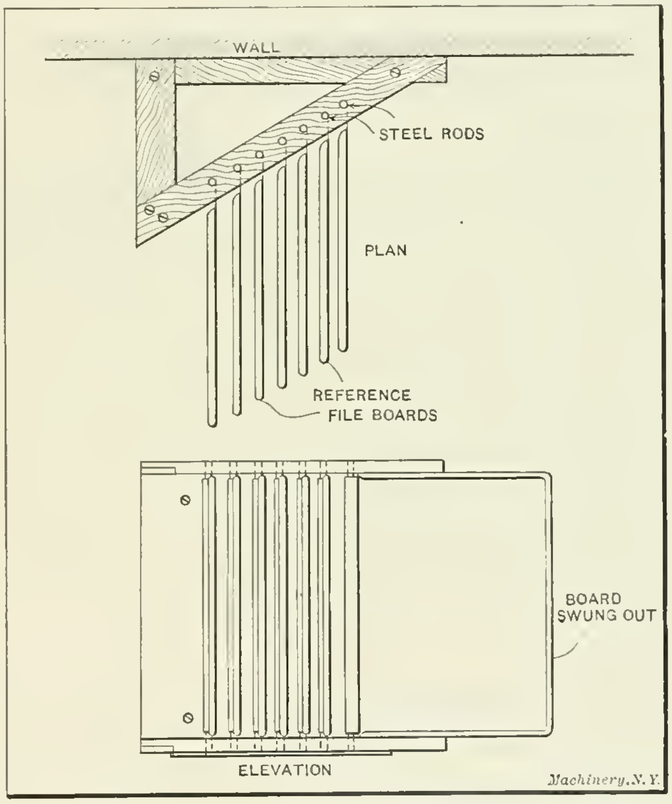
Another use is to tell instantly what gears to put on the screw machine to obtain the different productions. In the center of the dial is shown, for a No. 00 B. & S. automatic screw machine, the figures $\frac{10}{S}$; S is the seconds for one turn of the cam shaft (or for one piece), and 10 means that the driving shaft turns ten times as fast as the cam shaft, when the gears are one to one or $\frac{1 \text{ driver}}{1 \text{ driven}}$. Now opposite the number of seconds and inside of the production figures, are given the multipliers to obtain the gears which go with the machine. For example, what gears should be used for a 9-second job on the No. 00 B. & S. automatic screw machine? Opposite "9 seconds" will be found the multiplier 6, and 6 times $\frac{10}{S} = \frac{6}{6} \times \frac{10}{9} = \frac{60}{54}$, which is the number of teeth in the driver and driven gears.

The writer is aware that books and cards go with the machine, but all these tables can now be carried in your watch. It is very handy to pull out your watch any time, and note what gears are on a machine and what gears should be on. The method for the No. 0 B. & S. automatic screw machine is the same except that the ratio between the driving shaft and the cam shaft is $\frac{30}{1}$ instead of $\frac{10}{1}$; also the multipliers are on the inside row. The figures for the gears of the No. 2 B. & S. automatic screw machine are not given, as these gears are compounded, and this size of machine is not used so extensively as the smaller sizes. The operator of a few No. 2 B. & S. automatic screw machines will have his gears and speeds, etc., memorized, since the work is turned out much slower, some jobs running for weeks. S. N. Bacon

WALL REFERENCE FILE

In shops and drafting-rooms where frequent reference to tables, charts and drawings of standard parts and machinery is necessary, some form of reference file should be provided. This should not only be readily accessible, but also simple and comprehensive.

A manufacturing company in the West has a system of hinged file boards, shown in the accompanying view, which is admirably adapted to this purpose. The boards are made of sheet metal, about 36 inches high by 24 inches wide and are hinged at the back to steel rods fastened to the wall. The edges of the boards are rolled over a ¼-inch steel rod to prevent their being bent out of shape. Blueprints, tables, drawings, etc., are pasted to the boards, the first board being used as an index to the rest. The file, when assembled, is similar to a book of data, and just as simple to use.



Wall Reference File, the Elevation showing One Sheet Open for Reference

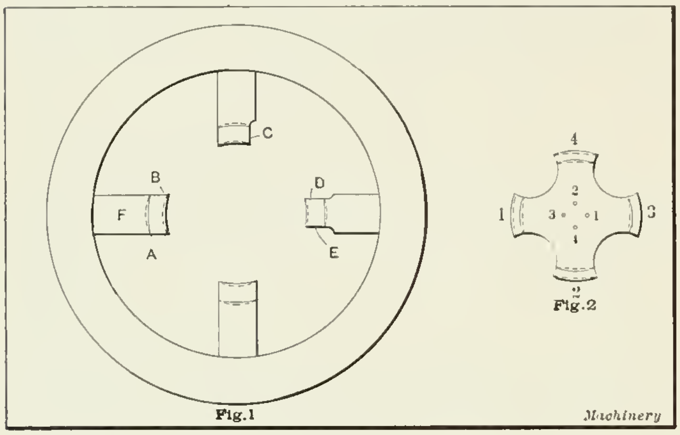
Indianapolis, Ind. F. B. Hays

RELIEVING DIE CHASERS

Having read the article by Correspondent on "Relieving Die Chasers" in the July number of Machinery, it occurred to the writer that the following method which has given satisfactory results, although it is not used to any great extent, might be of interest. The die chasers in this case are cut and relieved at the same time with a hob slightly smaller in diameter than the thread to be cut by the die. The chasers are cut by setting them to a diameter as much smaller than the thread to be cut as the hob is smaller than this thread. If, for any reason, the chasers cannot be adjusted in this manner, each chaser can be hobbed separately.

Chasers relieved in this manner bear as heavily on the screw being cut at the back edge *B* (see the accompanying illustration) as at the forward cutting edge *A*, except that the spring of the chaser under the strain of the cut tends to produce a slight relief at the back edge *B*. It is evident that the back edge will ride easily over the threads, and that it tends to steady the die. The result is an even and smooth thread.

In most cases a chaser such as shown at *F* works most satisfactorily, and if a thread must be backed out of the die it can be done without injury either to the chasers or the thread. If more relief than that provided for by the chaser *F* is required, the chaser can be ground away at the back as shown at *C*. When the chasers need to be sharpened, they should be ground on both edges as shown at *D* and *E*. The same principle of relief can be used with equally good results on taps, as indicated in Fig. 2. This relief can be produced on a lathe by the use of offset centers, but can also be very satisfactorily done by hand with a file. The same rules that govern the grinding of chasers apply also to the grinding of taps.

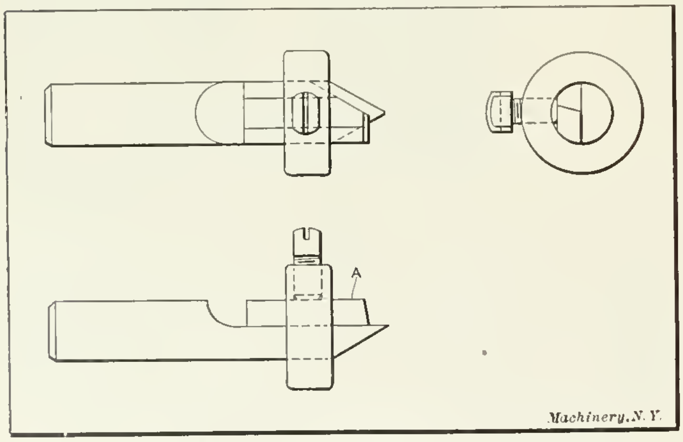


Figs. 1 and 2. Method of Relieving Die Chasers and Taps

Watervliet, N. Y. MARTIN H. BALL

COMBINATION CENTERING REAMER AND FACING TOOL

A convenient combination countersinking and facing tool is shown in the accompanying illustration. The countersink is made in the customary manner, except that the half removed is milled further back than usual. A piece *A* of the same stock is also milled down to half its diameter on one side, and the end shaped as shown, one corner being removed to clear the angle of the countersink and allow for chips, while the square face is backed off to form a cutting edge. This is securely clamped to the countersink by the set-screw in the encircling collar, and by the same means may be adjusted to give any desired depth of countersink. The advantage of facing the end lies in the superiority of the end-finish so that when the work is put in the lathe, it will run on true centers.



Combination Centering Reamer and Facing Tool

H. B.

DRILLING DIAMETRAL HOLES IN SHAFTS

There are various ways of drilling through round rods or shafts, but the device shown in Figs. 1 and 2 seems to have some merits peculiar to itself. It is made of two bars of rectangular steel *A* and *B*, preferably machined all over, but cold-rolled steel would do if the work is not too particular. The bar *A* is bored a slip fit for the hardened bushing *C*, of which there are several for drilling different sized holes. The hole in which the bushing fits must be exactly central with the V-notch in the bottom of *A*, and it must also be exactly central longitudinally in *A*, for reasons that will be referred to later. The bars *A* and *B* are held together by the two studs *D* and *E* running freely through *A*, screwed tightly into blind holes in *B*, and having hexagon nuts *F* and *G* bearing against the upper surface of *A*. The bars *A* and *B* are purposely left a little longer than would at first seem necessary; this is to afford an opportunity for applying calipers near the ends of the bars, to see if dimensions *H* and *K* are alike after the rod to be drilled is clamped in place. The bar *B* has a hole centrally through it a trifle larger than the largest hole in the set of bushings.

The reason for having the bushing longitudinally central in *A*, and also for having *A* exactly ½ inch thick, is to facilitate clamping the device in the proper location endwise of the shaft to bring the hole the right distance from the end, or from some shoulder on the shaft. Also, by having the outfit duplicated it is a comparatively easy matter to drill two diametral holes in the same shaft, where they are not less than ½ inch apart, and at the same time have the holes parallel by clamping both fixtures on the shaft at once. In case the two fixtures are clamped on different diameters of the same shaft, then a scrap piece of sheet metal is placed between the shaft and the lower bar of the fixture at the smaller diameter, the thickness of this piece being equal to half the difference of the diameters at the two points.

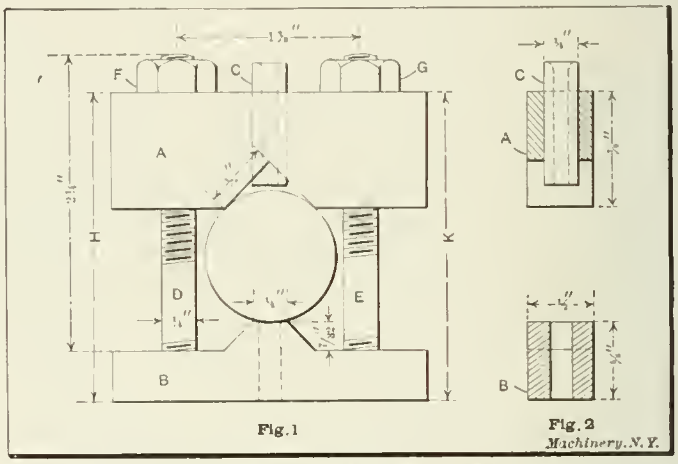


Fig 1. Jig for Drilling Diametral Holes in Shafts

Fig. 2. Cross-section of Strap A

Mr. Chas. W. Spicer is the originator of this device, but he made his with a V-notch in the lower bar also. There seems to be no advantage in that; but if made with a V-projection on the lower bar as shown in Fig. 1, the range of sizes that the fixture will take is then somewhat increased. If made to the dimensions given, it will take round rods from 3/16 to 1 inch diameter, if the drill press chuck is of the Almond or Beach type, with jaws sliding on a taper; but if the chuck body is at all bulky near its lower end, there will not be room for it between the studs when drilling a small sized shaft, so the drill will then either have to be spliced out longer, or the studs *D* and *E* set further apart when making the fixture. WALTER GRIBBEN

Brooklyn, New York.

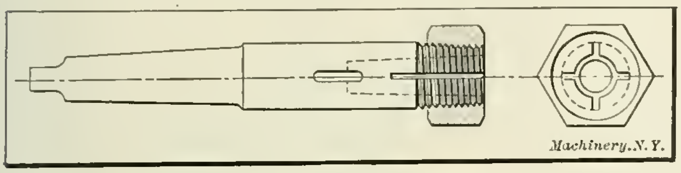
SHOP KINKS

PRACTICAL IDEAS FOR THE SHOP AND DRAFTING-ROOM

Contributions of kinks, devices and methods of doing work are solicited for this column. Write on one side of the paper only and send sketches when necessary.

A DRILL SOCKET FOR HOLDING DRILLS WITH BROKEN TANGS

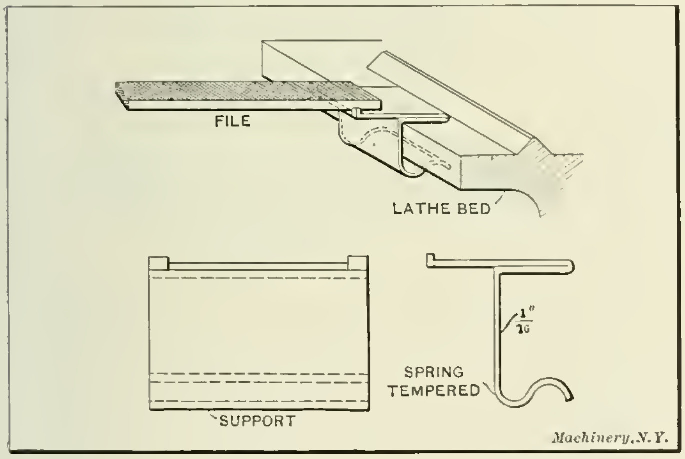
The accompanying illustration shows a socket for holding drills with broken tangs and also for protecting the tangs of good drills. This device can be made from an ordinary socket by slotting and threading the lower end as shown. A nut is then provided for tightening the socket on the drill shank. This device has been used by the writer for a considerable time and has proved satisfactory for holding drills with broken tangs as well as those in which the tangs were in good condition.


Machinery, N. Y.

Eddystone, Pa. WILLIAM THOMAS

FILE SUPPORT FOR THE LATHE

When a machinist is filing at a lathe and the file clogs up, it is necessary for him to turn around and place the file on a bench to clean it. Sometimes the end of the file is rested on the lathe bed, but this is not advisable, as the filings get on the ways of the lathe where they are objectionable.



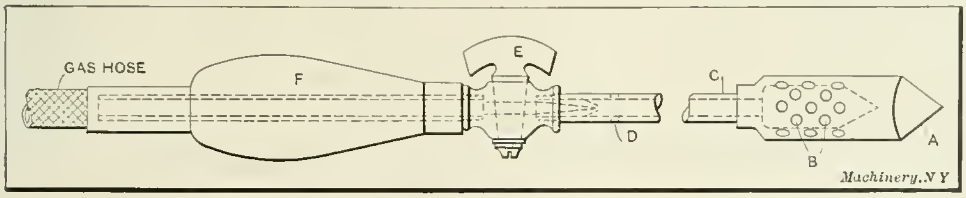
Machinery, N. Y.

The small device shown in the accompanying illustration can be used for supporting the file when cleaning it. This consists of a piece of sheet steel 1/16 inch thick, which is bent into the shape shown, and made to fit snugly on the lathe bed. The lower part of this device should preferably be spring tempered, so that it will have a good grip on the lathe bed. In use it can be placed near the headstock where it is convenient and out of the way.

Hartford, Conn. JAMES E. COOLEY

A GAS-HEATED SOLDERING IRON

The accompanying illustration shows a soldering iron that will be found very useful for light bench work, for it can be used continuously, doing away with the necessity of reheating or changing irons.



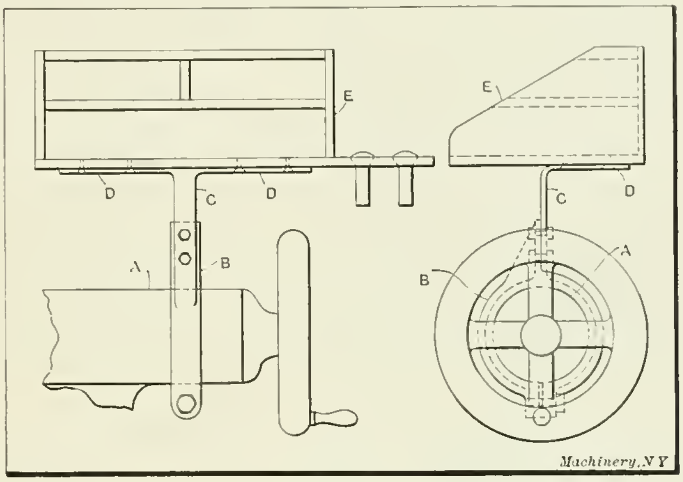
Machinery, N Y

A hollow copper soldering butt *A* having a number of radial holes *B*, connects with a pipe *C* in which there is a Bunsen burner *D*. The gas is controlled by a pet-cock *E* attached to a wooden handle *F*, the gas hose communicating with this handle. It can be connected to any gas burner and will be found very useful on some classes of work. W. ALTON

TOOL SHELF FOR THE LATHE

It is quite common to see hammers, turning tools, files and other lathe tools placed on the end of the lathe bed. Sometimes the mechanic puts a flat piece of board on the lathe bed to hold the tools, but this frequently gets in the way and many mishaps occur, such as spilling the tools all over the floor, etc.

A simply made tool shelf is shown in the illustration which can be made and applied at small cost. The spindle of the tailstock *A* is encircled with a bronze or malleable iron casting *B* to which is attached a strip of iron *C*, this latter having the upper end bifurcated at *D*. A wooden box structure *E* is set on this, attached by wood screws. One side of this wooden box is extended to hold collets.

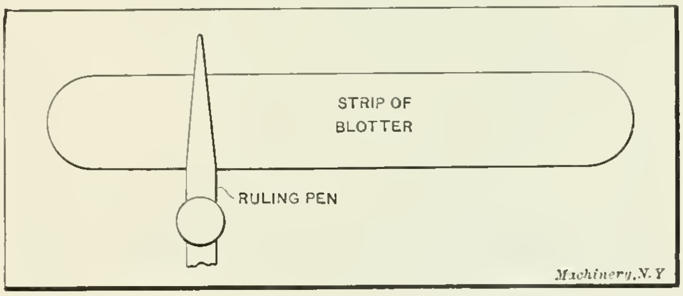


Machinery, N Y

Woonsocket, R. I. KINGSTON FORBES

RULING PEN WIPER

Here is something that every draftsman will appreciate, for any one who does any tracing shares the pen-wiping rag troubles. In order to overcome the wiping rag trouble, the writer began to use the corners of a large blotter and finding it satisfactory in every way, made a farther step by cutting a blotter into strips about ⅝-inch wide, the length being the width of the blotter, and rounding the corners off; this formed a neat little pen wiper. To wipe the ruling pen, push the blotter through the blades of the pen any distance and then pull it in the direction of the length of the blades, which action wipes the pen. The wiper can also be used for wiping writing pens, by simply moving its edge along the inside and outside of the pen. The writer has used these wipers for over two years; every one in our drawing-room now uses them, and finds them very satisfactory. They are always dry and ready for service.



Machinery, N Y

BENJ. BROWNSTEIN

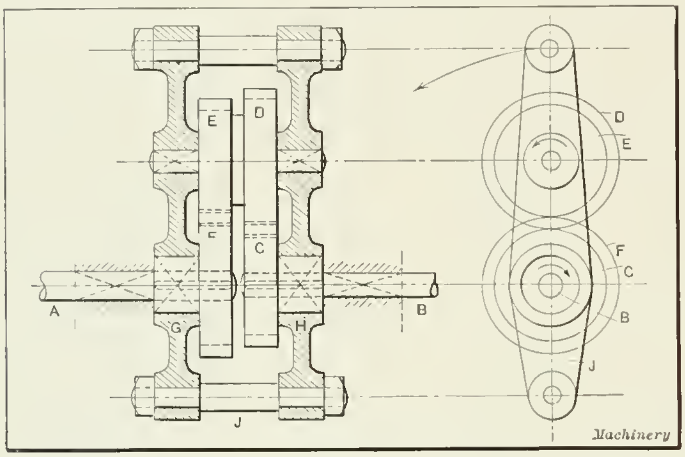
HOW AND WHY

DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST

Give details and name and address. The latter are for our own convenience and will not be published

PLANETARY GEAR DESIGN

O. S.—The illustration shows a train of gears between shafts *A* and *B*, of which pinion *C* is fixed on shaft *B*, gear *D* and pinion *E* are rigidly connected, and have their bearings in the pivoted frame *J* which consists of two parts *G* and *H* held together by distance bolts. The pivotal axis of the frame is coincident with the rotary axes of gears *C* and *F*. Gear *F* is fixed to shaft *A*. Now suppose that pinion *C* has 25 teeth, gear *D*, 30 teeth, pinion *E*, 25 teeth, and gear *F*, 30 teeth. The consequent relative movement of pinion *C* and gear *F* will be as 1 to 0.694. If now, for example, gear *F* is held stationary and power is applied to shaft *B* in the direction of the arrow, I assume that the frame will swing in a planetary manner in the opposite direction, as indicated. For the demonstration of motion I made a crude model similar to that shown in the illustration, but did not get the anticipated result. Will you kindly tell me through the How and Why columns of MACHINERY what the trouble is?



A.—The reaction of the frame *J*, as you assumed, is in a counter-clockwise direction when the shaft *B* is turned in a clockwise direction. The reason you did not get a satisfactory action probably is due to crudeness of the apparatus. Planetary gearing as ordinarily designed, offers high frictional resistance. It must be made with accurately cut teeth and well-fitted bearings in order to secure a satisfactory action. The ratio of motion of the driver to the driven shaft should be generally higher than in this case to avoid excessive frictional resistance which may be greater than the driving force on the frame. With low ratios the gears lock, that is, the friction of the teeth and bearings is greater than the driving force.

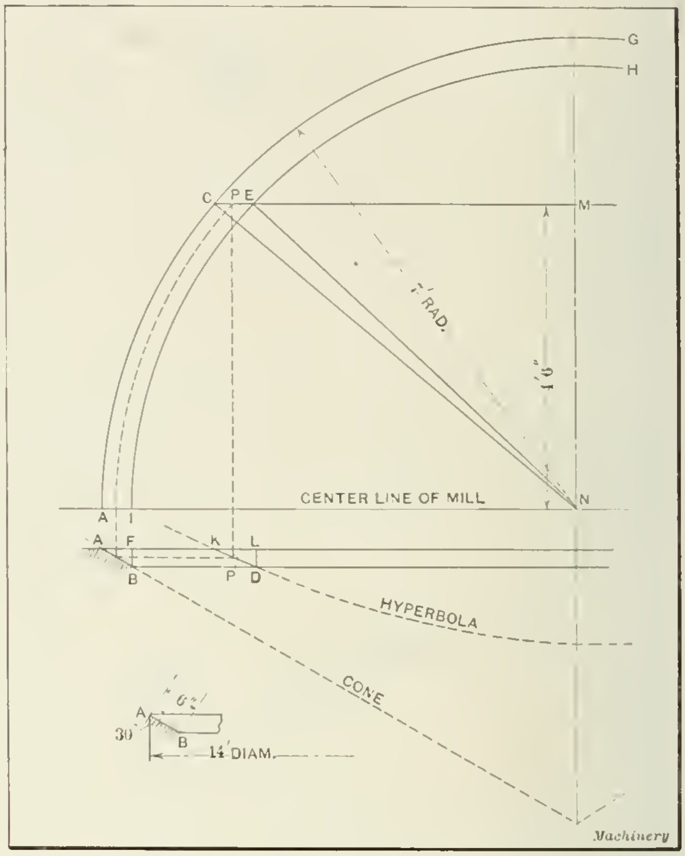
BORING LARGE BEVEL RING ON SMALL MILL

O. G. S.—A large ring, 14 feet 6 inches in diameter, for a blast furnace top, is to be bored out with a taper of 30 degrees over a surface 6 inches wide, as indicated in the lower left-hand corner of the accompanying illustration, the diameter of the ring at the point *A* being 14 feet. The only machine available for this job is a 10-foot Betts boring mill, and on account of the table being too small, strips have to be bolted onto it to support the ring. This necessitates that the housing be set back, which brings the tool 4 feet 6 inches back from the center line of the mill. The extension head cannot be used, so it is necessary to use the heads on the cross-rail. At what angle must the head be set in this location in order to give the 30-degree bevel?

A.—The answer to the question above may be obtained either by careful graphical construction or by a simple calculation. It should be noted, however, that feeding the tool in a straight line under the conditions given will not produce a perfectly straight beveled surface, but one that is slightly convex; the inaccuracy in this case is very slight, however, as can be shown by a simple graphical construction.

Draw, preferably to large scale, a sectional view and plan of the bevel ring, as shown in the illustration. Line *CE* shows the path of the tool projected on the horizontal plane. Points *C* and *E* projected to *K* and *D* give line *KD*, which is the path of the tool in the vertical plane. Angle *DKL*, therefore, is the angle to which the head should be set. This angle can be measured by a protractor, if the drawing has been carefully made. It will, in the given case, be found to equal 23 degrees, 30 minutes.

In order to ascertain if the line *KD* corresponds fairly well with the hyperbola along which the tool should properly be fed in order to produce a perfectly straight face at *AB*, construct the curve which forms the intersection between plane *CM* and the cone of which beveled face *AB* is a part. The construction of the intersecting curve, which is one of the problems found in practically all text-books on mechanical drawing, is accomplished by projecting points *P* from the plan view to the sectional view as indicated. It will be found that in the present case the hyperbola almost exactly coincides with the straight line between points *D* and *K*. Hence, the inaccuracy produced, that is, the convexity of face *AB* will be very slight.



To calculate angle *DKL*, proceed as follows: First find the length of *CM*.

$\sqrt{CN^2 - NM^2} = CM$. Hence, $CM = \sqrt{84^2 - 54^2} = 64.343$ inches.

Next find length of *EN* and of *EM*.

$EN = CN - AF = 84 - 6 \times \cos 30 \text{ deg.} = 78.804$ inches.

$EM = \sqrt{EN^2 - NM^2} = \sqrt{78.804^2 - 54^2} = 57.392$ inches.

Then, $CE = CM - EM = 6.951 = KL$.

$KL \div LD = \cot DKL$.

But $LD = AB \times \sin 30 \text{ deg.} = 3$ inches.

Hence, $\cot DKL = 6.951 \div 3 = 2.317$, and $DKL = 23$ degrees, 21 minutes. Apparently, the graphical solution, 23½ degrees, is close enough for all practical purposes.

* * *

A party of members of the Society of Automobile Engineers will make a trip to Europe, leaving New York November 1. The first few days in England will be spent in examining the exhibits of the automobile show which will then be in progress at Olympia, London. They will be entertained by the Incorporated Institution of Automobile Engineers, which is the English society corresponding to the S. A. E. A trip will be made to Birmingham, and some of the interesting country in the Warwickshire district, Stratford-on-Avon, and surrounding territory will be passed through. The Humber automobile factory, one of the largest in England, will also be visited, as well as a large number of other plants, the plan being to see the best factories and inspect them thoroughly.

NEW MACHINERY AND TOOLS

THE COMPLETE MONTHLY RECORD OF NEW DESIGNS AND IMPROVEMENTS IN AMERICAN METAL-WORKING MACHINERY AND TOOLS

LANGELIER HAMMERING MACHINE WITH PNEUMATIC ATTACHMENT

The Langelier Mfg. Co., of Providence, R. I., which has made a specialty of building hammering and swaging machines, recently added to its standard line the heavy No. 4 hammering machine shown in Figs. 1, 2 and 4. This design is equipped with a special rotary attachment having an automatic, pneumatically operated chuck for handling work similar to that illustrated in Fig. 3. This machine uses blanks that have been previously reduced and formed by a swaging machine as shown at *A*. A power press with suitable tools is then used, in this particular case, to square the shoulder, as indicated at *B*, after which the pieces are finished to the shape shown at *C* in the hammering machine. The output of this machine is six hammered pieces per minute, and the work is finished accurately within a limit of 0.0015 inch in diameter. In addition to reducing pieces of the shape illustrated, this machine can be used for making a great variety of other forms out of hollow stock.

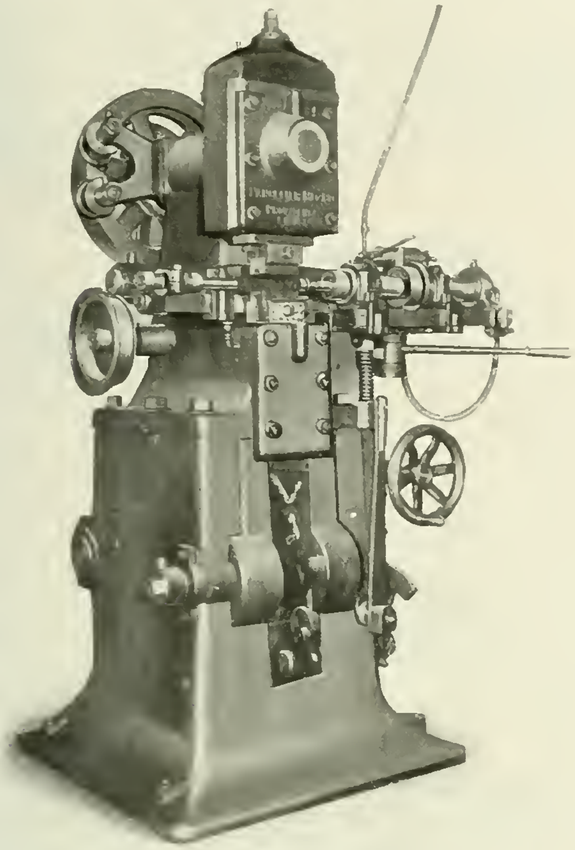


Fig. 1. No. 4 Heavy Hammering Machine, built by Langelier Mfg. Co.

Figs. 1 and 2 give a very good idea of the general construction of the machine and show the pneumatic rotary attachment and also the main driving mechanism. The column of the machine is formed by a heavy casting of square cross-section, upon which is mounted a head containing the main spindle, spindle rolls and upper vertical plunger. The main drive is mounted at the side of the base, which encloses the lower vertical plunger with its operating mechanism. The spindle is driven from an overhead countershaft by a belt which leads to a pulley at the rear. The spindle carries a heavy balance-wheel, which insures smooth operation and absorbs the vibration of the hammer blows.

The pulley for driving the pneumatic rotary attachment is mounted on the left at the rear, as shown in Fig. 1. This pulley drives a horizontal shaft extending across to the opposite side where connection is made with the attachment through a chain and sprocket drive, as shown in Fig. 2. The spindle rolls which operate the upper vertical plunger and upper die are located at the front. Twelve blows are struck for every revolution of the main spindle, and as the latter makes 325 revolutions per minute, it will be seen that the blank receives 3900 blows per minute. The intensity of the blow is controlled by adjusting a screw on the head.

The lower die, which is the moving die, is mounted in a holder on top of the lower plunger. This plunger works vertically between two members of the head which extends down inside of the base at the front of the machine. The reciprocating motion of the plunger is imparted by a powerful toggle lever, fulcrumed on a trunnion shaft that is laid in the hanging members just referred to, and is actuated by a large wiper face cam at the rear of the base. This cam receives its motion from the main driving shaft through the spur and worm gearing shown in Fig. 2. As the wiper cam revolves, it alternately raises and depresses the toggle lever arm, thus simultaneously lifting and lowering the plunger and bottom die, which is gradually brought into contact with the upper die. The dies remain in contact a sufficient time to finish the work uniformly, after which the lower plunger is quickly returned. The trunnion shaft bearing cap of the toggle lever is extended into a fork-shaped journal, which may be seen in Fig. 1 through the opening in the base. This forked journal is connected with a crank lever keyed to a shaft which extends through the side of the base and carries at its outer end a segment cam which may be seen in Fig. 2. In this way a rocking motion is given to the segment cam which transmits the movement, by means of a roller and vertical slide, to the pneumatic attachment. This alternate raising and lowering of the attachment is absolutely necessary in order to keep the work central with the dies at all times until the hammering operation is completed.

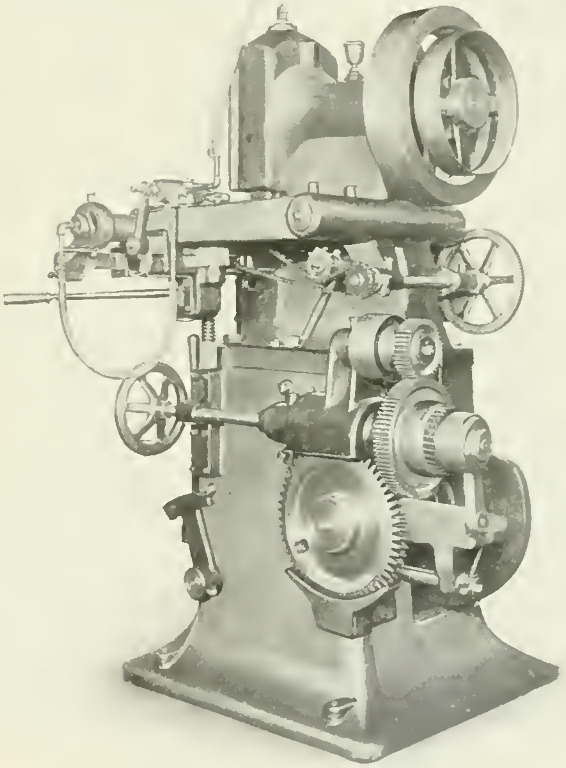


Fig. 2. View showing Main Driving Mechanism and Drive for Rotary Attachment

The attachment consists essentially of a U-shaped casting, oscillating on a shaft at the rear of the head and having arms which straddle the head and extend to the front of the machine. The left arm carries a work arbor which fits into the tubing to retain its size and support the walls and thus prevent crimping under the hammer blows. The right arm of the attachment carries the chain-driven pneumatic chuck which holds the work. Special air cylinders for opening and closing the chuck and for feeding and withdrawing the chuck pistons are also mounted on this arm. The reason for revolving the chuck and work during the hammering operation is to insure shaping the blank concentrically.

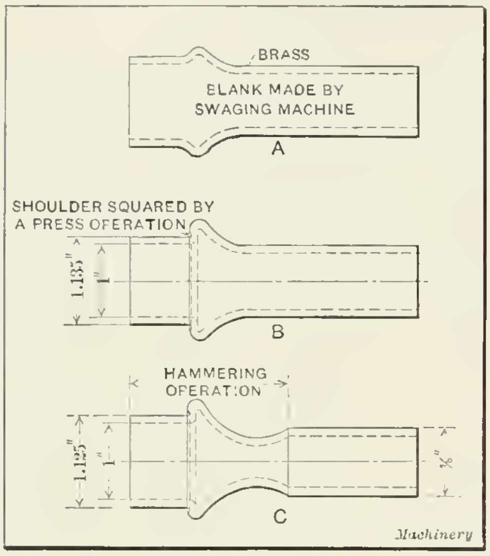

BRASS
BLANK MADE BY SWAGING MACHINE
A
SHOULDER SQUARED BY A PRESS OPERATION
1.135"
1"
B
HAMMERING OPERATION
1.125"
1"
7/8"
C
Machinery

Fig. 3. Typical Example of Work done in Hammering Machine

All the functions of the air cylinders are controlled by a simple movement of the lever seen to the right of the machine. When this lever is moved to the rear, the air pressure releases the chuck jaws and the air exhausts into the atmosphere. The chuck is closed by air in such a way as to hold the work tight while the hammering is in progress.

The operation of the machine is uninterrupted between the ejection of the finished pieces and the insertion of a new blank. The main driving pulley revolves continuously, and the cam at the rear is arranged to trip a ratchet pawl at every revolution, thus stopping a roll clutch. As soon as the operator has inserted a new blank in the chuck, he releases the clutch by a slight movement of the starting lever at the front of the machine, and the hammering proceeds. This machine weighs approximately 5900 pounds.

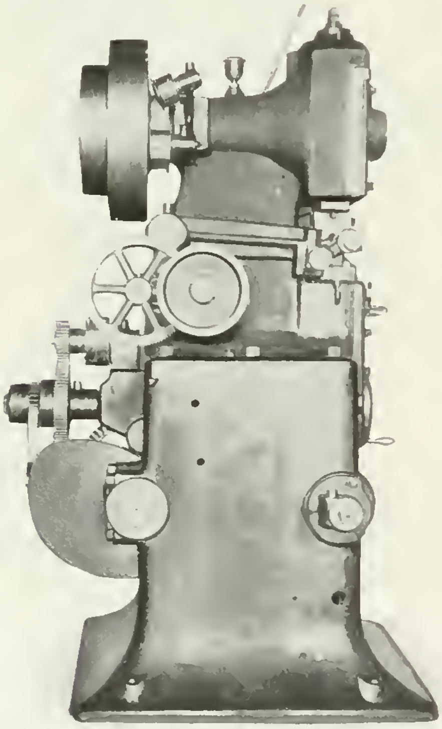


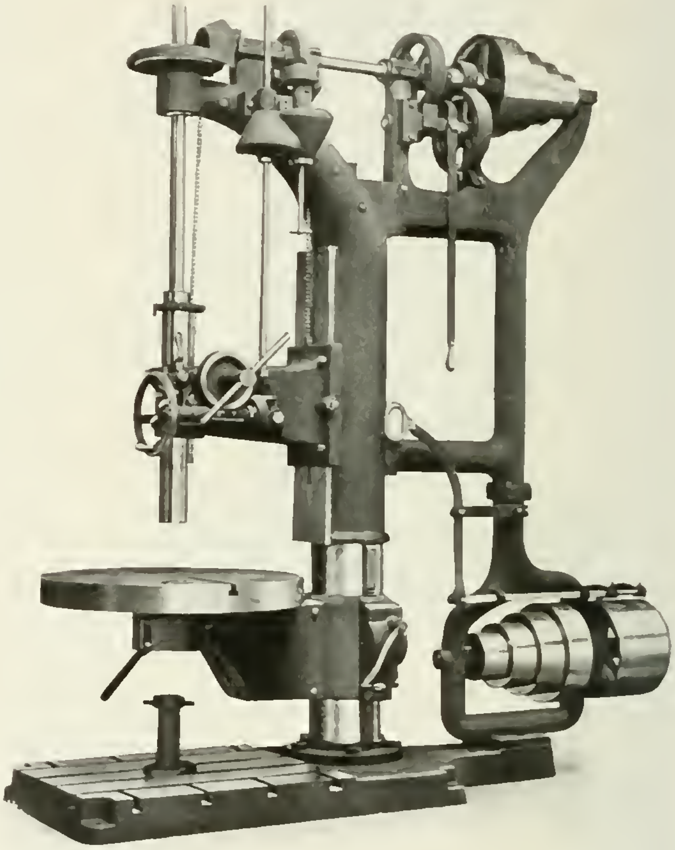
Fig. 4. Side View of Langelier Hammering Machine

SNYDER HEAVY-PATTERN UPRIGHT DRILL

The accompanying illustration shows a large 46-inch upright drill built by J. E. Snyder & Son, Worcester, Mass. This is said to be the heaviest 46-inch drill made in this country. It weighs, skidded for shipment, 6400 pounds, and has an over-all height from the floor to the top of the upper cone of 9 feet, 10 inches. The main column, which is strongly braced and very rigid, weighs 1100 pounds and is 11 inches in diameter. The base weighs 1300 pounds and is strongly ribbed underneath.

The spindle is made of crucible steel and it has a bearing in the sleeve 2½ inches in diameter. The nose of the spindle is 4 inches in diameter and the lower end is equipped with a ball bearing. The table is 37 inches in diameter and has a 12-inch bearing in the arm. The greatest distance from the spindle to the table is 37½ inches and from the spindle to the base, 59½ inches. The head has a traverse on the column of 25½ inches, and the table arm has a vertical adjustment of 14 inches. The vertical feed of the spindle is 18 inches, and suitable graduations are provided, thus giving direct measurements.

There are five changes of geared feed, ranging from 0.007 to 0.052 inch per revolution of the spindle. This machine will drill to the center of a circle 46¾ inches in diameter. The base is 84 inches long, 34½ inches wide, and 5½ inches deep. The head has a 10- by 18-inch bearing on the column, and the table-arm bearing is 15 inches. All gears are guarded, as the illustration shows, and the machine can be equipped with a tapping attachment if desired. Manning, Maxwell & Moore, Inc., are the selling agents.



Snyder 46-inch Heavy Upright Drilling Machine

GEOMETRIC SELF-OPENING AND ADJUSTABLE DIE-HEAD

The Geometric Tool Co., New Haven, Conn., is now manufacturing a new type of automatic opening die, which is shown in Fig. 1 and in detail in Fig. 2. This die, which is known as the "style DD," is especially designed for use in the turret of Cleveland automatic screw machines, but it can also be employed on other automatic or semi-automatic machines, the operation of which is similar to the make referred to. It is made regularly in 5/16, 9/16, 3/4, 1 and 1 1/4-inch sizes, the dimensions representing the maximum diameter of thread which each die-head is designed to cut.

The construction of this die is clearly shown in Fig. 2.

The dies are held at one side of the opening in which they are closely fitted, by splines of liberal size, and their position with relation to the diameter of the thread to be cut is controlled by cams *C*, engaging slots in the inner faces of the dies. As all four dies are adjusted simultaneously and are solidly supported as close as possible to the cutting strains, they cannot move away from the work and a high degree of accuracy is insured. The die-head is not held rigidly, as in the case of a solid die, but is supported by a spring mechanism *S* between the head and shank, which permits the chasers to compensate for any inaccuracy of turret adjustment. In other words, the head yields as it comes into contact with the work, thus allowing the chasers to adjust themselves. This feature also provides a certain amount of longitudinal movement independent of the turret feed, which allows the chasers to compensate, automatically, for any slight irregularities that may exist, thus insuring a product of uniform accuracy, and eliminating "wasters." The die-head is not mounted directly on the shank but is carried on heavy driving pins *P*, set into a substantial flange which is integral with the shank. Additional support is provided by the central extension *c* of the shank, on which the die-head is free to move.

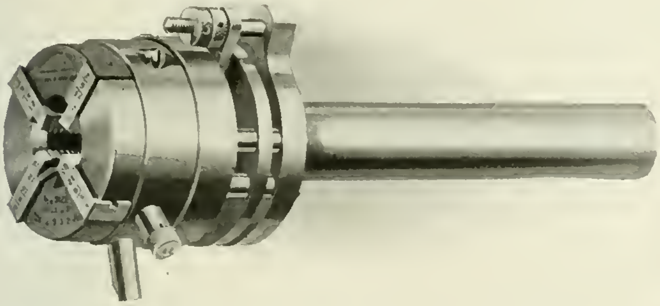


Fig. 1. Geometric Style DD Automatic Opening Die-head

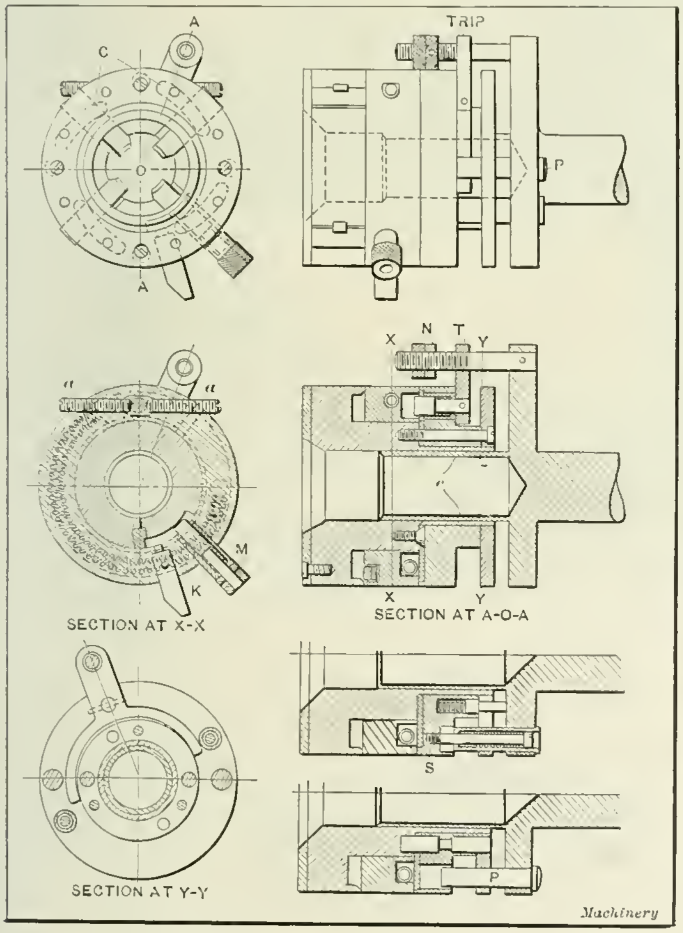


Fig 2. Detail Views of Geometric Die-head

The travel of the turret determines the length of thread to be cut, but this may be set to closer limits by means of the lock-nut adjustment *N* at the side of the die-head. When the turret reaches the limit of its travel, the die-head has a slight independent forward movement which causes the lock-nuts to contact with the hinged trip-plate *T*, thus releasing the locking bolt and opening the chasers. By adjusting these lock-nuts, more or less longitudinal movement can be obtained as required by the work. Fig. 3 shows the position of the die after completing a thread and just before the tripping mechanism opens the chasers, preparatory to moving back off the work.

A micrometer adjustment, controlled by two accurately fitted screws *a*, is provided at one side of the head, so that quick and accurate variations can be made in the diameter of the threads for a tight- or loose-fitting screw, as desired. The die-head is equipped with a closing pin *K*, which is used to close the chasers automatically by the rotation of the turret in connection with a closing bar attached to the turret housing, as indicated in Fig. 4, which shows the position of the die-head just prior to the closing of the chasers by the stationary bar. Owing to the great variation in size of the machines on which these tools can be employed, the closing bar is not included in the equipment.

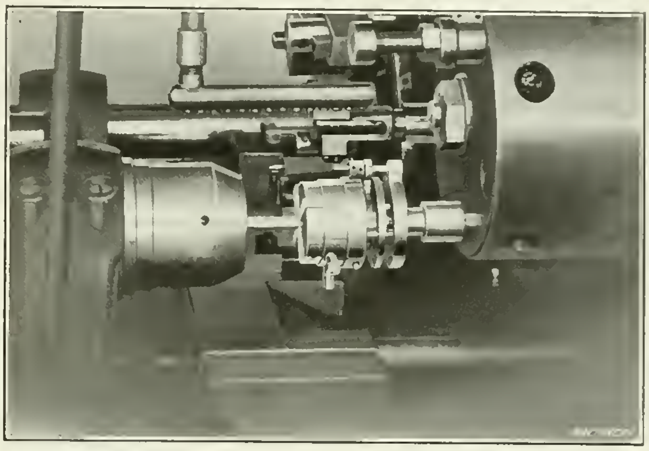


Fig. 3. Position of Die just prior to Operation of Tripping Mechanism

Should it be desired to remove the chasers when the die-head is in the turret, they are first placed in the open position. The spring plunger *M* is then withdrawn, which allows cams *C* to rotate sufficiently to release the chasers which are readily lifted out of place. After the chasers have been removed, the cam should be rotated back to its original position, which allows the plunger to drop into place. When the die-head is not in the machine, the chasers are removed by gripping the shank in a vise and turning the head to open the chasers. When replacing the chasers, care should be taken to see that the numbers stamped on them correspond with the numbers on the housings, so that they will "track," or lead, properly.

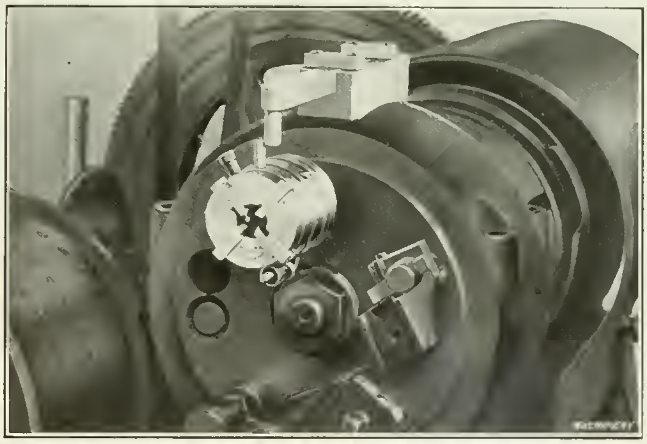


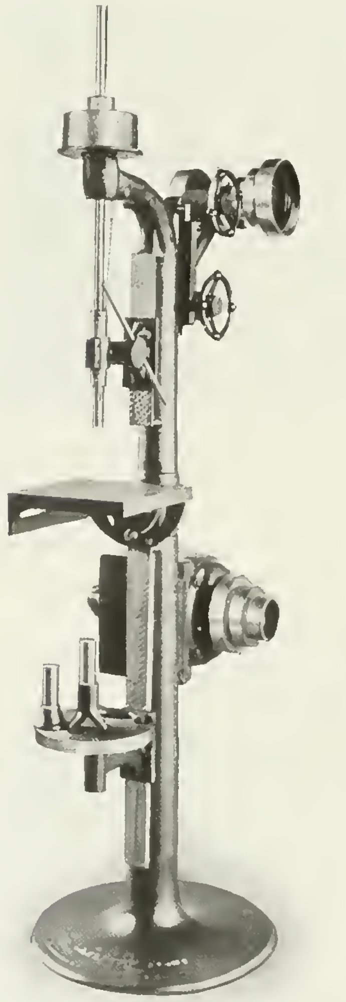
Fig. 4. Closing Pin on Die-head in Engagement with Stationary Pin which closes Chasers

While the style DD die-head is made regularly in only five sizes, as previously stated, larger sizes of either the regular or a special construction can be furnished.

MOTOR-DRIVEN SENSITIVE DRILL PRESS

A new type of motor-driven sensitive drill press has recently been placed on the market by the Washburn Shops of the Worcester Polytechnic Institute. Among the noteworthy features are the method of attaching the motor, and the ease with which the belt tension can be varied. As will be seen from the illustration, the motor is mounted at the rear of the column, thus balancing the tables at the front and giving a symmetrical effect to the whole machine.

The motor is attached to a baseplate bolted to the column, and the drive is from the cone on the motor to a cone on the drive shaft and then by a quarter-turn belt to the spindle. The tensions on these belts are controlled by automatically locked belt tighteners. The bearing for the drive shaft is made to slide in and out on a bracket, while the bracket itself has a vertical movement through a gibbed slide on the column, both motions being controlled by the handwheels, working through rack and pinion movements. Attached to and forming a part of the pinion shaft, is an automatic locking device. This locking device is so arranged that the bracket and slide is locked in every position, and the belt tension is varied by simply turning the handwheel. This device is very simple and does not get out of order, as the same arrangement has been used by the Washburn Shops on hundreds of drawing stands and drafting tables during the past few years without a single defect. With this arrangement it is possible to tighten the belt to the exact tension necessary for the best results, and it is so easily operated that, on completing a job, the tension of the belt can be instantly released, thus increasing the life of the belt.



Washburn 14 inch Sensitive Drill Press

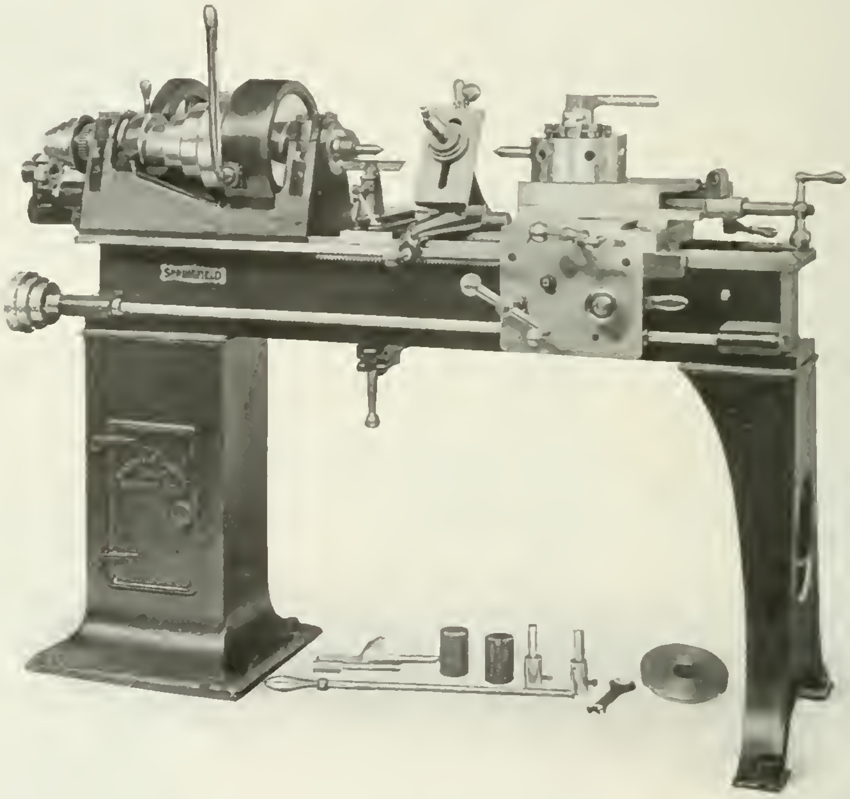
Both the motor shaft and drive shaft have ring-oiling bearings. The spindle pulley is supported on an independent bearing which takes the entire pull of the belt so that the spindle runs absolutely free. The bearing on which the spindle pulley runs is always flooded with oil, a retaining ring being cast concentric with the bearing which forms a basin for holding the oil and prevents all spatter.

The 14-inch drill has both a square and a round table as shown. The square table swings about the column and it can also be tipped to any angle. The round table is vertically adjustable on the column, and can be removed and either a cup center or a crotch center placed in the supporting bracket. These centers are both furnished with the machine. The 13-inch drill is of similar construction, but has only the square table. The square table is supported by a slide which runs the whole length of the column, the head bracket being on the same slide.

Both machines have a capacity up to 9/16 inch diameter. The spindle speeds are 644, 1130 and 1976 revolutions per minute. Any type of induction or direct-current motor can be used, but to give the speeds mentioned, with the regular cone arrangement, the speed of the motor should be 1130 revolutions per minute. This machine, equipped with a constant-speed motor, weighs 430 pounds.

SPRINGFIELD BRASS-WORKING TURRET LATHE

A brass-finishers' turret lathe that is a recent design of the Springfield Machine Tool Co., 631 Southern Ave., Springfield, O., is illustrated herewith. This is a 15-inch by 5-foot machine of the cabinet type, and is equipped with a friction-geared head. The turret is provided wth a new clutch mechanism which is an improvement on the old style in that it enables the turret to be handled more quickly.



Springfield 15-inch by 5-foot Cabinet Turret Lathe

The turret is designed so that a slight backward movement of the operating lever loosens it and at the same time withdraws the locking pin, while a slight forward movement indexes the turret, bringing the next tool into the working position, and at the same time locks and tightens the turret. This entire operation is performed with one hand and in a very short time. The turret has a power feed, having three changes, and its movement can be reversed by a handle at the side of the apron. There is also a longitudinal movement by either a lever or screw. The top turret slide rests upon a slide having a right-angle hand movement, operated by a screw at the front, which gives a large range for facing work held in the chuck. After using this hand cross-feed, the holes in the turret can always be brought central with the spindle by a positive stop, which can be quickly removed when tools are to be used back of the spindle center.

The slide has an additional cross-movement operated by a supplementary taper slide, the taper being derived from a bar between the ways of the bed, which is set by a graduated index to obtain any taper up to 4 inches per foot. This taper attachment makes it unnecessary to set over the headstock for taper boring or turning, and it also enables a part to be faced square after the taper work is completed, without any change. When used for straight work, the taper slide is locked to the saddle by a tapering tool-steel pin, having a square head to facilitate its removal.

Different pitches of thread are obtained in this machine by the well-known follower and leader device. One leader and follower for cutting 11½ threads per inch, and also one hob for cutting the follower, are furnished with each lathe. This machine is so arranged that left-hand threads may be cut with right-hand leaders, thus making it unnecessary to have a special set of left-hand hobs and leaders. Straight or tapering threads can be cut, and the change from one to the other may be quickly made. Inside boring and tapping can also be done while forming outside taper work. The front bearing of the chasing bar can be moved along the bed by means of a tongue and groove, in order to provide for changes in the chasing head when operating on work held in the chuck or between centers.

As the engraving shows, the lathe has one cabinet leg into which shelves can be fitted for the reception of tools, chucks, etc. The headstock has a four-step cone of large diameter, and is provided with back-gears having a ratio of 8 to 1. The spindle is of high-grade steel, accurately ground, and has a 1-inch hole through it. The journals are of phosphor-bronze. The diameter of the turret is 7½ inches, the length of the carriage, 12 inches; the movement of the top slide, 5¼ inches; the cross-movement of the top slide, 6¼ inches; and the maximum distance between the headstock center and turret, with a 5-foot bed, 23 inches.

SUPERIOR TOOL-HOLDERS

The tool-holders shown herewith combine strength with resiliency owing to the gun spring or "goose-neck" construction. These tool-holders are drop-forged from steel and are accurately machined and casehardened. The cut-off tool, Fig. 1, has high-speed steel blades which are beveled and ground and of a stock size. This holder is made in two sizes, known as Nos. 1 and 2. The first size has a ½- by 1⅛-inch shank and a ¾-inch blade, and the larger size has a ⅝- by 1¼-inch shank and ⅞-inch blade. The cutters for the thread tool, Fig. 2, are also made of high-speed steel. These cutters are furnished for either U. S. standard or V-threads. This type of holder is said to avoid all chatter and breaking of blades or cutters. The Superior Machine Tool Co., Kokomo, Ind., is the manufacturer.

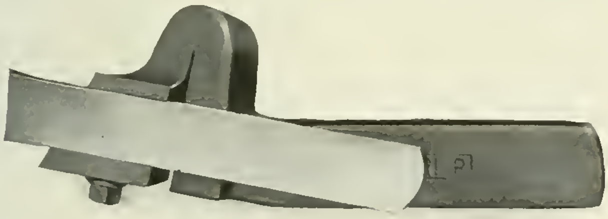


Fig. 1. Superior "High-speed" Cut-off Tool

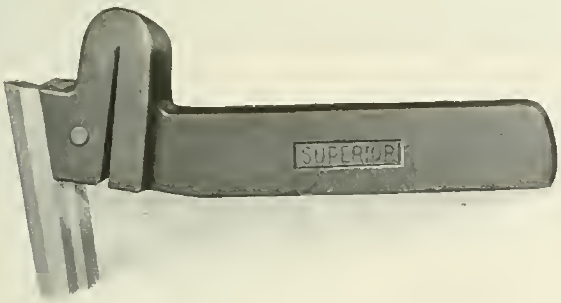


Fig. 2. Superior "High-speed" Threading Tool

NATIONAL AUTOMATIC DIE-HEAD

The die-head illustrated in Fig. 1 is an adjustable self-opening and self-closing type brought out by the National Tool Co., Cleveland, O. This die-head is designed for use on hand and automatic screw machines, for cutting threads of standard and special pitches or pipe threads of any size within its capacity.

Fig. 2 shows the various parts of the die-head. The chasers are mounted in carriers that slide in the grooved disk or block shown, which is contained in a shell screwed to the shank. Fitted over this shell and threaded to the latter, is a hardened and ground knurled adjusting ring that is tapering on the inside. Interposed between this ring and the chaser carriers there are hardened steel balls which are placed in holes drilled through the shell containing the die-block. The dies are adjusted for threads of various diameters by the knurled ring referred to, the diameter of the thread being increased or diminished by turning this ring to the right or left with relation to a suitable graduation mark.

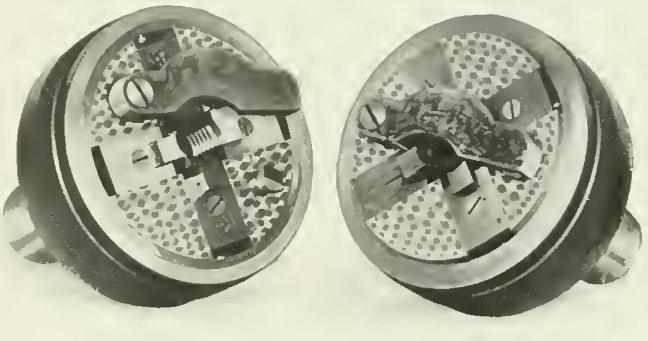


Fig. 1. National Automatic Die-head in the Closed and Open Positions

The die, which is mounted in the turret, is opened by stopping the travel of the turret slide. As soon as the turret comes to a stop, the inner die-block is drawn forward by the action of the thread which is being cut on the stock, and this movement of the die-block brings the recesses in the chaser carriers opposite the steel balls, and thus permits the chasers, which are under the tension of springs to open. The length of the thread is governed by setting the stop on the turret slide. The dies are closed by the latch shown attached to the die-block Fig. 1. This latch, when the dies are opened, extends across the center as shown to the right. The turret advances until this latch comes in contact with the end of the stock to be threaded, which forces the die-block and chasers back to the exact threading position, the dies being shifted inward by the hardened balls. During this backward movement of the die-block, and while the chasers are closing, the latch automatically swings upward out of the way as shown to the left in Fig. 1. From this, it will be seen that the die is entirely self-contained, no special fixture being required for closing it.

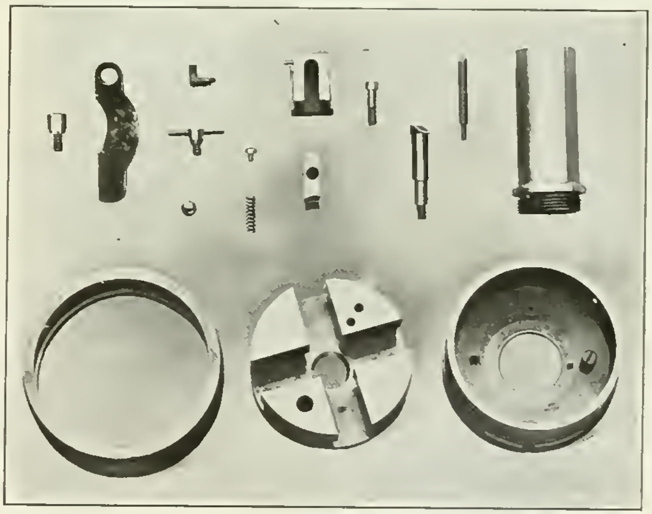


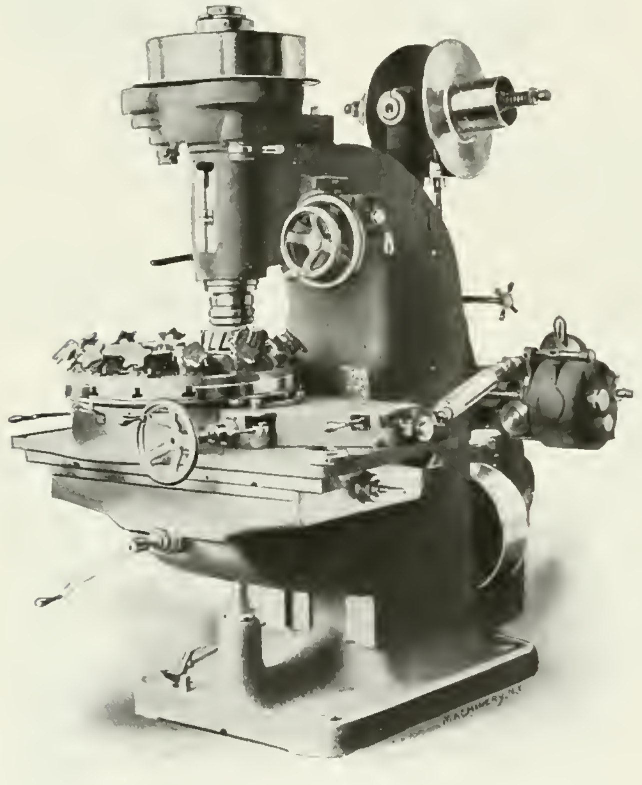
Fig. 2. Parts of the National Die-head

With this die, threads can be cut close to a shoulder, and as the shank is hollow, any length of thread within the range of the turret slide travel, may be cut. The features claimed for this die are simplicity, accuracy, and durability. No small parts are applied externally where they are liable to be broken, and the die cannot be rendered inoperative by any chips or dirt which might get into the working parts. This type of die is made in seven sizes. The smallest has a capacity of $\frac{3}{8}$ inch and the largest 2 inches.

BECKER CONTINUOUS CIRCULAR MILLING MACHINE

A special circular milling machine designed for continuous operation and built by the Becker Milling Machine Co., Hyde Park, Mass., is illustrated herewith. The table of this machine has a longitudinal feeding movement instead of a transverse adjustment to and from the operator, so that the machine can be used to advantage for surface milling in a straight line, as well as on strictly rotary work, which the machine is specially intended for.

The machine illustrated is fitted with a milling fixture for holding sad-irons. This fixture has a capacity for fourteen castings, and is mounted on a circular table 30 inches in diameter. The table makes one revolution in from three to four minutes, when doing this particular work, which gives the operator sufficient time to remove the finished castings, clean out the chips and insert rough castings while the machine is running, so that the milling operation is continuous. Two or three thousand pieces per day can be finished when the continuous method of milling is employed, the quantity depending on the character of the material.



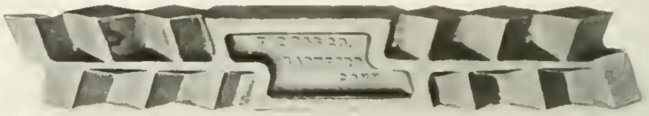
Special Circular Milling Machine for Continuous Operation, built by Becker Milling Machine Co.

When milling ordinary soft cast iron with a high-speed steel inserted-tooth surface mill, $7\frac{1}{2}$ inches in diameter, the table may be rotated at the rate of one revolution in three minutes with the spindle running sixty revolutions per minute, the drive being by an open belt with all the spindle gears out of mesh. When doing work of a heavier nature and when milling steel, the back-gears probably would be required, though this machine is designed to handle, satisfactorily, the average line of work without employing the spindle gears.

The spindle driving pulley is 20 inches in diameter and a 5-inch double belt is used, which gives a powerful drive. The open belt capacity is sufficient to take cuts, varying from 1/16 inch to 3/32 inch deep in cast iron with the table feeding 8 inches per minute and using surface mills 10 to 12 inches in diameter, and much heavier cuts can be taken when smaller mills are used. Therefore, under ordinary conditions, the back-gears are not necessary, and when these are thrown out, no gears are in mesh. The ratios of the spindle back-gears are 3 to 1, and 8 to 1. When using the 8 to 1 gears, the milling capacity is equal to the removal of 25 cubic inches of cast iron per minute.

JACQUES DIAMOND-POINT LATHE TOOL

The Jacques diamond-point lathe tool embodies in a single drop-forged piece, a succession of points which are used one after another as the end points are ground away. By referring to the illustration, it will be seen that these points are formed by V-shaped indentations in the sides of the tool, thus combining twelve tools in one. The points thus formed in each half are so spaced that when one point has been used up by grinding, another, on the opposite side, is exposed for use. This new point is then sharpened and hardened in the usual way. The economy of the tool lies, of course, in the fact that no blacksmithing is required in re-pointing.

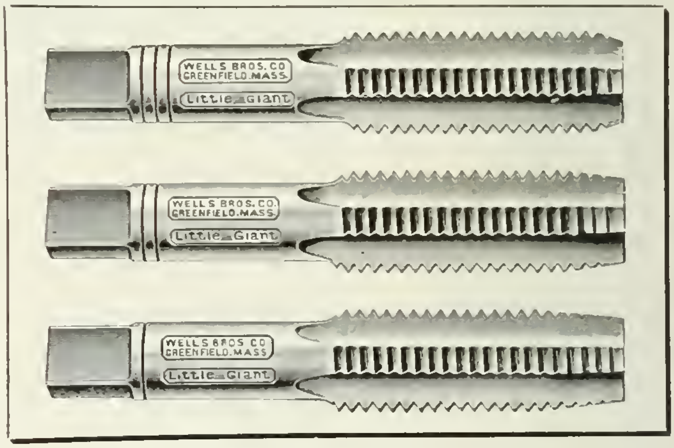


Lathe Tool having Twelve Points, which are used successively

This tool is manufactured by the Billings & Spencer Co., of Hartford, Conn. The first of these tools made was hardened throughout in order to do away with the necessity of re-tempering each point, but it was found that a fully hardened tool, when subjected to heavy strains, would break in the center. Therefore the tool, as now furnished, has only the two end points hardened, the middle portion being of normal temper to increase the strength. This tool is drop-forged from the best high-speed tool steel.

WELLS BROS. SERIAL TAPS

When a "blind" hole, or one that is closed at the bottom, is tapped with ordinary machinists' hand taps, the usual practice is to first use the taper tap which is followed by the plug and bottoming taps, providing the thread is to extend to the bottom of the hole. As these three taps are the same size and differ only in the number of cutting teeth, the taper tap does practically all the work and leaves very little metal to be cut by the plug and bottoming taps, which simply form threads at the bottom of the hole. The result is that the taper tap is either worn out sooner than the others in the same set, or is broken, because it does most of the work of tapping.



Wells Bros. Serial Taps, which are proportioned to more evenly distribute the Work of Tapping

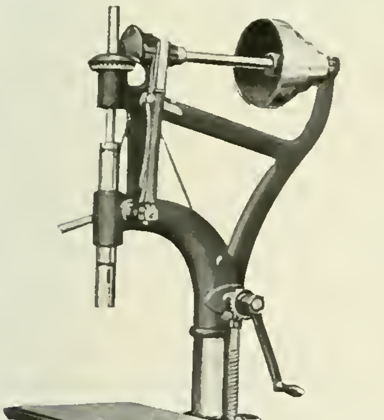
The Wells Bros. Co., Greenfield, Mass., has recently begun the manufacture of an improved line of taps designed to distribute the work of tapping a hole more equally along the three taps of the set. These are known as "serial" taps and are so named because they are made in a series of 1, 2 and 3. Unlike the ordinary hand taps, only tap No. 3 cuts the nominal size, so that the No. 1 tap does much less work because it is considerably smaller than the No. 3 size, in both outside and pitch diameters. The No. 2 tap more closely approaches the size of the No. 3, but it is also under-sized. The second tap of the set, however, enlarges the hole so that the No. 3 tap merely removes a few thousandths of an inch of material and finishes the thread to the exact size. The distribution of the work among the three taps is as follows: No. 1 takes 54 per cent of the cut, No. 2, 30 per cent, and No. 3, only 16 per cent. In order that any tap of the set may be picked out easily, even though covered with oil, there are rings on the shanks which shows the tap's number.

A special machine was constructed for recording the amount of power required to drive these taps, in order to proportion them correctly. Results of some of the tests are as follows: The power required for a No. 1 serial tap was 53 per cent of that necessary for an old-style tap, whereas the No. 2 serial tap required 49 per cent, and the No. 3 serial tap, 26 per cent. It was also found that the serial taps, when properly proportioned, have a factor of safety of 7, whereas an ordinary plug tap may have only a factor of safety of 2.

These serial taps are particularly desirable for tapping wrought iron, steel, and all tough material in which the service is severe. As is well known, a large proportion of the ordinary hand taps break instead of wearing out, and, naturally, by giving each tap a proportionate amount of work, a considerable reduction in breakage will result.

The serial taps are made to meet particular needs. If the set is to be used for tapping through open holes, each tap is tapered five or six threads, but if the threads must extend to the bottom of a hole, then the No. 1 tap is tapered six threads, the No. 2 is tapered four threads, and the No. 3 tap, two threads.

ADVANCE MACHINE TOOL CO.'S 18-INCH DRILL


Eighteen-inch Drill Press built by Advance Machine Tool Co.

The drilling machine illustrated herewith is built by the Advance Machine Tool Co., Milwaukee, Wis. The machine is equipped with an exceptionally large table and is especially adapted for tool-room work. The table arm is arranged so that the table can be removed and replaced by any platen, thus making a very convenient arrangement for jig work.

The spindle is counterweighted and has a ratchet lever feed, with a quick-return lever on the opposite side. The spindle has a vertical travel of 7½ inches, and the table a vertical movement on the column of 24 inches. The maximum distance from the spindle to the table is 28 inches, and the table can be swung out of the way to permit drilling on the base. The maximum distance from the base to the spindle is 39 inches. The spindle has a No. 2 Morse taper, a diameter of 1 1/16 inch, and an over-all length of 27 1/2 inches. The diameter of the sleeve is 1¾ inch. The cone pulley has four steps, the largest and smallest diameters of which are 8 inches and 3½ inches, respectively, with a width of 1¾ inch. The diameter of the tight and loose pulleys is 6 inches and the width 2¼ inches. This machine requires a floor space of 36 by 18 inches.

NORMA BALL AND ROLLER BEARINGS

The Norma ball and roller bearings have been on the European market for some years, but they are just being introduced in this country by the Norma Company of America, 20 Vesey St., New York.

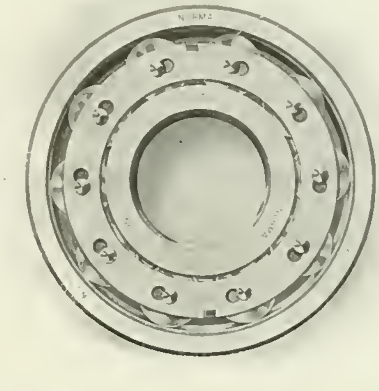


Fig. 1. Norma Roller Bearing

The Norma roller bearing is an open type, the outer races being open-sided so that the bearings can be taken apart, thus enabling the races to be separately fitted and mounted. The short cylindrical rollers are held and guided in a steel cage, as indicated in Fig. 1, and they are secured against skewing, binding or exerting any axial pressure on their side guides. The roller track of the outer race is slightly convex and the inner race is cylindrical. Both of these races are rigidly fastened in place when the bearings are installed. It is claimed that the efficiency or action of the bearing is not affected by axial displacement of the shaft, by small errors in mounting, or by any vibration or jarring motion which may occur. These roller bearings will carry more than twice the radial load of ball bearings of the same dimensions, and in the new construction, weight and space can often be saved by using roller bearings in place of ball bearings. The roller bearings are supplied for medium or heavy service. They are not intended to take end thrust, and in installations where a thrust occurs a combination roller and ball thrust bearing, or the Norma thrust bearing in combination, is recommended.

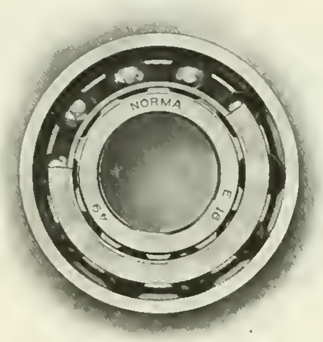


Fig. 2. Norma Ball Bearing

Fig. 3. Sectional View of Norma Roller Bearing

The Norma annular ball bearing, which is illustrated in Fig. 2, is also an open type, the outer race being open on one side so that the bearing can be taken apart. The members of this bearing can be mounted independently of each other, and all parts are interchangeable. These features facilitate the fitting and assembling of the bearing and its surrounding details. The outer race with the open side permits a convenient mounting in undivided housings, either free of play or with an allowance for lateral movement. The outer and inner races, however, are always held rigidly. The ball cage yieldingly grips and guides the balls at their axes of rotation and holds them free from contact with the apertures in the cage, thus insuring a free rotation of the balls, an almost entire absence of friction, and silent operation. These bearings are supplied in all the usual dimensions and for light, medium or heavy service. Both the ball and roller bearings are manufactured by the Norma Company of Cannstatt, Stuttgart, Germany. They are made of the best materials and finished to a high degree of accuracy.

GENERAL ELECTRIC CLOTH PINIONS

The General Electric Co., Schenectady, N. Y., is now applying cloth pinions to gear transmissions, where, because of noise or for other reasons, the meshing of metallic pinions with metallic gears would be impracticable or undesirable. The advantages claimed for these pinions are, great tooth strength, noiseless operation, freedom from damage by exposure to dampness, dryness or temperature changes, elasticity of the teeth sufficient to absorb shocks liable to break cast iron or brass pinions, self-lubrication, and long life.

Several different styles of these pinions are shown in Figs. 1, 2 and 3 of the accompanying illustrations. The blanks from which these pinions are formed, consist, essentially, of a filler of cotton or similar material, which is confined at a pressure of several tons to the square inch between steel shrouds or side-plates, which are held together by threaded rivets, or, in the case of very small pinions, by threaded sleeves. The teeth are cut to the 14½-degree involute system according to Brown & Sharpe's standard. After the teeth are cut, the cloth filler is impregnated with oil and it is entirely impervious to moisture and unaffected by atmospheric changes. It is also proof against injury by vermin.

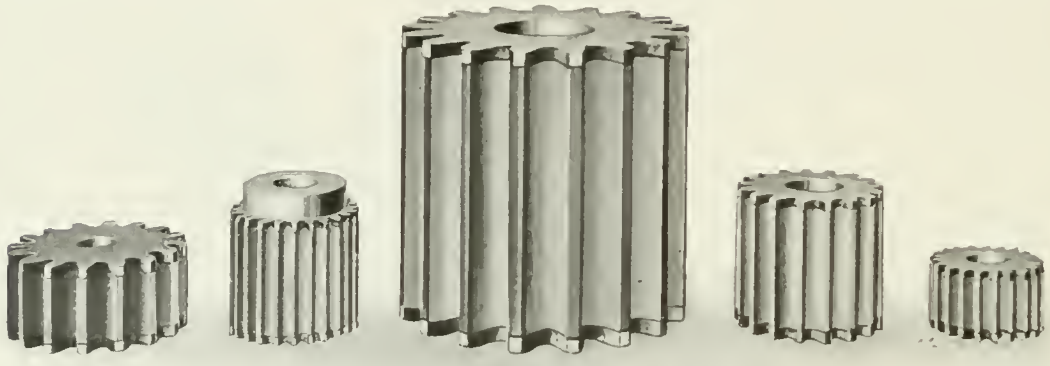


Fig. 1. Cloth Pinions developed by the General Electric Co.

The strength of these cloth pinions is said to be equal to that of any other non-metallic gearing and, as a slight elasticity gives the meshing teeth a good bearing across the full width of the face and absorbs the shock of rapid torque variations, it is claimed that these gears can safely be used for practically any service within the limit of the strength of similar cast-iron gears. While these pinions are ordinarily furnished for the smaller members of gear trains, they are made in a wide variety of forms including a type of gear of large diameter, consisting of a spider having a cloth-filled rim. The thickness of the shroud varies somewhat with the diameter and pitch, but, in general, it is approximately equal in thickness to the teeth at the pitch line. The width of the cloth face should be equal to the width of the companion gear, plus the total end play of both shafts, so that the shroud will not come in contact with the meshing gear.

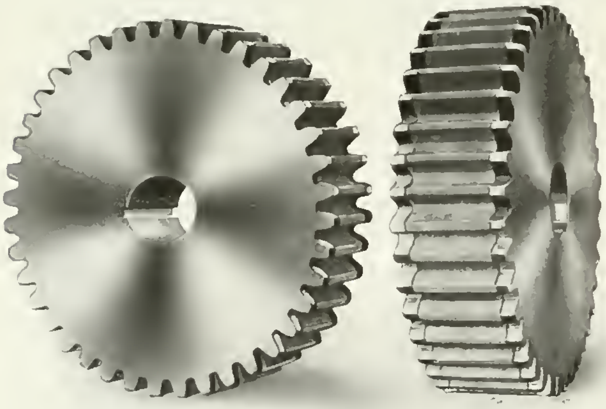


Fig 2. Forty-tooth Four-pitch Cloth Pinions used on Battleship "Kearsarge"

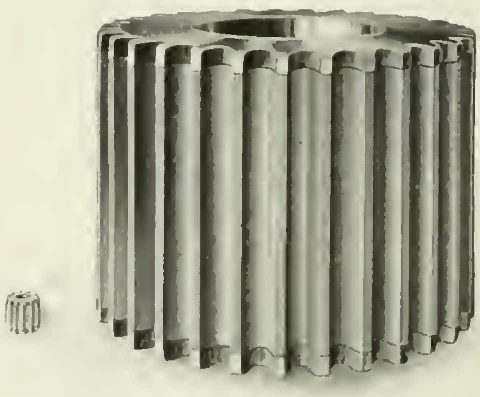


Fig. 3. Large and Small Cloth Pinions. Large Size has Thirty-one Teeth of 2 Pitch, and Small Size Twelve Teeth of 10 Pitch

These cloth pinions are intended for application to shop tools, such as lathes, planers, traveling cranes, drill presses, shears, punches, etc., and they are specially recommended for motor-driven tools. These pinions are also applicable to the driving of looms and spinning frames for the heavy machinery of paper and pulp mills, gas engine ignition drives and timing-gear trains, etc.

The invention of the cloth pinion was the result of a search for a pinion to successfully operate the combined punch and shear used in the General Electric Co.'s forge shop. This machine was originally fitted with a train of gears consisting of a brass pinion on the motor shaft, driving a cast-iron cut gear on a countershaft, which, in turn, drove the main gear through another pinion. A heavy flywheel was mounted on the countershaft and the backlash stripped the teeth from the cast-iron gear; the brass pinion also rapidly lost its shape and considerable trouble was experienced. At first a railway type of steel gear and pinion was used in place of the cast-iron and brass gearing, but the resulting noise was intolerable. It was then that the cloth pinion was conceived and applied, and it has been in constant operation for over two years; it requires no attention, runs without noise and, as yet, shows no appreciable signs of wear. This experience resulted in the application of a great many other cloth pinions in transmissions which had heretofore given trouble.

* * *

What is said to be the longest and heaviest train ever operated was recently run from Altoona to Enola, Pa., a distance of 127 miles. The length of the train was 4888 feet—nearly a mile—and it consisted of 120 steel gondola cars loaded with 6450 tons of coal. It was pulled at the rate of thirteen miles an hour by a single locomotive of the type known as "H-8-B." The engine was connected with the caboose by telephone. The train was run as a test to determine the capacity of freight locomotives over the improved sections of the line, where grades have been removed and curves compensated.

NEW MACHINERY AND TOOLS NOTES

Side-Tool: Ready Tool Co., Bridgeport, Conn. Offset side-tool especially made for facing close to a shoulder or to the chuck of a lathe. The cutter is rigidly supported, and it can be given clearance both on the side and front by grinding one face only. Common sizes of flat steel, such as 5/8 inch by 1/8 inch, or 7/8 inch by 3/16 inch, are used for cutters in these holders, or by means of an adjusting screw, thinner stock may be employed.

Crank Shaper: Ohio Machine Tool Co., Kenton, O. Shapers built in four sizes with strokes varying from 16 to 24 inches and having single- and back-gears. The 18-inch single-geared machine has speed variations for the ram ranging from 16 to 70 per minute, whereas the back-geared shaper of the same size has changes varying from 7 to 115 strokes per minute. Adjustments of the ram for position and stroke may be made while the machine is in motion.

Boring Machine: Newton Machine Tool Wks., Inc., Philadelphia, Pa. Horizontal double-spindle boring machine designed especially for boring two single automobile cylinders or one twin cylinder, simultaneously. The spindles are driven by a three-step cone through intermediate spur gearing. The distance from the center of the spindle to the table is 8 inches, and the distance between the spindle centers is 5 inches. The work-table is 18 inches long and 20 inches wide. There is a feeding movement of 18 inches having two gear changes, an automatic release, and hand adjustment.

Tilting Vise: F. A. Schulz, 218 N. Jefferson St., Chicago, Ill. A quick-acting tilting vise for use on the drill press, shaper, or milling machine. This vise is adjustable to different angular positions, varying from 0 to 45 degrees, and it can often be used in place of a jig. The adjustment of the jaws is practically instantaneous, a clutch nut being provided which can be quickly released in order to give the screw a free longitudinal movement. In addition to the regular jaws, removable tool steel V-shaped jaws can also be supplied. This vise is built in three sizes with weights varying from 20 to 75 pounds.

Boring, Drilling and Milling Machine: Newton Machine Tool Wks., Inc., Philadelphia, Pa. Heavy portable boring, drilling and milling machine especially adapted for electrical works, locomotive plants and similar lines of manufacture. The maximum distance from the center of the spindle to the base of this machine is 68 inches; the diameter of the spindle is 5 inches, and the length of the feed, 32 inches. Power is supplied by a motor mounted on a pedestal in the rear, and the drive to the spindle can be either direct or through back-gears. The machine is equipped with facing arms of an improved type.

Drill Sockets: Corona Mfg. & Supply Co., 311 Atlantic Ave., Boston, Mass. Drill socket designed for holding reamers, milling cutters and different types of twist drills. The socket has extensions on either side which, in the case of a twist drill, come in direct contact with the sides of the flute, thus giving a powerful drive. Drills with broken tangs can be made to fit this form of socket by cutting the flute back to the shank at a depth corresponding to the diameter of the shank. Milling tools and reamers for this new socket are made with an engagement which comes against the projections on the socket.

Relieving Attachment: Bradford Machine Tool Co., Cincinnati, O. Improved design of Bradford relieving attachment for relieving straight or tapered work with any number of flutes varying from two to twenty-four, inclusive. All parts are self-contained in a substantial bracket, which is mounted on the headstock at the front of the lathe. The attachment is driven by a spur gear meshing with the spindle face gear. The amount of relief may be quickly and accurately adjusted without stopping the lathe. A set of change gears and an index plate are furnished providing from two to twenty-four movements per revolution of the spindle.

Air Drills: Cleveland Pneumatic Tool Co., Cleveland, O. Pneumatic air drill having four single-acting pistons arranged in pairs with each pair connected to opposite wrists of a double crankshaft. These drills are made in either reversible or non-reversible types. The crankshaft is mounted on annular ball bearings in place of plain bronze bearings, thus minimizing friction and wear. The air valve is a rotary duplex type driven through gearing. It is placed between each vertical set of cylinders and controls the admission of air to all four pistons, thus simplifying the construction. The pistons are secured to their connecting-rods by ball-and-socket joints to allow universal motion and adjustment for wear.

Combination Grinder: Challenge Machine Co., Inc., 5116 Springfield Ave., Philadelphia, Pa. Combination grinding machine so designed that the table can be placed above or below the wheel to accommodate work which can be ground better with the wheel above or below, as the case may be. When the table is placed over the wheel, the latter operates through a slot. If dies or other pieces are to be ground that can be handled to better advantage by passing them under the wheel, a plain table or one without a wheel slot is used. The machine has two wheels, one of which can be equipped with a plain work-rest or a water arrangement for wet tool grinding, so that there are practically three machines in one. This grinder is built in four sizes and can be furnished for either bench or floor use.

Comptometer: Felt & Tarrant Mfg. Co., 1713 N. Paulina St., Chicago, Ill. New type of comptometer for use in drafting-rooms, containing two columns of keys for the addition of inches and fractions of inches in eighths. This feature enables the machine to be used for checking detail dimensions with over-all lengths in constructional plans, and is particularly useful where measurements involve feet, inches and fractions of inches. Such dimensions are added by merely pressing the keys corresponding to each whole number and fraction, in feet and inches, so that the operation is purely mechanical and entirely automatic as far as computation is concerned. In case two or more keys are struck simultaneously, no error results, and it is possible with a little practice to depress from four to eight keys at a time, the only restriction being that no two shall be in the same vertical column. This machine is also adapted to other forms of calculation common to engineering practice and general accounting.

Ball Bearing Ring and Plug Gages: New Departure Mfg. Co., Bristol, Conn. A set of ring and plug gages made by this company to demonstrate the merits of the straight chamfer for the inner races of ball bearings, in comparison with races having a rounded corner. This set consists of six rings and an equal number of plugs. The plugs represent the shafts for three standard sizes of bearings and show the various fillets recommended by several bearing manufacturers for use in the respective sizes. The rings correspond to the inner races or bearing cones and each ring shows two methods of finishing the corners of the cones to correspond with the plugs. A portion of the rings is cut away so that the fitting or relation of the chamfer or radius (as the case may be) to the fillet on the shaft can easily be observed. The advantage claimed for the straight chamfer is that it can be more easily machined and clears the shaft fillet more readily than does the round corner, thus insuring a good bearing of the cone against the shaft shoulder.

* * *

DISK GRINDING NOT A SECRET

We quote the following from the *Gardner Grinder*, a house organ issued by the Gardner Machine Co., Beloit, Wis., as being a good editorial on the futility of secretiveness in machining methods:

"There is no secret or mystery in modern disk grinding or disk grinding processes. If your competitor is at all alive, he knows—or can if he wants to—whether or not you operate a disk grinder.

"Time was, however, when the first disk grinders were installed that their owners did not want anyone else to know there was such a tool on the market. They guarded their disk grinder with envious eyes for fear their competitors might learn of this labor-saving tool.

"But that time has passed. Trade papers, advertising, salesmen and all bearer of new 'thinks' make it impossible to keep the disk grinder hidden. It is needless to say we are doing our best to make it public property.

"This leads us to the question, 'Is it worth while to try to keep secret your methods of machining?' This has been tried —and is being tried to-day—by many manufacturers, but generally with little success. As long as your method requires you to employ help your secret is bound to leak out. Your employes are apt to leave you, either in good or bad graces, and with them goes your secret.

"Of course, this matter is the manufacturer's own business, but it has been demonstrated beyond doubt that those who invite visitors into their plant and show them how they do things are just as prosperous as those who do not. This latter type may be likened to an ostrich which buries only his head in the sand and thinks he is entirely under cover. If you have tools, methods and devices upon the exclusive use of which your success depends it would be far more satisfactory to have them patented."

* * *

Investigations have been made at the German official testing bureau for materials to ascertain to what extent repeated meltings of bearing metals influence their strength and reliability. As regards white metal (alloys of copper, antimony and tin) it was found that repeated meltings did not noticeably alter the grain, but that the rate of cooling had a considerable influence. Quick cooling yielded a finer grain and higher hardness and strength, and the investigators recommend that white metals should not be heated to high temperatures and that they should be cooled rapidly. Bronze, poor in tin, and, therefore, comparatively inexpensive, may have the hardness and strength increased by being rapidly cooled from a temperature of 1440 degrees F.

QUICK-RETURN MOTION OF THE STOCKBRIDGE SHAPER

A simple form of quick-return mechanism, which is sometimes applied to shapers, is shown diagrammatically in Fig. 1. This mechanism, which is well known, especially to designers of machine tools, consists principally, of a crank-gear G, which is driven by a pinion and actuates a vibrating slotted link L that is connected at its upper end with the shaper ram. As the illustration shows, the crankpin or swiveling block B (which slides in the slotted arm) moves through an arc a during the cutting stroke, whereas for the return stroke it moves through a much shorter arc b. As gear G rotates at a uniform speed, obviously the time required for the return stroke, as compared with the cutting stroke, is in the same proportion as the lengths of the arcs a and b. This mechanism is very simple, but it imparts a variable speed to the ram, the speed increasing toward the center of the stroke S and then diminishing, as will be explained more fully later.

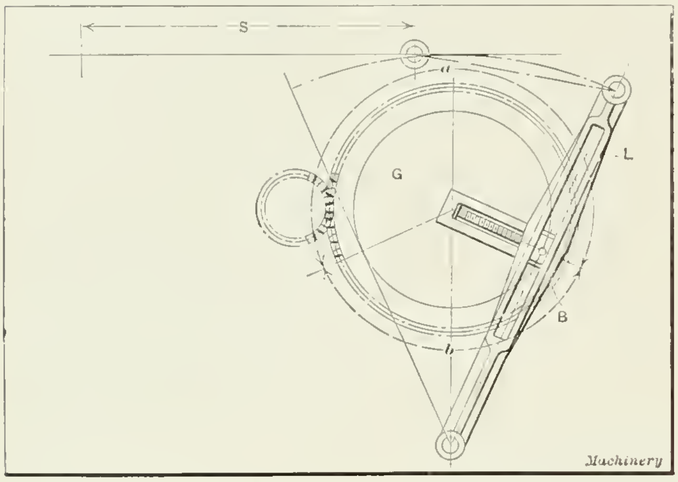


Fig. 1. View illustrating the Quick-return of a Plain Slotted Crank

Another quick-return motion that has been widely used in slotter construction is illustrated by the diagram Fig. 2. This mechanism, known as the Whitworth quick return, is similar in principle to the vibrating link previously referred to, though the construction is somewhat different. The gear G drives a slotted link L, which is pivoted at some point within the path of the crankpin or block B, thus permitting the link to rotate through a complete revolution. As the center about which link L rotates, is offset with relation to the center of the driving gear G, the driving pin B moves through an arc a during the cutting stroke, and through a shorter arc b for the return stroke, which, therefore, requires less time, in proportion to the respective lengths of arcs a and b.

Figs. 4 and 5 illustrate a quick-return mechanism that is a modification of the Whitworth motion combined with the slotted link. This motion is applied to the shapers built by the Stockbridge Machine Co., Worcester, Mass., and has the advantage of giving, not only a quick return, but a cutting speed that is practically constant throughout the working stroke; in addition, the construction is such that the stroke can be varied at will, while the machine is in motion.

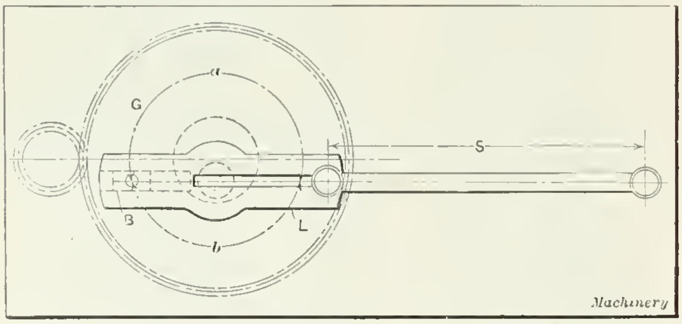


Fig. 2. Diagram illustrating Principle of Whitworth Quick-return Motion

The way the speed is gradually increased toward the center of the stroke and then diminished by a plain vibrating slotted link, is shown by the velocity curve V, Fig. 4. This curve was plotted by the well-known method of dividing the path of the driving crankpin (which rotates at a uniform speed) into a number of equal parts as shown. Lines were then drawn through points 0, 2, 4, 6, etc., thus locating on the line of motion M—M the respective positions 2, 4, 6, etc., of the ram for the different angular positions of the driving crank. All lines thus obtained by the divisions lying within arc a represent the movement of the ram on the forward stroke, and similar lines located with reference to divisions 50, 52, 54, etc., in arc b, show the movement for the return stroke. After these points are located on the line of motion, the velocity curve V can be plotted by drawing vertical ordinates 1, 3, 5, 7, etc., midway between points 0 and 2, 2 and 4, etc., and laying off on these vertical lines distances equal to the distance from 0 to 2, 2 to 4, etc. The velocity curve is then drawn through points obtained in this way, and it shows, graphically, the velocity of the ram at any point of the stroke, by its distance from the line of motion. It will be seen that the velocity gradually increases toward the center of the working stroke, then diminishes, and the ram returns to the starting point at a relatively high speed. Evidently this change of speed during the working stroke is objectionable.

The mechanism illustrated in Fig. 3 gives a uniform speed, as shown by the velocity curve V_1, Fig. 5. This curve, it will be noted, is flat, or an equal distance from the line of motion from C to D, or for practically the entire working stroke, whereas the speed, as shown by curve V, gradually increases up to point A and diminishes after passing point B. As these curves are drawn to a very small scale, a slight change in the vertical distance from the horizontal line indicates a considerable change in speed. For example, if the height x represents a speed of 50 feet per minute, the slight fall of the curve at y would mean a reduction of about 8 feet per minute. Therefore the difference in action, as represented by curves V and V_1, is greater than is apparent from a casual inspection.

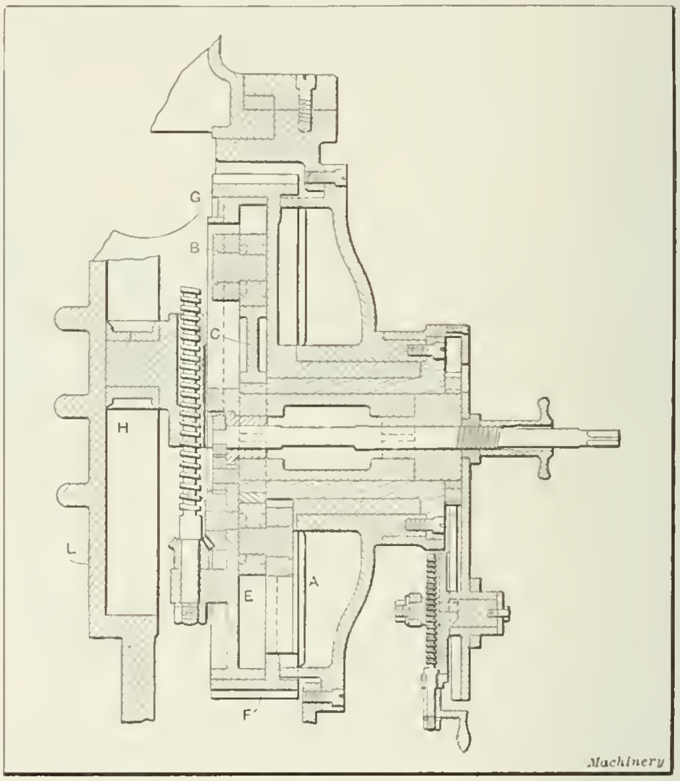


Fig. 3. Sectional View of Crank Mechanism applied to Stockbridge Shapers

The mechanism for obtaining the constant cutting speed and quick return shown by curve V_1 consists principally of a driving gear F, Fig. 3, which transmits its rotary movement through a swiveling block A to a ring E, which turns about an eccentric C. On the opposite side of this ring there is a second swiveling block B, which drives the crank-disk G, on which is mounted the main crankpin block H, engaging the vibrating arm or link L, that in turn, is connected with the ram. The eccentric C is offset with relation to the center of the driving gear F, and it remains permanently in a fixed position; therefore the circular path of the eccentric ring blocks A and B is not concentric with the path described by the main crankpin *H*, as shown in Fig. 5. In other words, the circle which these blocks describe as they are driven around by gear *F*, has a constantly varying radius from the center of the gear which compensates for the irregularity of speed obtained by a plain slotted link and gives a practically constant movement during the working stroke.

The action of the mechanism will doubtless be made clearer by considering the method of plotting the velocity curve (Fig. 5), previously referred to. The large outer circle representing the driving gear, is divided into a number of equal parts indicating different positions of the gear which, it should be remembered, rotates at a uniform speed. The position of the swivel block *A*, (see Fig. 3), is first located for positions 2, 4, etc., of the gear, by the intersection of radial lines with the circle described by block *A*. For example, when the driving gear has moved an angular distance 0—2, block *A* will have moved to position *a* in the eccentric circle. As block *B* is diametrically opposite block *A*, its position is located for point 2 by drawing a line through the center of the eccentric circle. The next step is to determine the location of the main crank-block *H* for the different positions of block *B*. As crank *H* revolves about the center of the gear and is diametrically opposite block *B*, its location is determined by the intersection of radial lines with the crank-pin circle, the lines being drawn from the center of gear *A* and through the different points occupied by block *B*. After having located these points on the crankpin circle, the position of the ram for each respective division is found by drawing a line representing the slotted arm, through each point, 2, 4, etc. The velocity curve is then plotted as described, in connection with Fig. 1.

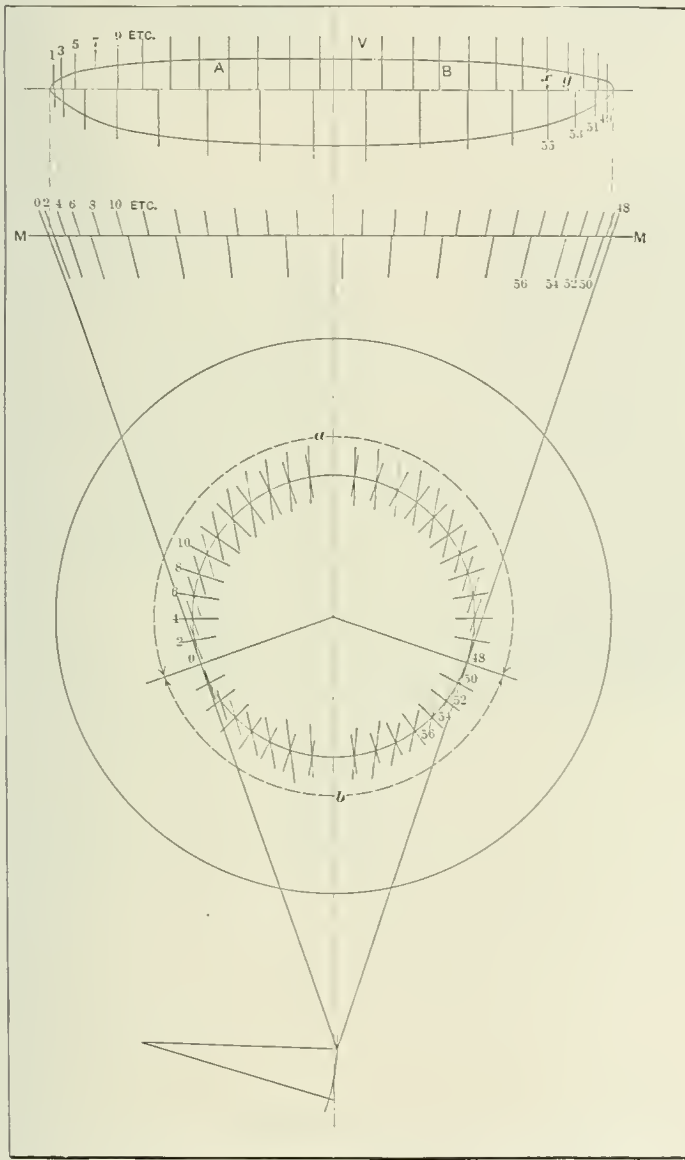


Fig. 4. Diagram showing the Velocity of a Shaper Ram during the Forward and Return Strokes when driven by a Plain Slotted Crank

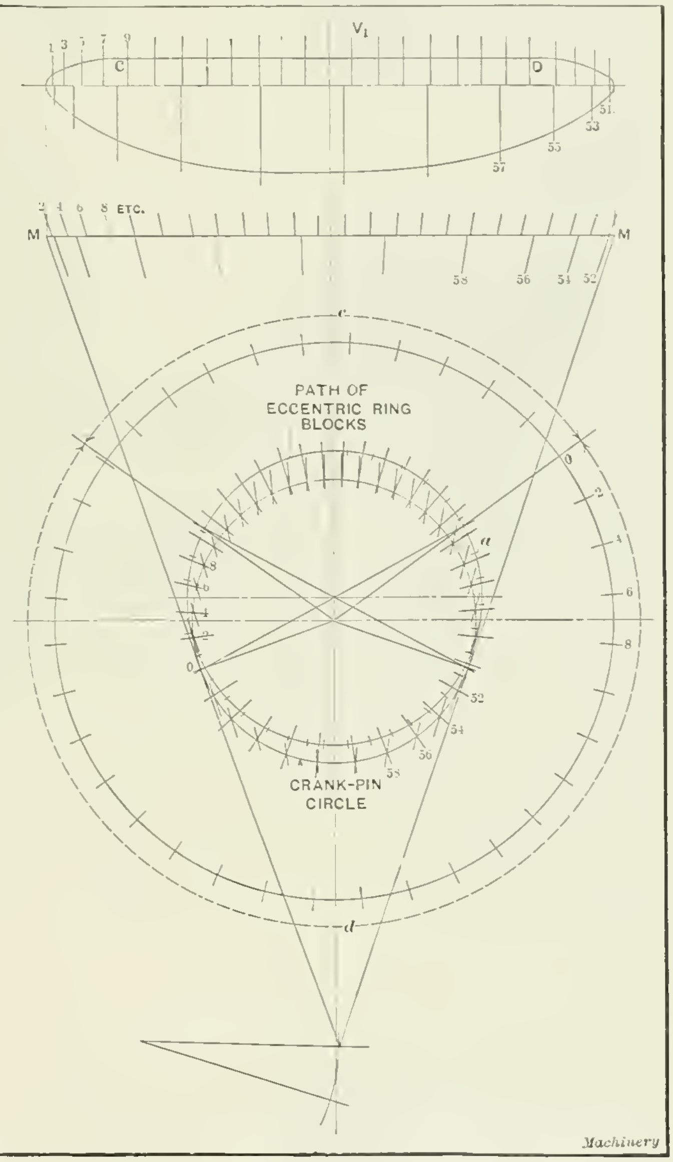


Fig. 5. Velocity Curve obtained with Quick-return Motion of Stockbridge Shapers

With this mechanism the driving gear rotates through an are *d* during the cutting stroke, whereas the return stroke is accomplished while the gear moves through the comparatively short arc *c*. The positions of the slotted arm at the beginning, center, and end of the cutting stroke are shown in Figs. 6, 7 and 8, respectively, and also the respective positions of eccentric ring *E*, through which crank-disk *G* is driven. From the beginning to the end of the cutting stroke, blocks *A* and *B* move through an angle of approximately 270 degrees, so that a movement of only 90 degrees is required for the return stroke, thus giving a ratio of 3 to 1. This ratio, however, is as high as 4 to 1 on some sizes of the Stockbridge shapers, and it also varies somewhat with the length of the stroke, the ratio diminishing as the stroke is reduced. The ratio of the return to the cutting speed, obtained by the mechanism illustrated in Fig. 3, is much higher than that obtained with a plain slotted crank, as shown by the diagrams Figs. 4 and 5. In Fig. 4 the arc *a* through which the crankpin moves during the cutting stroke is, of course, equal to the angular movement of the driving gear as both revolve together about a common center. In the case of Fig. 5, however, the driving gear, instead of rotating through an arc equal to that described by the crankpin during the cutting stroke, turns through about three-fourths of a revolution, or a greater angular distance. The result is that a comparatively short angular movement *c* returns the ram, and greater power is obtained for the working stroke. (The comparative results of power tests made with the regular crank motion and the Stockbridge motion were previously published in the November, 1909, number of MACHINERY.) The ratio of the return to the cutting stroke with a plain crank depends entirely on the relation of the rocker arm to the crank-block circle. The ratio diminishes rapidly as the stroke is shortened, whereas with the motion illustrated in Fig. 5, the change of ratio is small, even for very short strokes.

Another method of plotting the velocity curve, which shows not only the speed at different points of the stroke, but also the relative time required for the forward and return movements, is shown in Fig. 9. In this illustration, a number of vertical ordinates 1, 3, 5, etc., representing positions midway between positions 0 and 2, 2 and 4, etc. (Fig. 5), of the driving gear, have been drawn at right angles to a horizontal line x—x. The curve is then plotted by laying off on these lines distances representing the different positions of the ram. For example, a vertical distance is laid off on line 1 equal to the movement 0—2 of the ram, a point is located on line 3 corresponding to movement 2—4, etc. After all the positions of the ram on the forward stroke have been transferred to the vertical lines, corresponding points are laid off below the line of motion to represent the return stroke. A curve is then drawn through these various points, as shown. This curve by its distance above and below the line of motion shows, graphically, the relative velocity of the ram for the working and return strokes, and the distances a and b indicate the time required for these movements.

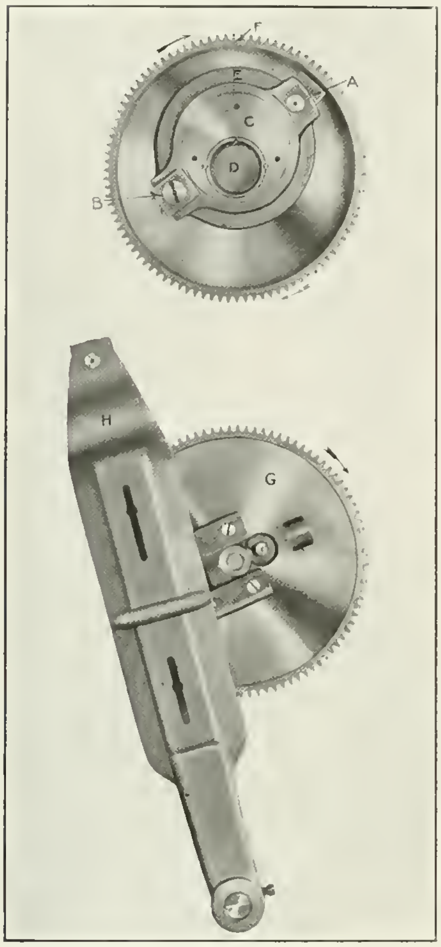


Fig. 6. Crank at Beginning of Cutting Stroke

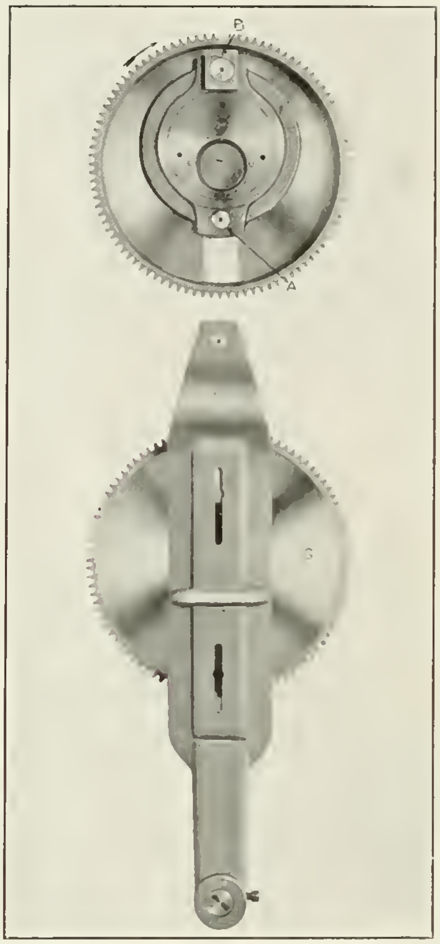


Fig. 7. Center of the Cutting Stroke

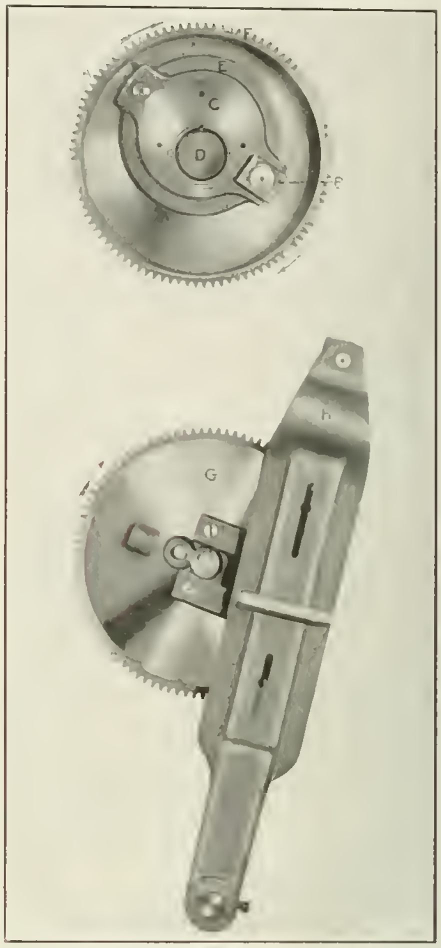


Fig. 8. End of the Cutting Stroke

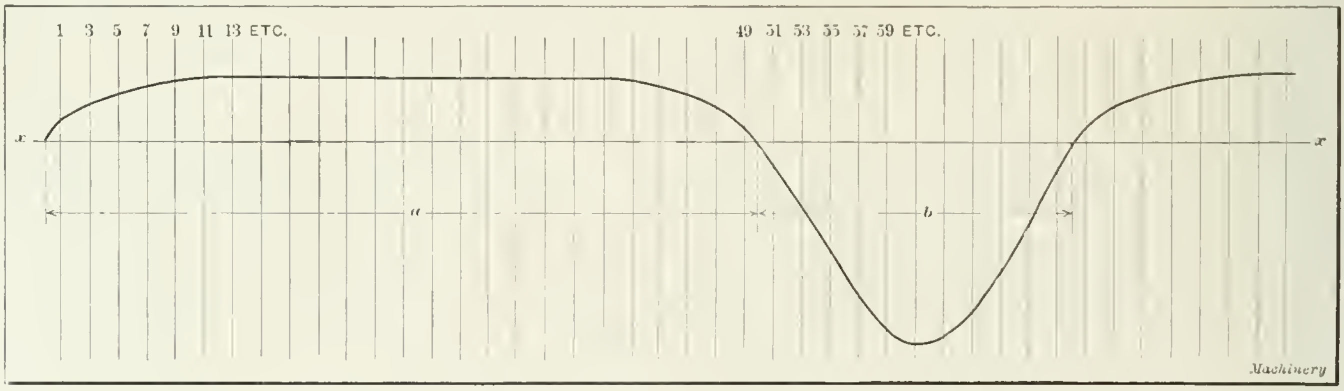


Fig. 9. Curve showing Velocity during Forward and Return Strokes and Time required

SEASONING HARDENED STEEL

It is a well-known fact that hardened pieces of steel will undergo minute but measurable changes in form during a long period of time after the hardening has taken place. These changes are due to the internal stresses produced by the hardening process, which are only slowly and gradually relieved. In order to eliminate the unfavorable results of these changes, gages and other tools of which a high degree of accuracy is required, are permitted to "season" for several months—or even a year—before they are finally ground and lapped to the finished dimensions. Experiments undertaken by A. Leman and A. Werner at the *Physikalisch-Technischen Reichanstalt*, and recorded in the August, 1911, number of *Werkstattstechnik*, indicate that changes in the dimensions of hardened steel take place sometimes during a period as long as three years. In order to find a method of overcoming the delay due to "seasoning" hardened steel for so long a time, experiments were undertaken which proved very successful. The investigators found that by heating the hardened steel in oil at a temperature of 150 degrees C. (302 degrees F.) for a period of ten hours, the internal stresses which cause changes, were eliminated.

ROTARY MAGAZINE WORK ON THE CLEVELAND AUTOMATIC

The phosphor-bronze shell shown in Fig. 1 is an interesting example of automatic turret machine work, owing to the number of operations that must be performed and the remarkably short time required, the total time per piece being about nine minutes. The over-all length of this shell, which is shown on a reduced scale, is 6½ inches the maximum diameter, 2⅝ inches, and it must be finished accurately to gage. This work is done on the automatic turret machine built by the Cleveland Automatic Machine Co., a 2¼-inch machine increased to 2⅝ inches being used.

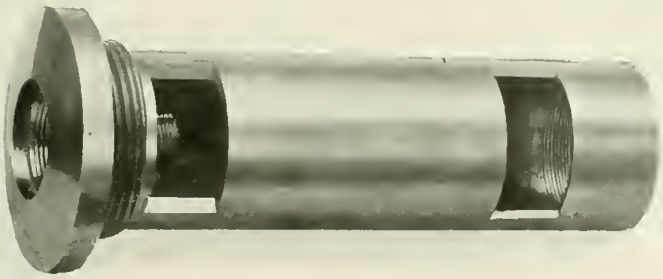


Fig. 1. Hard Phosphor-bronze Shell turned complete in Nine Minutes

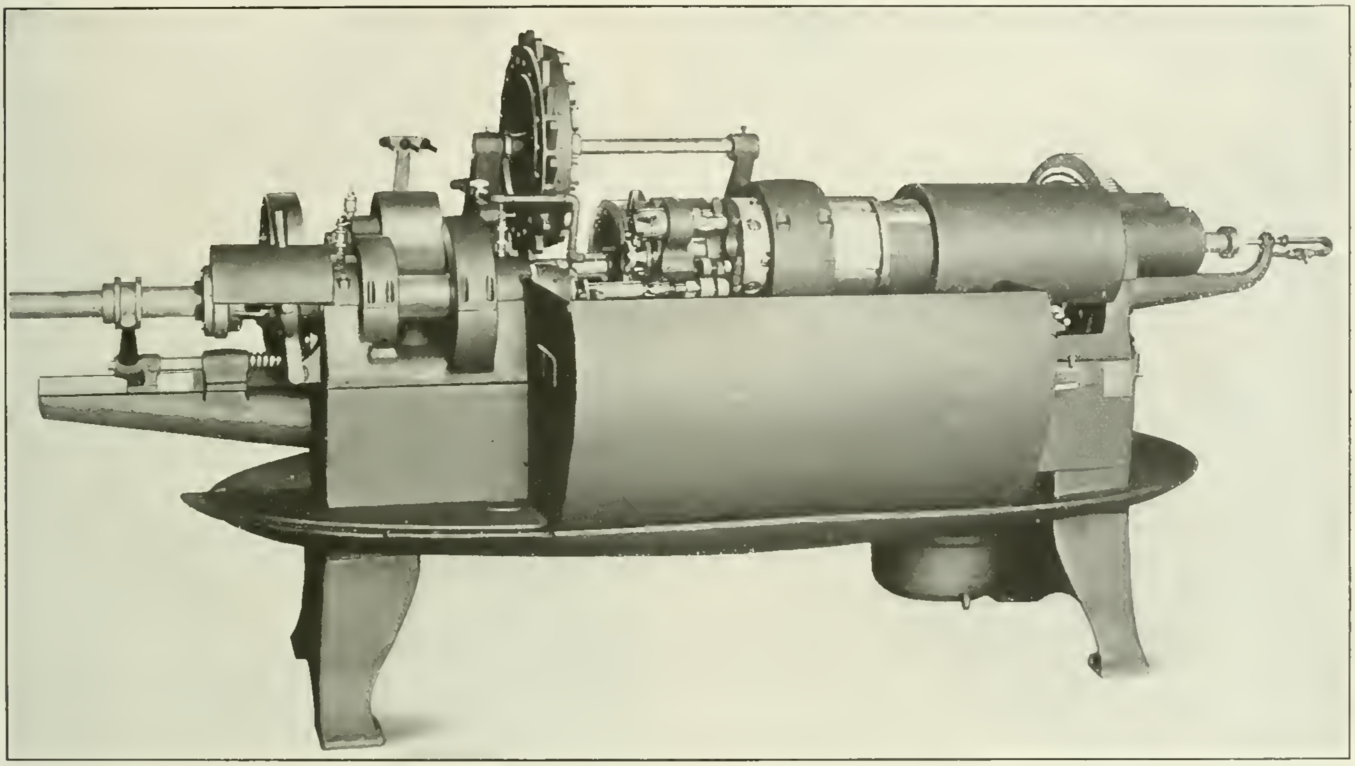


Fig. 2. Cleveland Automatic set up for Turning Shell shown in Fig 1

As Fig. 1 indicates, these shells are rough- and finish-turned on the outside from the solid bar and bored, counterbored and reamed on the inside; stud is formed and threaded at the bottom of the bore; the right end is threaded internally; a coarse thread is cut close to the flange, as shown; the latter is rounded, and the left end is drilled, counterbored and threaded internally. Only two separate operations are required for doing the work specified, the shell being first machined from the bar and then finished in a second operation, which requires the use of the rotary magazine attachment. The various steps or phases of each operation are indicated in Fig. 4, the letters *A* to *F*, inclusive, showing the work done during the first operation, and the three detail views *G*, *H* and *I*, the successive steps of the second operation.

The first step of Operation 1 is to gage the stock to length as at *A*. The work is then rough-turned at *a* (see sketch *B*) by a hollow mill held in a special overhanging tool-holder, and hole *b* is drilled. The shoulder *d*, which is subsequently threaded, is also formed, and surface *e* is rounded, as shown, this work being done by flat forming tools mounted on the rear of the cross-slide and with the spindle running reversed. The time required for the work indicated at *B* is two minutes, fifty seconds.

The third operation in connection with the first complete operation consists in finishing surface *a* (sketch *C*) by using a special shaving mill held in an overhanging tool-holder, reaming and counterboring hole *f* and forming stud *c*. This stud is formed by a hollow cutting end of the counterbore. The spindle rotates backward while the tools are in operation, but it is given a forward motion as the tools back off to prevent the shaving mill cutter from marking the finish of surface *a*. The time for the third operation is two minutes, thirty seconds.

The thread is next cut on shoulder *d* with a special die-holder and finger die, which requires thirty seconds. During the fifth operation a thread is tapped at *g* in the end of the bore *f*, and a thread is also cut on stud *c*. A special combination tap and die is used to perform both threading operations simultaneously. The tap and die are fitted together in such a way that they can be adjusted.

The sixth and last step connected with the first operation is to part the shell from the bar, which is done by a circular cut-off tool mounted on the front of the cross-slide. An idle movement requiring thirty-five seconds then follows, giving a total time of seven minutes, thirty-five seconds.

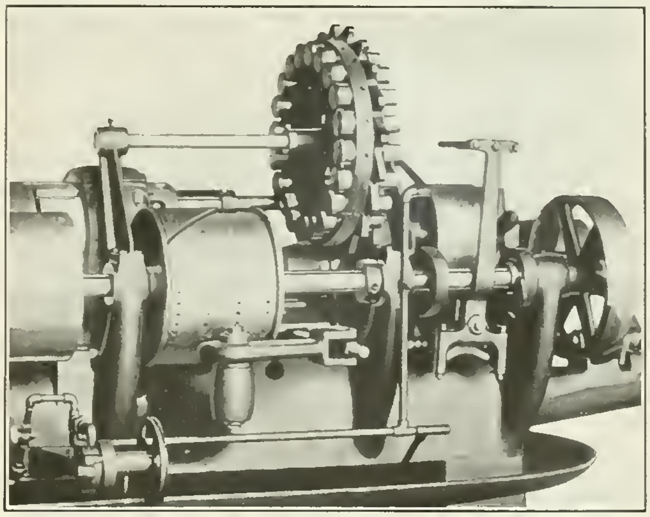


Fig. 3. Rotary Magazine Attachment loaded with Partly Finished Shells

The rotary magazine used in connection with the second operation is shown loaded in Fig. 3. This magazine is fitted with bushings that are bored to receive the body *a* of the shell, and after the first operation, the work is placed in these bushings in practically the same way that cartridges are inserted in a revolver chamber. The magazine is very simple in construction, and it can be loaded by a boy; in fact, one boy can attend to several machines if necessary.

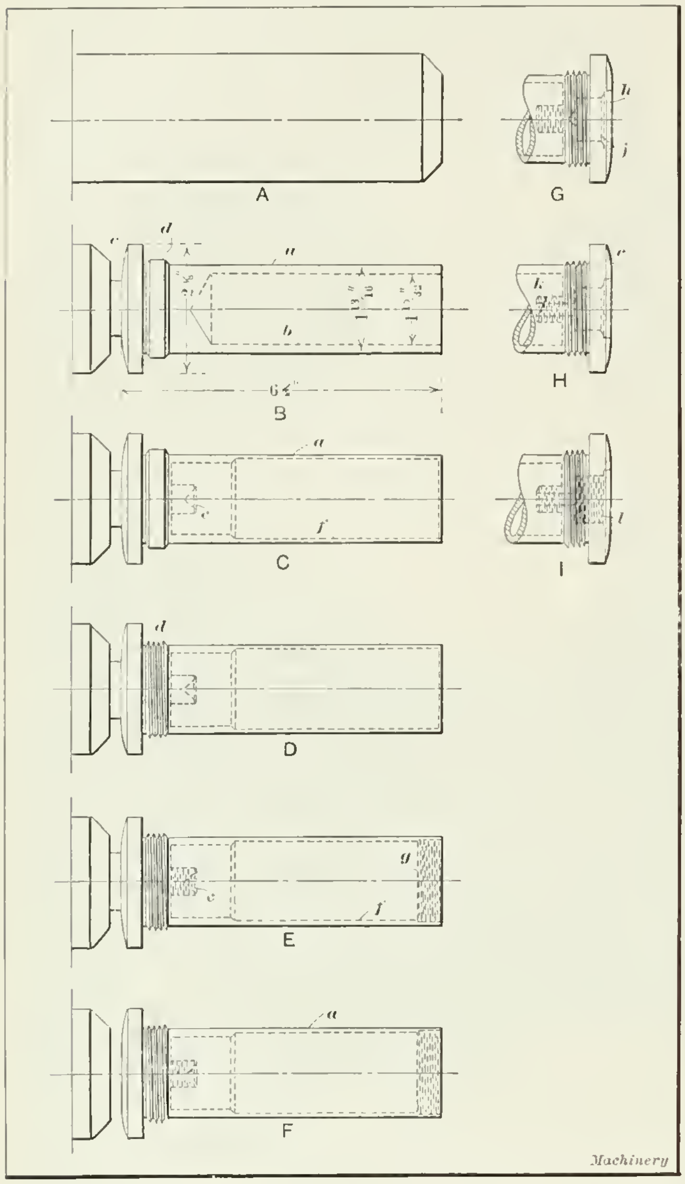


Fig. 4 Successive Steps of First and Second Operations performed on Shell, Fig. 1

During the second operation the shells are removed from the magazine and inserted in the chuck by a conveyor attached to the turret. The first step in the second operation is indicated at *G*. It consists of drilling and counterboring at *j* and *h* and spotting or centering the bottom of *j* for a small hole *k* that is drilled in the succeeding operation. A special combined drill, counterbore and centering tool is used, and the spindle runs reversed. The time required is thirty-five seconds. The high-speed drilling attachment is then used to drill hole *k* (sketch *H*) and a light shaving cut is taken over surface *e* with a flat forming tool mounted on the rear of the cross-slide. The spindle also runs reversed for the second step, and the time is twenty seconds. The third and last step of the second operation is to tap thread *l*, which requires thirty seconds. There is then an idle period of thirty-five seconds, making a total of nine minutes, thirty-five seconds for finishing the shell complete, which is a remarkable performance, especially when we consider that these shells are made from very hard phosphor-bronze. The stock removed during both operations weighs 9⅜ pounds and the weight of a finished shell is 1¾ pound.

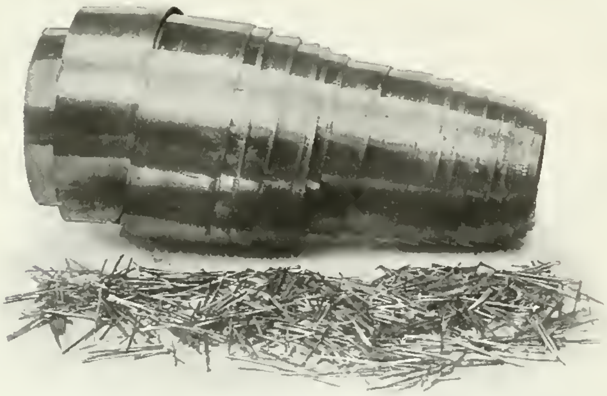


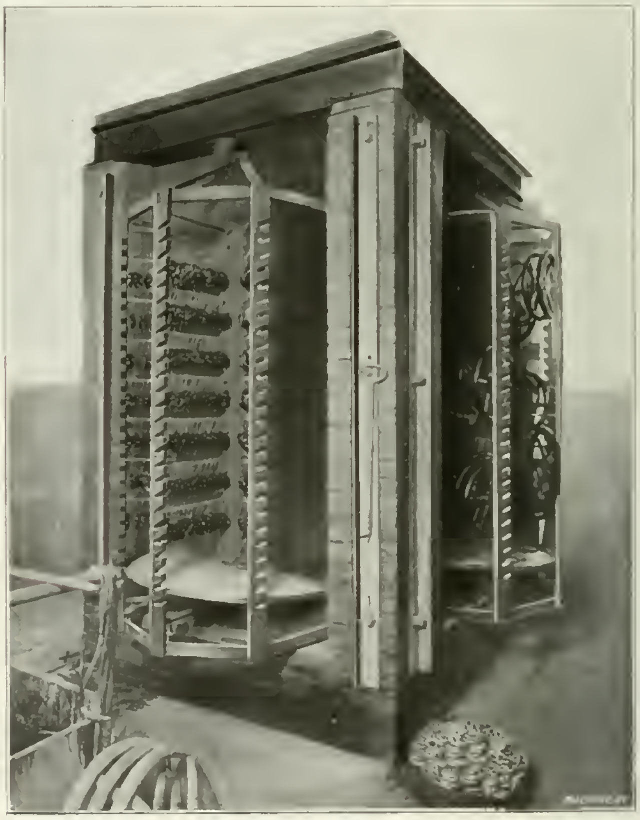
Fig. 5. Showing Change in Formation of Chips removed from Bars made by Different Formulas

In Fig. 5 some chips are shown merely to illustrate the great change in the formation of chips removed from phosphor-bronze bars made by different formulas. In one case the chips are in the form of long flat ribbons, and in the other, the tool removed very fine cuttings which are no larger than a common pin. Of course the same tool was used in each case and the chips were removed from corresponding surfaces.

* * *

JAPANNING OVEN

A japanning oven for continuous operation was recently developed by Mr. Mason, vice-president and manager of the Nelson Valve Co., Philadelphia, Pa., in conjunction with Mr. George K. Hooper, of the Hooper-Falkenau Engineering Co., New York. This oven consists of three reels mounted in a substantial brick casing; two of these reels may be seen in the accompanying illustration. They are so located that one half of each is always inside the oven, while the other half projects beyond the oven casing. Each is built up on a central pipe which is perforated to receive rods or bars resting in slotted vertical outer ribs. Upon these bars are hung the articles to be japanned. The reel is divided vertically by a sheet metal diaphragm which serves to close the oven, confining one-half of the reel within the heated space.



Japanning Oven

To operate this oven, the articles dipped are hung upon the racks of that half of the reel which is outside the oven. The reel is then revolved half a turn, which moves the pieces into the heated space; at the same time the other half of the reel containing the pieces which have been baked, is brought outside the oven. When the baked pieces are removed, that half of the reel outside the oven is ready to be filled with freshly dipped pieces as previously described. This operation is continuous, involves a very low labor cost, and great elasticity is provided for, because various types of pieces to be baked can be kept in the oven the proper length of time for each.

* * *

TOOL TEMPERING FURNACE

A tool tempering furnace which can be built with about one hundred standard fire-bricks on any tool temperer's forge is shown in Figs. 1 and 2. The advantages of the type of fire obtained with this furnace, as compared with the ordinary forge fire, are, that it gives the three most important qualities of a good tempering fire: First, a deep permanent fire; second, an intensely hot fire, when wanted; and third, a fire in which it is possible to get a very short heat on a tool, the high heat extending only to the cutting edge or nose of the tool.

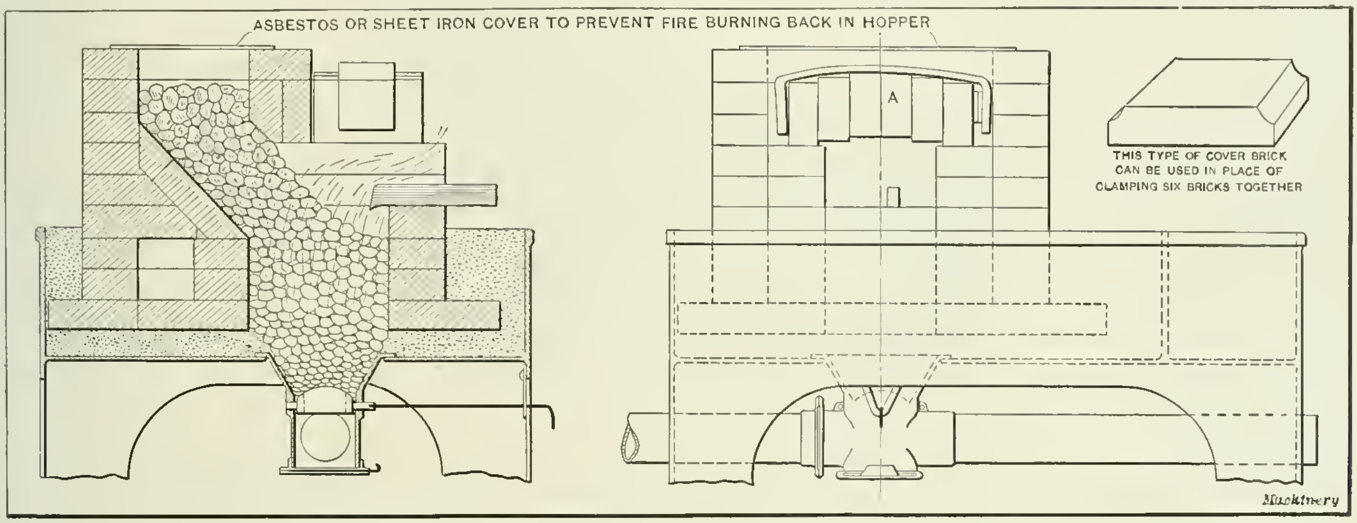

ASBESTOS OR SHEET IRON COVER TO PREVENT FIRE BURNING BACK IN HOPPER
A
THIS TYPE OF COVER BRICK CAN BE USED IN PLACE OF CLAMPING SIX BRICKS TOGETHER
Machinery

Fig. 1. Section and Front Elevation of Tool-tempering Furnace built of Fire-brick

As shown in the sectional view, the fire is deep below the nose of the tool, and does not burn out, as new fuel constantly works down from the hopper. This insures a good heat continuously, so that tool after tool, or two or three at a time, may be tempered at a high heat without placing them in contact with the coals. To prevent the fire from burning back into the hopper, a piece of sheet iron or asbestos is laid over the top as indicated in Fig. 1.

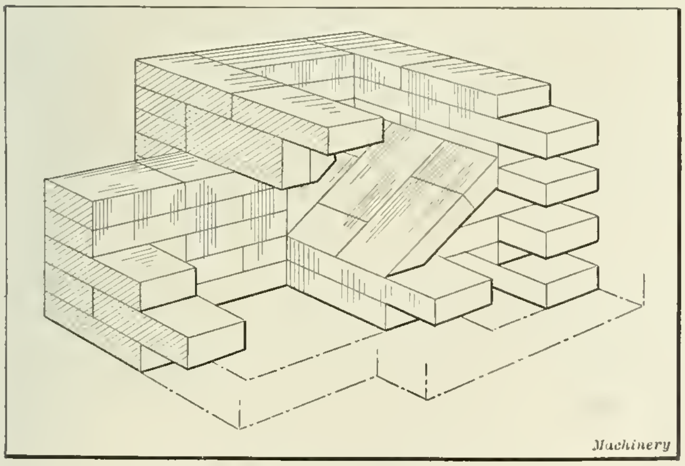


Fig 2. Perepective View of Tempering Furnace

By resting the tool on a firebrick with the cutting edge down, a heat is obtained just where it is wanted, that is on the cutting edge, and at the same time the heat is confined to the nose of the tool. For fuel, either coke or hard coal may be used to advantage. The furnace is cleaned out the same as a forge.

The construction of the furnace requires no special bricks or foundation other than a blacksmith's forge. The six bricks *A*, clamped together as a "top brick", should be removable, so that they can be taken off when a tool of special shape requires it.

This type of furnace has been worked out by the tempering department of the Firth-Sterling Steel Co., Pittsburg, for the benefit of customers using its Blue Chip steel; but it is, of course, equally useful in the treatment of any high-speed steel. Neither the furnace nor the material used in its construction are sold by this company. This type of furnace is said to be very effective in aiding the man at the fire to produce better and more uniform tools.

* * *

THE WENTWORTH INSTITUTE

The Wentworth Institute, a new industrial school of a practical type, was opened in Boston on September 25. The school is the result of a bequest by Arioch Wentworth of Boston, who by his will made $3,500,000 available for a school whose purpose it should be "to furnish education in the mechanical arts."

The Wentworth Institute is located on Huntington Ave., directly opposite the new Museum of Fine Arts, and occupies a plot of ground of between twelve and thirteen acres. The aim of the school is primarily to train young men to become foremen and superintendents in building construction and manufacturing industries, but a course is also included for young men who want to acquire some practical skill in the trades, so as to be able to enter them with a good earning power from the start. That there is a demand for a school of this kind in Boston is evidenced by the fact that eight- or nine-hundred students had registered at the time the school opened. Most of the applicants are young men between seventeen and twenty-eight years of age. Most of these have been engaged in some comparatively unskilled occupation, and finding the opportunities for advancement slow and uncertain, have turned to the institute in order to obtain instruction of such a practical character that it could be immediately used in obtaining a higher grade of employment. As it is only the shops belonging to large corporations that are able to maintain up-to-date apprenticeship systems, the value of a school of this type cannot be questioned.

It is proposed to keep the students at the Wentworth Institute one half of the day in the shop, while the other half of the day will be devoted to actual class-room instruction. The buildings so far completed are only a part of the ultimate plan for the school. The foundry and main shop building now ready is 145 feet long by 49 feet wide. This building is five stories high, and contains the carpenter shop, pattern shop, machine shop, blacksmith shop, plumbing shop and electric-wiring room. A small wing contains the administrative offices. The power plant occupies a building 80 feet square. The shops are equipped with the very best makes of modern tools and apparatus; for example, in the machine shop there are two high-grade horizontal boring machines, two different types of vertical boring mills of the best make, three milling machines, of which one is of the heavy-duty type, two modern grinding machines, etc. In all cases it has been the effort of the administration to include different types of machines, and also examples of the best makes of each type. In engine lathes, for example, the four most prominent makers of machines of this kind are represented. In this respect, the institute differs largely from the ordinary trade school, where frequently a single type of small inexpensive machines is installed. The student then has no opportunity to become familiar with the machines ordinarily found in the machine shops throughout the country, and while he may learn the principles, he cannot gain that familiarity with machine tools which is a very valuable asset to him.

The power-house installation consists of a 230-horsepower water-tube boiler, a simple Corliss-type steam engine, and a 300 K. W., 220 volt, direct-current generator. The engine-room also contains the dynamo laboratory, consisting of a group of direct- and alternating-current generators, motors, transformers and testing apparatus. The tremendous increase in the application of electric motors to the driving of shop tools, and of electric power to locomotives and automobiles, makes it necessary that every skilled workman in almost any trade should have at least a slight acquaintance with electric generating and power machinery, so that he may have a sense of what is reasonable or unreasonable to expect of any given machine, and know how to recognize and remedy simple troubles in the electrical machinery he uses or is responsible for. The electrician must, in addition, be given further instruction so as to be able to trace and remedy troubles and faults in electrical machinery, and to carry out all such work in connection with installation, wiring, and testing, as may be required in the ordinary shop.

The institute will provide both day and evening courses. The day courses are of two types, a one-year course, and a more thorough two-year course. The one-year course is intended to prepare the student for ordinary practical industrial work, while the two-year course is intended for the young men who wish to obtain advanced positions. The graduates from this course will be prepared to fill positions as inspectors, testers, foremen, etc.

The large endowment fund left by Mr. Wentworth does not necessitate the payment of a tuition fee. However, if no fee at all were charged, some might apply who have little or no real interest in the work. For this reason, fees amounting to six dollars per term for day students, and six dollars per year for evening students, are charged. A very important adjunct to the work of the institute is found in the employment bureau officially maintained. It is considered that in a school of this type the securing of satisfactory employment for the students is one of the important functions of the work.

Great care has been exercised in selecting the instructors. The principal is Arthur Williston, who was at the head of the School of Science and Technology at the Pratt Institute in Brooklyn, N. Y., for twelve years. Mr. Williston is a graduate of the Massachusetts Institute of Technology. He has had experience as an engineer on one of the great western railroads and was a member of the commission which established the Carnegie Technical School in Pittsburg. He was also formerly a member of the faculty of the Ohio State University. The growth of the Pratt Institute under his direction has been very rapid, and his selection as principal will, no doubt, be found to be very advantageous for the Wentworth Institute.

* * *

Joseph A. Barraja Frauenfelder, a German, was arrested September 21 for communicating knowledge of the construction of United States submarine vessels to Henry Harrison Suplee in New York, publisher of *Cassier's Magazine*. Frauenfelder will be prosecuted under the Act of Congress, March 3, 1911, providing penalties for disclosing knowledge of defenses without permission of authority. The indictment charges that Frauenfelder communicated a story with drawings descriptive of the construction of a submarine boat built by the Electric Boat Co.

* * *

WASTE IN LUBRICATION

"Cylinder oils," says Arthur D. Little, "generally cost about what the user is accustomed to pay. Plants which employ a chemist pay from 19 to 27 cents. Manufacturers who do not need a chemist commonly pay 45 cents, 65 cents, or even, if they know their own business very well, $1.50 a gallon! There is probably not a large plant in the country in which if it is not already under chemical control, the lubrication account cannot be cut in two. In an engine room of one large cement plant the average monthly cost for lubricants had been $337. It is now $30. A concern paying 37 cents a pound for a special grease which the superintendent needed to run the mill now buys on specification for 5½ and the mill still runs. Another company within our knowledge saves $12,000 a year on cutting oils alone."

* * *

PERSONALS

A. H. Teuchter, president of the Cincinnati-Bickford Tool Co., Cincinnati, Ohio, returned from a three months' European trip the latter part of August.

E. R. Euston, vice-president of the Stoever Foundry & Mfg. Co., Myerstown, Pa., who has been in charge of the company's New York office for the past ten years, will remove to its new plant at Easton, Pa., October 2.

Louis Parent, engineer with Fenwick Freres & Co., Paris, France, is in the United States on a two and one-half months' trip in the interests of his concern. His headquarters are Waterbury Farrel Foundry & Machine Co., Waterbury, Conn.

Crocker-Wheeler Co., Ampere, N. J., announces the resignation of Mr. Gano Dunn, who for a great many years has filled the position of chief engineer and first vice-president in the Crocker-Wheeler Co., with conspicuous ability. He leaves with the very best wishes of the company and his many friends and associates in it, for his future success.

W. Bonsor, recently associated with the Packard Motor Car Co., is now connected with the Stevens-Duryea Co. in the production department of the factory in the capacity of supervisor of parts. Mr. Bonsor's manufacturing experience has been rather extensive, and for some years he was connected with the Daimler Motor Co., Ltd., of Coventry, England.

Benjamin T. Delafield, who formerly represented the Lunkenheimer Co. for a number of years in the St. Louis and Kansas City territory, has become connected with the Best Mfg. Co., Pittsburg, Pa., to handle its line of valves, fittings, flanges, pipe bends, fabricated pipe and other power plant material in the same territory. He will make his headquarters in Kansas City.

Arthur E. Meyer, assistant and secretary to the general manager of the Toledo Machine & Tool Co., Toledo, Ohio, has resigned to become traveling representative for the Acklin Stamping Co., Toledo, Ohio. Mr. Meyer is the author of the articles on power presses and sheet-metal working machinery, appearing lately in MACHINERY under the nom-de-plume of "Hart Preston."

Chester L. Lucas, author of many valuable articles published in MACHINERY during the past four years, has joined the editorial staff. Mr. Lucas is an expert toolmaker and diemaker, having acquired much valuable experience with some of the best known concerns in New England. He will contribute articles on various phases of the metal-working industries, especially those that are comparatively little known outside of a narrow field.

Charles H. Jumper, chemical engineer of Arthur D. Little, Inc., chemists and engineers, Boston, Mass., will act as assistant to D. T. Randall in the centralized testing department which has recently been organized under Mr. Randall's direction by the above-mentioned concern. Mr. Jumper has had several years' experience in both the chemical and engineering divisions of the company from which he is detailed. This was preceded by service in the testing departments of the Pennsylvania and Union Pacific Railroads.

* * *

OBITUARIES

Franklin B. Shuster, president and treasurer of the F. B. Shuster Co., New Haven, Conn., died of bronchial asthma at his home in New Haven, August 14, aged forty-five years.

Elias Burwell, a pioneer clockmaker, died in Bristol, Conn., September 2, aged nearly one hundred and one years. He invented the calendar clock, and for a long time was its exclusive manufacturer.

* * *

COMING EVENTS

October 2-3.—Autumn meeting of the Iron & Steel Institute at Turin, Italy. G. C. Lloyd, secretary, 28 Victoria St., London, S. W., England.

October 2-28.—Industrial and educational exposition under the auspices of the Boston Chamber of Commerce, held in the Mechanics' Building at Boston, Mass. This exposition is devoted strictly to New England industries. No manufacturer outside of New England will be allowed to exhibit.

October 9-13.—Convention of the American Electric Railway Association, Young's New Pier, Atlantic City, N. J. H. C. Donecker, secretary-treasurer, 29 West 39th St., New York.

October 10.—MACHINERY'S ninth annual entertainment, Hotel Astor, New York, Tuesday evening at 8 o'clock.

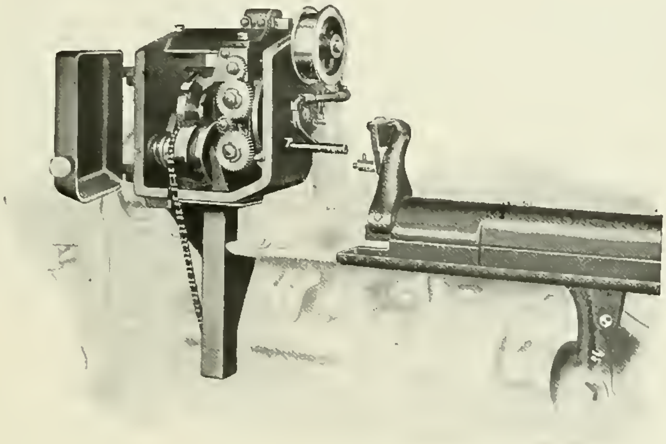
October 10-12.—Tenth annual convention of the National Machine Tool Builders' Association, in New York City. Charles E. Hildreth, 134 Gold St., Worcester, Mass., secretary.

Oct. 12-14.—Tuck School conference on scientific management at

Castellated nuts made complete on one machine

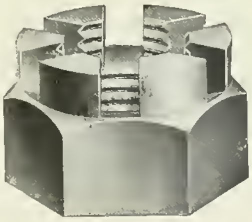
B & S CASTELLATING ATTACHMENT

For No. 2 Automatic Screw Machine



MANUFACTURERS whose machines require locking nuts have always been troubled by the fact that they could not make them complete on one machine but had to make the nut on one machine and then slot it on another. Many different devices have been tried without success but this device, a new design recently brought out, has at last solved the problem. After the nut has been cut, formed, and threaded, a transferring arm conveys it to the attachment where the work of slotting is done. All this is quickly and efficiently done, three nuts being slotted at a time.

Other attachments can be furnished for our automatics as follows: Screw Slotting Attachment—for slotting screws automatically; Index Drilling Attachment—for drilling several cross holes in pieces otherwise finished on the machine; Burring Attachment—for drilling, counterboring, facing and burring.



Send for circular and further information.

BROWN & SHARPE MFG. CO.

PROVIDENCE, RHODE ISLAND, U. S. A.

Hanover, N. H. The principles of scientific management will be discussed by Frederick W. Taylor, H. L. Gantt, Harrington Emerson and others, and round table conferences will be held on scientific management of machine manufacture, shoe manufacture, printing and publishing, pulp and paper manufacture, lumbering, etc. Further particulars will be furnished by Walter B. Snow, 170 Summer St., Boston, Mass.

November 2-4.—Annual meeting of the International Society for the Promotion of Industrial Education, Cincinnati, Ohio. R. T. Davis, secretary, 18 W. 44th St., New York.

January 18-20, 1912.—Annual meeting of the Society of Automobile Engineers in New York. Coker F. Clarkson, general manager, 1451 Broadway, New York.

NEW BOOKS AND PAMPHLETS

Lamps and Shades in Metal and Art Glass. By John D. Adams. 114 pages, 4¾ by 7 inches, 27 illustrations. Published by Popular Mechanics Co., Chicago, Ill. Price, 50 cents.

In this book is presented a series of descriptions of home-made lamps in the construction of which metal and glass are utilized. The book contains eighteen complete designs with working drawings and full directions for the making of the lamps. It will be of interest to the amateur craftsman with a modest equipment.

Heating and Ventilating Shops and Offices. By Charles L. Hubbard. 39 pages, 6 by 9 inches, 45 illustrations. Published by the Industrial Press, 49-55 Lafayette St., New York. Price, 25 cents.

This book, which is No. 66 of Machinery's Reference Series, contains two chapters, one on Shop Heating by Direct Radiation and the other on the Heating and Ventilating of Offices in Shops and Factories. The apparatus required for an efficient shop heating system is illustrated and described. Piping systems are outlined, and the methods used for calculating the required size of the system are included. The chapter on heating and ventilating of offices in shops and factories is partly devoted to simple methods which can be applied to existing installations without a great deal of trouble or expense, and partly to the design and arrangement of new systems.

Steam Boilers. 48 pages, 6 by 9 inches, 43 illustrations. Published by the Industrial Press, 49-55 Lafayette St., New York. Price, 25 cents.

This book is No. 67 of Machinery's Reference Series. It is the first of six books dealing with power plant machinery and apparatus. It contains chapters on Steam Generation; General Proportions of Boilers; Classification and Types of Boilers; Designs of Horizontal Tubular Boilers; and Boiler Testing. It is a simple but comprehensive treatise of the subject, containing the essential elements relating to steam boiler types and boiler design.

Boiler Furnaces. 45 pages, 6 by 9 inches, 48 illustrations. Published by the Industrial Press, 49-55 Lafayette St., New York. Price, 25 cents.

This book is No. 68 of Machinery's Reference Series and is the second of a series of six books on power plant machinery and apparatus. It deals specifically with the combustion in boilers and the furnaces used. It contains chapters on Combustion and Fuels; Furnaces; Mechanical Stokers; Mechanical Draft; Oil Fuel; and Chimneys.

Feed Water Appliances. 48 pages, 6 by 9 inches, 46 illustrations. Published by the Industrial Press, 49-55 Lafayette St., New York. Price, 25 cents.

This book is No. 69 of Machinery's Reference Series and is the third of a series on power plant machinery and apparatus. It deals specifically with the characteristics of feed water and the methods used for its purification and heating. The various apparatus and machinery used for handling the feed water are illustrated and described. The chapters contained are entitled: Impurities in Feed Water for Boilers; Purification of Feed Water; Feed Water Heating; and Feeding and Regulating Devices.

Steam Engines. 48 pages, 6 by 9 inches, 53 illustrations. Published by the Industrial Press, 49-55 Lafayette St., New York. Price, 25 cents.

This book, which is No. 70 of Machinery's Reference Series, contains a concise treatise on the general characteristics and types of reciprocating steam engines. It contains six chapters entitled: Action of Steam Engines; Rating and General Proportions of Steam Engines; Steam Engine Details; Steam Engine Economy; Types of Steam Engines; and Steam Engine Testing. Being profusely illustrated, it gives in a small space a very complete idea of the various types of steam engines in general use, and the characteristic features of their design.

Steam Turbines. 48 pages, 6 by 9 inches, 56 illustrations. Published by the Industrial Press, 49-55 Lafayette St., New York. Price, 25 cents.

This book is No. 71 of Machinery's Reference Series. It comprises a treatise on the action of steam in steam turbines, describing the difference between impulse and reaction turbines and the combination types known as compound and multiple-stage turbines. Illustrations of a number of different types of steam turbines with a description of their peculiarities are included. A chapter is devoted to steam turbine economy and deals with the steam consumption, the effect of condensing, economy of low pressure turbines, the effect of load variation, the efficiency of turbines, and the effect of superheated steam on the efficiency.

Pumps and Condensers, Steam and Water Piping. 48 pages, 6 by 9 inches, 60 illustrations. Published by the Industrial Press, 49-55 Lafayette St., New York. Price, 25 cents.

This book is No. 72 of Machinery's Reference Series. It contains descriptions and illustrations of various types of pumps, discussing the details and characteristics of pumps, and their calculation. Various types of condensers are illustrated and described, and methods given for calculating their capacity. The subject of steam and water piping is also treated, and piping diagrams for the general arrangement of power plants, both non-condensing and condensing, are shown.

Isometric Drawing. By Alpha Pierce Jamison. 69 pages, 6 by 9 inches, 58 illustrations and 8 plates. Published by McGraw-Hill Book Co., New York. Price, $1.00.

The convenience and adaptability of isometric drawing are readily recognized, and a knowledge of the principles underlying this method of representing objects is desirable, if not necessary, to all draftsmen. In works on descriptive geometry or mechanical drawing, the subject is usually dismissed with a few words and one or two illustrations. It is impossible for the student to obtain a clear idea of the methods from such meager treatment. This book has been written in the hope that a greater number of draftsmen, after they have studied the subject, will find it as useful as the author in the preface says that he has found it. The book is divided into four parts, the first being devoted to preliminary discussions and explanations, the second, to the drawing of plane figures, the third, to the drawing of solids, and the fourth and last, to a course in isometric drawing, containing eight plates of exercises.

Machine Drawing and Sketching for Beginners. By J. H. Robson. 196 pages, 5¼ by 8¼ inches, 315 illustrations. Published by D. Van Nostrand Co., New York. Price, $2.00.

In this work the author has endeavored to assist the beginner in acquiring a knowledge of the design of machine details by providing a large number of illustrations, many of which are fully dimensioned, and which will give the student an idea of the approved methods of design and drawing. The book is of a practical character and differs considerably from the ordinary type of text book on mechanical drawing, which is largely devoted to examples of geometrical drawing and contains but few examples of common machine details. The great number of illustrations included is one evidence of the scope of the work; a fuller idea will be gained from a list of contents. The sixteen chapters are headed as follows: Introduction; Materials used in Machine Construction; Projection; Riveted Work; Screws, Bolts and Nuts; Keys, Shafting and Shaft Couplings; Wheels and Pulleys; Bearings for Shafts; Cranks and Eccentrics; Connecting-rods; Crossheads and Slide Bars; Pistons and Stuffing Boxes; Cocks and Valves; Pipe Joints; Workshop Practice and Appliances; Questions and Exercises.

Hendricks Commercial Register. 1419 pages, 7½ by 10 inches. Published by S. E. Hendricks Co., 74 Lafayette St., New York. Price, $10.00.

This well-known trade directory has been published for twenty years and the twentieth annual revised edition is larger than ever. The aim of its publishers is to furnish complete classified lists of manufacturers for the benefit of those who want to buy as well as for those who have something to sell. It covers every branch of the architectural, engineering, electrical, mechanical and kindred trades and professions. An idea of the scope can be obtained from the fact that the twentieth edition requires for the index alone, 128 pages, set in six-point type, four columns to the page. The total number of classifications is over 45,000, each representing the manufacturers or dealers of some machine tool, specialty or material required in the industries, the whole comprising 350,000 names and addresses. The book can be used for either purchasing or mailing purposes. The change of importance in the twentieth edition is making the index refer to the classification numbers instead of the page numbers. The user has his attention directed at once to the paragraph containing the names of the desired concerns, whereas in the former arrangement he first had to find the page and then find the group of concerns desired. The register is recommended to all who have need of a work of this nature, and that means practically all manufacturing concerns of importance.

CATALOGUES AND CIRCULARS

Charles A. Stickney Co., St. Paul, Minn. Leaflet on the Stickney worm-gear pump jacks.

American Blower Co., Detroit, Mich. Bulletin No. 315 on "Ventura" disk ventilating fans.

Millers Falls Co., Millers Falls, Mass. Circulars of hand drills, backsaws and carpenters' tools.

Moline Tool Co., Moline, Ill. Perforated wall hanger illustrating the Moline multiple-spindle drills.

Thomas H. Dallett Co., York and 23d Sts., Philadelphia, Pa. Bulletin No. 301 of Dallett's pneumatic boiler scaler.

Pittsburg Emery Wheel Co., Park Bldg., Pittsburg, Pa. Catalogue of emery wheels and swing frame grinding machines.

Dean Mfg. Co., Newport, (South Cincinnati), Ky. Catalogue of Fox fourth-port gasoline motors, special motors, heavy-duty motors and de luxe motors.

New England Annealing & Tool Co., 74 K St., So. Boston, Mass. Catalogue of granite and marble workers tools, wedges and shims, pneumatic chisels, etc.

Reade Mfg. Co., 1021-1027 Grand St., Hoboken, N. J. Circular of Reade's non-corrosive soldering fluid which gives off no offensive fumes and facilitates the soldering of metal joints.

Butterfield & Co., Derby Line, Vermont and Rock Island, Canada. Catalogue of taps, screw plates, stock and dies, hand and machine reamers, tools for engineers and steam fitters, etc.

Superior Machine Tool Co., Kokomo, Ind. Circular of Superior high speed "goose-neck" tool-holders which combine strength and resiliency. A high-speed cut-off tool and a threading tool are illustrated

Medhirs-Phil Mfg. Co., Hastings, Minn. Circular of the "Beats-Em All," combination pincers, pliers and pipe wrench; a tool with double jaws which can be set at various positions relative to the handles for convenient use.

Warner & Swasey Co., Cleveland, Ohio. Card illustrating the Warner & Swasey factory, August 5, 1881, and the present factory on August 5, 1911. The development of the company in thirty years is thus graphically shown.

Diamond Chain & Mfg. Co., 240 W. Georgia St., Indianapolis, Ind. Ninety-six-page reference book containing treatise by Mr. L. M. Wainwright on power chains and sprockets; also engineering data pertaining to pitch chains for transmission of power.

Blanchard Machine Co., Cambridge, Mass., has just issued a pamphlet descriptive of the newly designed Blanchard continuous reading caliper or "excess stock indicator." The many advantages of the Blanchard method are made evident by the pamphlet, which will be sent on request.

Standard Machinery Co., Providence, R. I. Catalogue of 131 pages on single and double-acting power presses, both plain and geared; also transfer, reducing, coining and double crank presses and various applications for which special presses are used. It also covers a line of foot and screw presses.

Hyatt Roller Bearing Co., Newark, N. J. Circular illustrating uses of Hyatt roller bearings on machine tools, gasoline locomotive, tumbling barrel, trolleys, countershafts, car loader, harvesters, etc. The circular is cut in the form of a perspective view of the Hyatt bearing and the halftones on the covers complete the illusion.

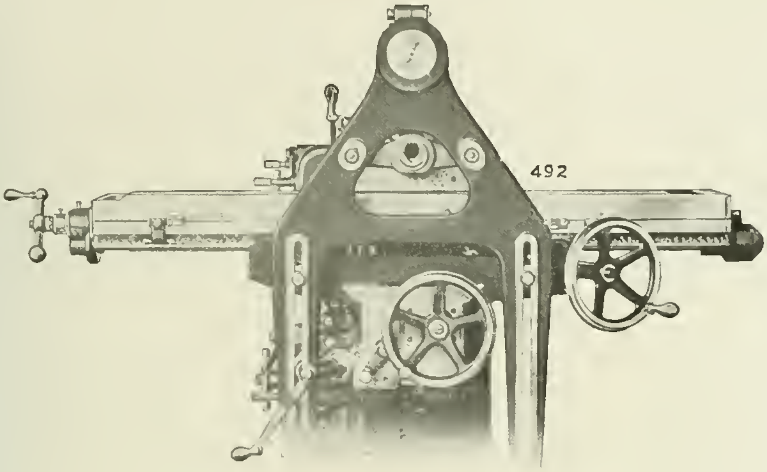
Billings & Spencer Co., Hartford, Conn. Circular of lathe tools, comprising the Jacques patent diamond point tool; the B. & S. tool-holders; Beach's improved patent thread-cutting and diamond point lathe tool; Billings patent cutting-off tool; Billings improved knurling tool; B. & S. planer tool-holder and drop forged lathe dogs.

Ohio Machine Tool Co., Canton, Ohio. Circular of Ohio metal planers, and standard and heavy-duty shapers. The Ohio planers are built in sizes 24 by 24 inches to 56 by 48 inches with various lengths of platens. The Ohio standard shaper is built in 16-inch, 18-inch and 22-inch stroke, and the heavy pattern in 20-inch or 24-inch stroke.

Westinghouse Electric & Mfg. Co., Pittsburg, Pa. Circular No. 1028, "Westinghouse Rotary Converters";; circular No. 1190, "Engine Driven Alternating Current Generators, Type E"; folder No. 4217 "Watthour Meters, Type C"; folder No. 4216, "Direct Current Switchboard Meters"; and folder No. 4215, "Alternating Current Switchboard Meters."

Victor Vise Co., 15-19 W. Washington St., Springfield, Ohio. Circular of the Victor vise made in four styles as follows: solid base, solid jaw; solid base, swivel jaw; swivel bar, solid jaw; and swivel base, swivel jaw. The vise can be easily adjusted to hold any odd shaped work as well as all ordinary shapes. Only one locking lever is required for all swivels.

Cincinnati High Power Arbor Supports



Usual position of Table when doing heavy cutting.

The importance of a rigid support for the outer arbor bearing is evident when we remember that this bearing gets as heavy pressures due to the cut, as does the main bearing of the machine.

The resultant of these pressures is approximately horizontal, in the direction of the table level.

Our outer bearing support is designed to provide the greatest stiffness against these pressures.
It is made in one piece, truss form, bolted to its supporting member on the knee.

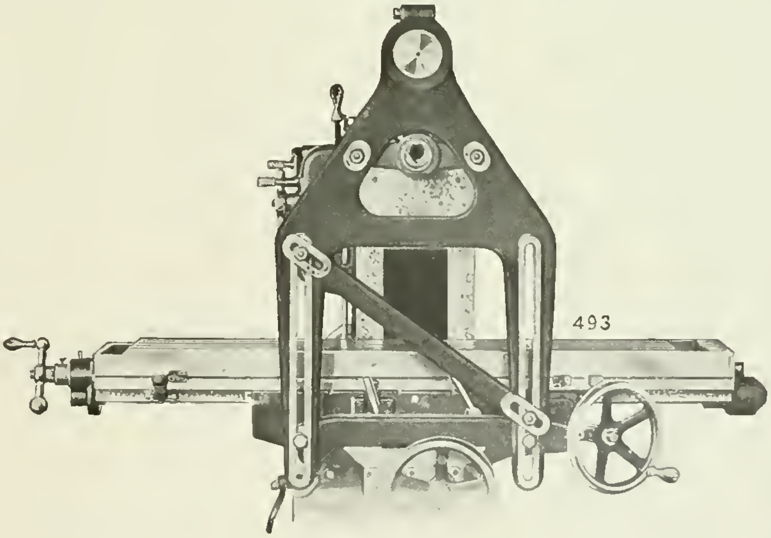
For work requiring the knee in a low position, an additional diagonal brace makes it a double truss.

This is the principle on which bridges are designed.

It also applies in correct machine tool design.

We have applied this principle in every important part of our High Power Millers.

Get our new catalog.



Usual position of Table.
Braces provided with an additional truss member.

The Cincinnati Milling Machine Co.

CINCINNATI, **Milling Specialists** **OHIO, U. S. A.**

EUROPEAN AGENTS—Alfred H. Schutte, Cologne, Brussels, Milan, Paris and Barcelona. Donauwerk Ernst Krause & Co., Vienna, Budapest, Prague and Berlin. Chas. Churchill & Co., London, Birmingham, Manchester, Newcastle-on-Tyne and Glasgow. CANADA AGENT—H. W. Petrie, Limited, Toronto, Montreal and Vancouver. AUSTRALIA AGENTS—Thos. McPherson & Son, Melbourne. JAPAN AGENTS—Andrews & George, Yokohama. CUBA AGENT—Adolfo B. Horn, Havana. ARGENTINE AGENTS—Adolfo Mantels & Co., Buenos Ayres.

Universal Electric Welding Co., 227 Borden Ave., Long Island City, N. Y. Catalogue of electric welding machines for point, spot and ridge welding. The company's machines are constructed with the best type of transformers, flexible secondaries, and the copper jaws are water cooled. Methods of welding commercial shapes are being constantly developed and equipment provided for manufacturers having difficult shapes to weld.

Superior Machine Tool Co., Kokomo, Ind. Catalogue of the Superior upright drilling machines, which are built in 20-inch, 21-inch, 23-inch, 24-inch, 25-inch, 28-inch, 32-inch and 36-inch sizes with various combinations of lever feed, cone belt feed, back gears, positive geared feed, sliding head, compound table, gear tapping attachment, etc. An illustration of the plant is shown; also interesting details of the machines, which are fully described.

Jos. T. Ryerson & Son, Chicago, Ill. Catalogue of Prentice lathes, comprising high-speed geared head lathes, high-speed geared head turret lathes, heavy-duty double- and back-geared lathes and engine lathes. This handsome catalogue has a frontispiece illustrating the large machinery display room of the Ryerson plant at Chicago. Details of the headstock construction, attachment of motors, and turret tool-holders are shown in addition to illustrations of the lines of machine tools.

Cleveland Planer Works, 3148 Superior Ave., Cleveland, Ohio. Circular of the Cleveland open-side planer illustrating features of construction that are advantageous. These include closed top and integral column base; integral casting for knee; closed bottom to column base and section opposite in the bed; heavy column; cross ribbed construction; bosses cast integral with the bed; solid table on small size planers and cross ribbed tables on large sized machines, etc.

Wm. Ganschow Co., Chicago, Ill. General catalogue No. 25 on cut and planed gears, rawhide pinions, cut steel machine racks and gear patterns of all descriptions. The catalogue includes valuable data among which are comparative sizes of gear teeth, standard sizes of key-seats, rules for ordering gears and worm gearing, lists of gears that can be furnished from patterns, general rules for mensuration, weight tables, strength of gear teeth, horsepower of shafting, sizing and cutting gears, natural trigonometrical functions, pitch diameters of circular pitch gears, etc.

Hammacher Schlemmer & Co., 4th Ave., and 13th St., New York. Catalogue No. 446 on truck casters for use in shops, mills, factories, warehouses and wherever goods are handled on trucks. Many manufacturers have found it preferable to make their own trucks, not only because it is cheaper to make them but because they can get a truck that will be just suited to their particular requirements; to these the catalogue will be of value, as a large variety of truck casters suitable for all conditions of service are listed. Particular attention is called to the Martin anti-friction casters and Clark's rubber wheel casters.

Mesta Machine Co., Pittsburg, Pa. Souvenir, containing program of the inspection trip of the American Society of Mechanical Engineers to the West Homestead plant of the company, June 2, and some illustrations of the various products inspected. The booklet illustrates cutting a 24-foot steel gear weighing 100,000 pounds; machining a rope wheel 24 feet diameter, 4 feet 8 inches face with 20 grooves; a 20,000 horsepower reversing engine weighing complete about 900,000 pounds; other interesting heavy machine work; an 800-ton steam hydraulic, quick-acting forging press; and the inspection party assembled at the works.

Landis Tool Co., Waynesboro, Pa. Treatise on abrasives for grinding wheels comprising emery, corundum, carborundum, aloxite, alundum, crystolon; manufacture of grinding wheels, grain, grade; grinding wheel speeds; truing of grinding wheels; ordering grinding wheels; about grinding wheels; and grinding wheel shapes. Every manufacturer and user of grinding wheels should obtain a copy of this pamphlet. A study of the characteristics of abrasives will undoubtedly cause grinding wheels to be used more intelligently than they commonly are. The pamphlet, which is No. 7 of a list of literature offered by the company, will be sent free upon request.

New Departure Mfg. Co., Bristol, Conn., is sending to members of the Society of Automobile Engineers, and others who ask for them, a neatly printed set of twelve data sheets ready for insertion in the S. A. E. hand-book. These sheets describe all New Departure ball bearings in the double row, single row, magneto, new cup and cone type; and also contain accurately compiled tables giving standard press fits and push fits on shafts, and in casing. Diagrammatic tables compiled by Mr. Frederick Hughes, the company's chief engineer, are included, by which the maximum thrust and radial load capacity of any bearing running at any speed can be easily determined.

Pratt Institute, Brooklyn, N. Y. Circular of evening technical courses for 1911-1912. These courses designed for young men employed during the day comprise the following subjects: practical mathematics, technical chemistry, industrial electricity, elementary electricity, practical mechanics, electrical machinery, electrical design, mechanical drawing, machine design, mechanism, steam and steam engines, strength of materials. The tuition varies from $10 to $15 per season of six months depending on the course. Evening trade courses are also offered in carpentry and building, patternmaking, machine work, toolmaking, sheet metal work, plumbing, and advanced woodworking for teachers.

Atlas Engine Works, Indianapolis, Ind. Bulletin No. 201, illustrating and describing the Atlas crude oil engine, Diesel type, which is built in two, three and four cylinder vertical units of 300, 450 and 600 rated horsepower. These engines use crude oil containing about 19,000 B. T. U., and generate one brake horsepower per hour on less than one-half pound of fuel. The thermal efficiency based on indicated horsepower approximates 37½ per cent, and the absolute efficiency based on the brake horsepower at full load and mechanical efficiency of the engine of about 80 per cent, is 30 per cent. On the basis of 2 cents per gallon for fuel with a liberal overhead charge the cost of current is claimed to be 1 per cent per kilowatt hour.

TRADE NOTES

Emerson Co., 424 McCormick Bldg., Chicago, Ill., standard practice and efficiency engineers, are desirous of receiving catalogues and data from American machinery manufacturers.

National Tool Co., Cleveland, Ohio, manufacturer of milling cutters, collets and self-opening dies, has opened a new office at 9500 West Madison Ave. The company will build a large shop early in 1912.

Rockford Milling Machine Co., Rockford, Ill., manufacturer of bench and column type milling machines, is erecting a new factory on Harrison Ave., which is expected to be ready for occupancy this Fall.

Rummell Machine Screw Co., Cleveland, Ohio, manufacturer of automatic machine screw products, has erected a new factory at 1978 West 77th St., which affords about five times the capacity of the old shop.

Toledo Bridge & Crane Co., Toledo, Ohio, announces the appointment, effective October 1, of E. T. and F. E. Mathewson, Real Estate Trust Bldg., Philadelphia, Pa., as its representatives for Philadelphia and vicinity.

F. E. Wells & Son Co., and E. F. Reece Co., of Greenfield, Mass., have consolidated under the same ownership and (beginning September 1) the business will be transacted under the name of F. E. Wells & Son Co.

Sheffield Tool Steel Co., 60 Elm St., Cincinnati, Ohio, has been appointed exclusive agent for the sale of "Toledo" (Sheffield) tool steel in Cincinnati and surrounding territory. The company will carry a complete stock of all grades including "Toledo" high-speed steel.

Standard Welding Co., 76th St., N. W., and L. S. & M. S. R. R., Cleveland, Ohio, has opened a branch office in the Ford Bldg., Detroit, Mich. Mr. C. E. Miller, in charge, will give the Standard Welding Co.'s business direct representation throughout the state of Michigan.

Standard Welding Co., Cleveland, Ohio, manufacturer of automobile, motor truck, motorcycle and bicycle rims, and seamless steel tubing, etc., has terminated its arrangements with L. E. McClernan & Co., of Chicago, Ill., for the sale of its products. Mr. B. A. Quayle will have charge of the Chicago office.

Crocker-Wheeler Co., Ampere, N. J., announces the opening, on September 1, of offices in San Francisco, Cal., located at Room 400, First National Bank Bldg. Motors, generators, and transformers of various sizes will be carried in stock for immediate coast shipment. Mr. John S. Baker, well known among the electrical trade on the Pacific Coast, has been placed in charge.

Thielicke & Co., have just finished equipping their offices at 102-104 Lutzowstr. Berlin, W., Germany, and are advantageously located to represent American machine tool builders who desire an agency in Germany. In the basement of the building where their offices are located, Thielicke & Co. have a well lighted demonstration room which is well arranged to show machines in operation.

International Oxygen Co. has removed its New York headquarters from 68 Nassau St., to 115 Broadway, where increased facilities have been secured for transacting its growing business. The new location is well suited to the company's needs and is easy of access for persons coming to New York who wish to investigate the methods of the I. O. C. system of oxygen and hydrogen manufacture for commercial purposes.

Stoever Foundry & Mfg. Co., having been absorbed by the Treadwell Engineering Co., will discontinue its New York office and plant at Myerstown, Pa., and in the future maintain general sales offices at Easton, Pa., under the name of the Treadwell Engineering Co., where the line of pipe threading, cutting and bending machines will be manufactured. The company also expects to add kindred lines of machine tools in the near future, due announcement of which will be made in this paper.

American Emery Wheel Works, Providence, R. I., is erecting an addition to its plant approximately 50 by 100 feet, to be three stories for part of its length and four stories the remainder. This building will be used to increase the general facilities, and to add to the storage room for new material. The company's business, both foreign and domestic, has been extremely good during the past year, the foreign business having been particularly heavy. The works are running full time and the payroll one week in August was the largest of any in fifteen years of business.

Gandy Belting Co., Baltimore, Md., sole manufacturer of the Gandy belt in the United States, has adopted a novel and original idea for distinguishing its product from other stitched cotton duck belts. Beginning September 1, 1911, one edge of Gandy belting will be painted green, while the remainder of the belt will remain red as before, and will continue to bear the brand "The Gandy Belt" and the trademark. The design of the trademark is a coil of belt and a bale of cotton laid across it. The new method of marking was adopted to prevent the substitution of imitations by unscrupulous competitors who have been selling through the dealers to unsuspecting customers.

Lees-Bradner Co., Cleveland, Ohio, manufacturer of gear generators and generator cutters, has just completed a new shop at 6210 Carnegie Ave., Cleveland. The building is of brick, two stories, 150 by 50 feet, and new equipment has been provided. The company, which started manufacturing gear generators in a very small way only two years ago, is now doing a large business. Mr. Lees is a man of well-known mechanical ability, having been connected with the Ingersoll Milling Machine Co., Rockford, Ill., and with the Grant-Lees Co., of Cleveland, Ohio. Mr. Bradner was sales manager and stockholder in the Grant Lees Co. The phenomenal success of the company may be considered indicative of the excellence of its product.

Ohio Machine Tool Co., Cincinnati, Ohio, contemplates building a 60 by 100-foot addition to its present building, to increase its facilities. The company has manufactured for over twenty years a line of planers and shapers that are well and favorably known wherever used. The Ohio standard pattern shapers are built single- or back-geared in 16-inch, 18-inch and 22-inch stroke sizes, and the Ohio heavy-duty 24-inch back-geared shaper is built by the same company. The company calls attention to the fact that the managers of many manufacturing concerns do not seem to be aware that there are standard as well as heavy-duty shapers. The standard shapers are considered to be much more efficient than the latter when castings and forgings are made with a minimum of excess material to be removed.

Aerial Construction Co., Hartford, Conn., has been organized for the purpose of building a commercial airship which will demonstrate the practicability of aerial navigation. The company is capitalized for $50,000. The officers are: President, F. W. Dart; vice-president, F. W. Stickle; treasurer, F. C. Billings; secretary, H. Franklin Wells; managing director, Joseph K. Kopacka, all of Hartford. The company's chief engineer is John Twardus. An office has been established at No. 212 Asylum St., and the construction of the first machine will begin at once. The company proposes to build the first machine with a seating capacity of seven passengers and the navigator, the craft being 135 feet, equipped with a 75-horsepower motor, and capable of maintaining an average speed of 40 to 50 miles an hour. The combination of aeroplanes with the dirigible feature is said to insure the safety of this type of airship, under all atmospheric conditions.

J. T. Slocomb Co., Providence, R. I., manufacturer of machinists' tools, has opened a store in New York at 126 Chambers St. The store is in charge of Mr. A. Z. Boyd who has a wide acquaintance with the hardware dealers in the New York district, inasmuch as he represents a number of well-known tool manufacturers. The J. T. Slocomb Co. has been manufacturing for a number of years a superior line of small tools, the Slocomb micrometer being the principal product. These are made with drop-forged steel frames in all sizes up to 6 inches. Larger sizes with steel casting frames are made in all sizes up to 24 inches inclusive for outside dimensions. The company also makes a screw-thread micrometer, a comparative screw-thread micrometer, a micrometer for measuring flutes of tap drills, tube micrometers, micrometer heads and quick-acting micrometers, reference disks, and measures, inside micrometers, height and depth gages, and combined center drills. This company was the first to put the combined drills on the market and it has worked up a large trade.

Supplement to M

Tables for Article in this numb

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MILLING RADIAL TEETH IN CUTTER BLANKS—I

Angle of Milling Cutter in Degrees	Number of Teeth in Cutter Blank	Width of Land, Radius = 1	Depth of Cut, Radius = 1	Angle of Elevation of Head	Number of Teeth in Cutter Blank	Width of Land, Radius = 1	Depth of Cut, Radius = 1	Angle of Elevation of Head	Number of Teeth in Cutter Blank	Width of Land, Radius = 1	Depth of Cut, Radius = 1	Angle of Elevation of Head
50	6	0.0150	......	......	8	0.0150	0.8215	32° 57′	10	0.0150	0.5950	52° 26′
		0.0200	......			0.0200	0.8156			0.0200	0.5903	
		0.0250	......			0.0250	0.8097			0.0250	0.5855	
		0.0300	......			0.0300	0.8037			0.0300	0.5806	
		0.0350	......			0.0350	0.7977			0.0350	0.5757	
55	6	0.0150	......	......	8	0.0150	0.6858	45° 33′	10	0.0150	0.4966	59° 25′
		0.0200	......			0.0200	0.6808			0.0200	0.4926	
		0.0250	......			0.0250	0.6759			0.0250	0.4885	
		0.0300	......			0.0300	0.6709			0.0300	0.4844	
		0.0350	......			0.0350	0.6659			0.0350	0.4804	
60	6	0.0150	0.9827	00° 00′	8	0.0150	0.5641	54° 44′	10	0.0150	0.4093	65° 12′
		0.0200	0.9769			0.0200	0.5601			0.0200	0.4060	
		0.0250	0.9712			0.0250	0.5560			0.0250	0.4027	
		0.0300	0.9654			0.0300	0.5520			0.0300	0.3993	
		0.0350	0.9596			0.0350	0.5480			0.0350	0.3960	
65	6	0.0150	0.7936	36° 8′	8	0.0150	0.4565	62° 12′	10	0.0150	0.3306	70° 12′
		0.0200	0.7889			0.0200	0.4532			0.0200	0.3279	
		0.0250	0.7843			0.0250	0.4500			0.0250	0.3253	
		0.0300	0.7796			0.0300	0.4467			0.0300	0.3226	
		0.0350	0.7750			0.0350	0.4434			0.0350	0.3199	
70	6	0.0150	0.6194	50° 55′	8	0.0150	0.3563	68° 39′	10	0.0150	0.2580	74° 40′
		0.0200	0.6158			0.0200	0.3538			0.0200	0.2560	
		0.0250	0.6122			0.0250	0.3512			0.0250	0.2539	
		0.0300	0.6086			0.0300	0.3486			0.0300	0.2518	
		0.0350	0.6050			0.0350	0.3460			0.0350	0.2497	
75	6	0.0150	0.4559	62° 22′	8	0.0150	0.2623	74° 27′	10	0.0150	0.1898	78° 47′
		0.0200	0.4532			0.0200	0.2604			0.0200	0.1883	
		0.0250	0.4506			0.0250	0.2585			0.0250	0.1867	
		0.0300	0.4479			0.0300	0.2566			0.0300	0.1852	
		0.0350	0.4452			0.0350	0.2547			0.0350	0.1837	
80	6	0.0150	0.3000	72° 13′	8	0.0150	0.1724	79° 51′	10	0.0150	0.1248	82° 39′
		0.0200	0.2983			0.0200	0.1712			0.0200	0.1238	
		0.0250	0.2966			0.0250	0.1700			0.0250	0.1228	
		0.0300	0.2948			0.0300	0.1688			0.0300	0.1218	
		0.0350	0.2930			0.0350	0.1676			0.0350	0.1208	
85	6	0.0150	0.1489	81° 17′	8	0.0150	0.0856	84° 59′	10	0.0150	0.0619	86° 22′
		0.0200	0.1480			0.0200	0.0850			0.0200	0.0614	
		0.0250	0.1471			0.0250	0.0844			0.0250	0.0609	
		0.0300	0.1462			0.0300	0.0838			0.0300	0.0604	
		0.0350	0.1454			0.0350	0.0832			0.0350	0.0599	

Contributed by George W. Burley

No. 148, Data Sheet, MACHINERY, November, 1911

MILLING RADIAL TEETH IN CUTTER BLANKS—II

Angle of Milling Cutter in Degrees	Number of Teeth in Cutter Blank	Width of Land, Radius = 1	Depth of Cut, Radius = 1	Angle of Elevation of Head	Number of Teeth in Cutter Blank	Width of Land, Radius = 1	Depth of Cut, Radius = 1	Angle of Elevation of Head	Number of Teeth in Cutter Blank	Width of Land, Radius = 1	Depth of Cut, Radius = 1	Angle of Elevation of Head
50	12	0.0150	0.4850	61° 2′	14	0.0150	0.3903	66° 10′	16	0.0150	0.3340	69° 40′
		0.0200	0.4799			0.0200	0.3857			0.0200	0.3294	
		0.0250	0.4749			0.0250	0.3810			0.0250	0.3249	
		0.0300	0.4699			0.0300	0.3763			0.0300	0.3204	
		0.0350	0.4649			0.0350	0.3716			0.0350	0.3159	
55	12	0.0150	0.3919	66° 10′	14	0.0150	0.3254	70° 18′	16	0.0150	0.2786	73° 9′
		0.0200	0.3879			0.0200	0.3215			0.0200	0.2748	
		0.0250	0.3838			0.0250	0.3176			0.0250	0.2710	
		0.0300	0.3798			0.0300	0.3137			0.0300	0.2673	
		0.0350	0.3758			0.0350	0.3098			0.0350	0.2635	
60	12	0.0150	0.3234	70° 31′	14	0.0150	0.2686	73° 51′	16	0.0150	0.2298	76° 10′
		0.0200	0.3201			0.0200	0.2654			0.0200	0.2267	
		0.0250	0.3167			0.0250	0.2622			0.0250	0.2236	
		0.0300	0.3134			0.0300	0.2589			0.0300	0.2205	
		0.0350	0.3101			0.0350	0.2557			0.0350	0.2174	
65	12	0.0150	0.2611	74° 23′	14	0.0150	0.2169	77° 1′	16	0.0150	0.1857	78° 52′
		0.0200	0.2584			0.0200	0.2143			0.0200	0.1830	
		0.0250	0.2557			0.0250	0.2117			0.0250	0.1805	
		0.0300	0.2530			0.0300	0.2091			0.0300	0.1780	
		0.0350	0.2503			0.0350	0.2065			0.0350	0.1756	
70	12	0.0150	0.2039	77° 52′	14	0.0150	0.1693	79° 51′	16	0.0150	0.1449	81° 20′
		0.0200	0.2018			0.0200	0.1673			0.0200	0.1429	
		0.0250	0.1996			0.0250	0.1653			0.0250	0.1409	
		0.0300	0.1975			0.0300	0.1632			0.0300	0.1390	
		0.0350	0.1954			0.0350	0.1612			0.0350	0.1371	
75	12	0.0150	0.1501	81° 6′	14	0.0150	0.1246	82° 35′	16	0.0150	0.1067	83° 38′
		0.0200	0.1486			0.0200	0.1231			0.0200	0.1052	
		0.0250	0.1470			0.0250	0.1216			0.0250	0.1037	
		0.0300	0.1454			0.0300	0.1201			0.0300	0.1023	
		0.0350	0.1439			0.0350	0.1187			0.0350	0.1009	
80	12	0.0150	0.0988	84° 9′	14	0.0150	0.0819	85° 8′	16	0.0150	0.0702	85° 49′
		0.0200	0.0978			0.0200	0.0809			0.0200	0.0692	
		0.0250	0.0968			0.0250	0.0800			0.0250	0.0682	
		0.0300	0.0958			0.0300	0.0790			0.0300	0.0673	
		0.0350	0.0948			0.0350	0.0780			0.0350	0.0664	
85	12	0.0150	0.0491	87° 6′	14	0.0150	0.0407	87° 35′	16	0.0150	0.0348	87° 55′
		0.0200	0.0486			0.0200	0.0402			0.0200	0.0343	
		0.0250	0.0481			0.0250	0.0398			0.0250	0.0339	
		0.0300	0.0476			0.0300	0.0393			0.0300	0.0334	
		0.0350	0.0471			0.0350	0.0388			0.0350	0.0329	

Contributed by George W. Burley

No. 148, Data Sheet, MACHINERY, November, 1911

MILLING RADIAL TEETH IN CUTTER BLANKS—III

Angle of Milling Cutter in Degrees	Number of Teeth in Cutter Blank	Width of Land, Radius = 1	Depth of Cut, Radius = 1	Angle of Elevation of Head	Number of Teeth in Cutter Blank	Width of Land, Radius = 1	Depth of Cut, Radius = 1	Angle of Elevation of Head	Number of Teeth in Cutter Blank	Width of Land, Radius = 1	Depth of Cut, Radius = 1	Angle of Elevation of Head
50	18	0.0150	0.2923	72° 13′	20	0.0150	0.2592	74° 10′	22	0.0150	0.2334	75° 44′
		0.0200	0.2880			0.0200	0.2550			0.0200	0.2291	
		0.0250	0.2836			0.0250	0.2505			0.0250	0.2247	
		0.0300	0.2793			0.0300	0.2461			0.0300	0.2203	
		0.0350	0.2750			0.0350	0.2417			0.0350	0.2159	
55	18	0.0150	0.2439	75° 14′	20	0.0150	0.2163	76° 51′	22	0.0150	0.1947	78° 8′
		0.0200	0.2403			0.0200	0.2127			0.0200	0.1910	
		0.0250	0.2367			0.0250	0.2090			0.0250	0.1874	
		0.0300	0.2330			0.0300	0.2053			0.0300	0.1838	
		0.0350	0.2294			0.0350	0.2017			0.0350	0.1801	
60	18	0.0150	0.2010	77° 52′	20	0.0150	0.1784	79° 11′	22	0.0150	0.1605	80° 14′
		0.0200	0.1979			0.0200	0.1754			0.0200	0.1575	
		0.0250	0.1948			0.0250	0.1724			0.0250	0.1545	
		0.0300	0.1917			0.0300	0.1693			0.0300	0.1515	
		0.0350	0.1887			0.0350	0.1663			0.0350	0.1485	
65	18	0.0150	0.1624	80° 14′	20	0.0150	0.1442	81° 17′	22	0.0150	0.1296	82° 8′
		0.0200	0.1598			0.0200	0.1417			0.0200	0.1271	
		0.0250	0.1573			0.0250	0.1393			0.0250	0.1247	
		0.0300	0.1548			0.0300	0.1368			0.0300	0.1223	
		0.0350	0.1524			0.0350	0.1344			0.0350	0.1199	
70	18	0.0150	0.1267	82° 23′	20	0.0150	0.1126	83° 13′	22	0.0150	0.1012	83° 52′
		0.0200	0.1248			0.0200	0.1106			0.0200	0.0993	
		0.0250	0.1228			0.0250	0.1086			0.0250	0.0974	
		0.0300	0.1207			0.0300	0.1067			0.0300	0.0955	
		0.0350	0.1190			0.0350	0.1049			0.0350	0.0936	
75	18	0.0150	0.0933	84° 24′	20	0.0150	0.0828	85° 0′	22	0.0150	0.0745	85° 29′
		0.0200	0.0918			0.0200	0.0814			0.0200	0.0731	
		0.0250	0.0904			0.0250	0.0800			0.0250	0.0717	
		0.0300	0.0889			0.0300	0.0786			0.0300	0.0703	
		0.0350	0.0875			0.0350	0.0772			0.0350	0.0689	
80	18	0.0150	0.0614	86° 19′	20	0.0150	0.0545	86° 43	22	0.0150	0.0490	87° 2′
		0.0200	0.0601			0.0200	0.0535			0.0200	0.0481	
		0.0250	0.0595			0.0250	0.0526			0.0250	0.0472	
		0.0300	0.0585			0.0300	0.0517			0.0300	0.0463	
		0.0350	0.0576			0.0350	0.0508			0.0350	0.0453	
85	18	0.0150	0.0304	88° 11′	20	0.0150	0.0270	88° 22	22	0.0150	0.0243	88° 32′
		0.0200	0.0299			0.0200	0.0265			0.0200	0.0288	
		0.0250	0.0295			0.0250	0.0261			0.0250	0.0234	
		0.0300	0.0290			0.0300	0.0256			0.0300	0.0229	
		0.0350	0.0286			0.0350	0.0252			0.0350	0.0225	

Contributed by George W. Burley

No. 148, Data Sheet, MACHINERY, November, 1911

MILLING RADIAL TEETH IN CUTTER BLANKS—IV

Angle of Milling Cutter in Degrees	Number of Teeth in Cutter Blank	Width of Land, Radius = 1	Depth of Cut, Radius = 1	Angle of Elevation of Head	Number of Teeth in Cutter Blank	Width of Land, Radius = 1	Depth of Cut, Radius = 1	Angle of Elevation of Head	Number of Teeth in Cutter Blank	Width of Land, Radius = 1	Depth of Cut, Radius = 1	Angle of Elevation of Head
50	24	0.0150	0.2118	77° 0′	26	0.0150	0.1939	78° ′4	28	0.0150	0.1785	78° 58′
		0.0200	0.2075			0.0200	0.1896			0.0200	0.1742	
		0.0250	0.2032			0.0250	0.1852			0.0250	0.1699	
		0.0300	0.1988			0.0300	0.1809			0.0300	0.1656	
		0.0350	0.1945			0.0350	0.1766			0.0350	0.1613	
55	24	0.0150	0.1766	79° 11′	26	0.0150	0.1617	80° 4′	28	0.0150	0.1489	80° 49′
		0.0200	0.1731			0.0200	0.1582			0.0200	0.1453	
		0.0250	0.1694			0.0250	0.1546			0.0250	0.1418	
		0.0300	0.1658			0.0300	0.1510			0.0300	0.1382	
		0.0350	0.1622			0.0350	0.1473			0.0350	0.1346	
60	24	0.0150	0.1458	81° 6′	26	0.0150	0.1335	81° 49′	28	0.0150	0.1228	82° 26′
		0.0200	0.1428			0.0200	0.1305			0.0200	0.1199	
		0.0250	0.1398			0.0250	0.1275			0.0250	0.1169	
		0.0300	0.1368			0.0300	0.1245			0.0300	0.1139	
		0.0350	0.1339			0.0350	0.1215			0.0350	0.1109	
65	24	0.0150	0.1178	82° 49′	26	0.0150	0.1077	83° 24′	28	0.0150	0.0992	83° 54′
		0.0200	0.1153			0.0200	0.1053			0.0200	0.0968	
		0.0250	0.1129			0.0250	0.1029			0.0250	0.0945	
		0.0300	0.1105			0.0300	0.1005			0.0300	0.0920	
		0.0350	0.1081			0.0350	0.0980			0.0350	0.0896	
70	24	0.0150	0.0919	84° 24′	26	0.0150	0.0841	84° 51′	28	0.0150	0.0775	85° 14′
		0.0200	0.0900			0.0200	0.0822			0.0200	0.0756	
		0.0250	0.0882			0.0250	0.0803			0.0250	0.0737	
		0.0300	0.0863			0.0300	0.0784			0.0300	0.0718	
		0.0350	0.0844			0.0350	0.0766			0.0350	0.0699	
75	24	0.0150	0.0678	85° 53′	26	0.0150	0.0619	86° 13′	28	0.0150	0.0570	86° 30′
		0.0200	0.0663			0.0200	0.0606			0.0200	0.0556	
		0.0250	0.0649			0.0250	0.0592			0.0250	0.0543	
		0.0300	0.0635			0.0300	0.0578			0.0300	0.0529	
		0.0350	0.0621			0.0350	0.0564			0.0350	0.0515	
80	24	0.0150	0.0445	87° 18′	26	0.0150	0.0408	87° 30′	28	0.0150	0.0375	87° 42′
		0.0200	0.0436			0.0200	0.0398			0.0200	0.0365	
		0.0250	0.0427			0.0250	0.0389			0.0250	0.0356	
		0.0300	0.0418			0.0300	0.0380			0.0300	0.0347	
		0.0350	0.0409			0.0350	0.0371			0.0350	0.0338	
85	24	0.0150	0.0221	88° 39′	26	0.0150	0.0202	88° 45′	28	0.0150	0.0186	88° 51′
		0.0200	0.0216			0.0200	0.0198			0.0200	0.0182	
		0.0250	0.0212			0.0250	0.0193			0.0250	0.0177	
		0.0300	0.0207			0.0300	0.0188			0.0300	0.0172	
		0.0350	0.0203			0.0350	0.0184			0.0350	0.0168	

Contributed by George W. Burley

No. 148, Data Sheet, MACHINERY, November, 1911

MACHINERY
November, 1911

THE EXTRUSION OF SHELLS AND TUBES*

By CHESTER L. LUCAS†

JUST because a diemaker miscalculated a little, leaving the face of a punch too long, there is a healthy, growing corporation doing business in a comparatively new field of metal goods manufacturing. This, in a nutshell, explains the existence of the Metallic Shell & Tube Co., of Pawtucket, R. I., although the whole story is somewhat longer.

In 1903, George W. Lee was located in Binghamton, N. Y., engaged in the manufacture of the familiar one-piece collar button shown at *A*, Fig. 4. After a short time it became apparent that the Connecticut Yankees, by means of just such machines as the multiple plunger press, described in the August, 1911, number of MACHINERY, were turning out collar buttons by the ton so cheaply that he could not compete with them. Naturally, he began to look around for some other similar product that he could manufacture with his equipment of presses, shears and tools, and he hit upon the idea of a fastener, part of which is shown at *B*, Fig. 4. He immediately patented this "bachelor's button," and commenced to manufacture it on a small scale.

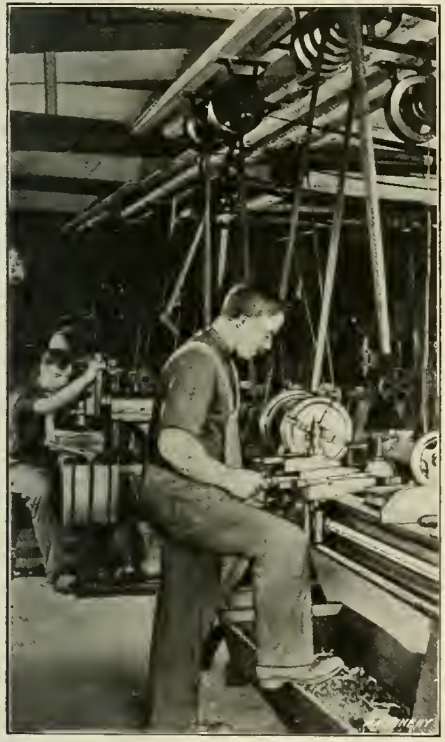
Fig. 1. Making Extrusion Dies

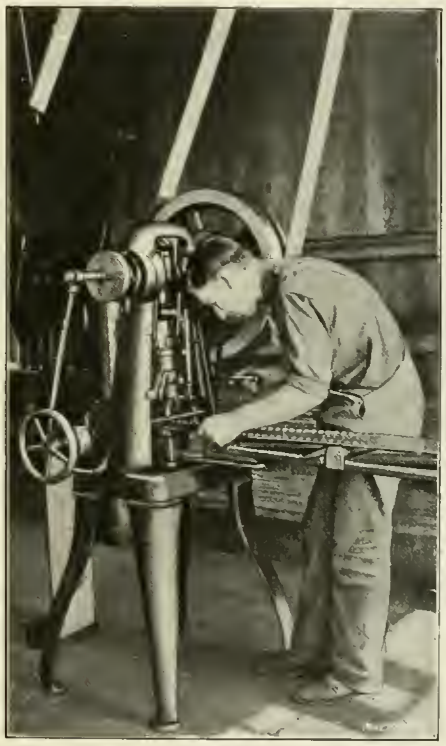
Fig. 2. Cutting and Drawing the Blanks

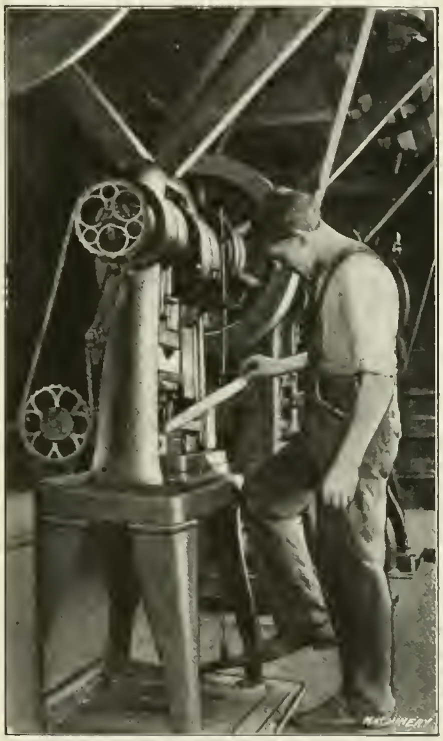
Fig. 3. Feeding the Blanks to the Extrusion Dies

After getting fairly well started, it occurred to him that if he made a slight change in his dies, so as to give the face of the button the appearance indicated at *C*, Fig. 4, the product would have a more finished appearance, without increasing the cost of manufacture. The dies for the button appeared about as shown at *A*, Fig. 5, in which the aluminum blanks, ½ inch in diameter, were placed and formed in the usual manner. To obtain the improved shape of the face of the button, he assumed that it would only be necessary to leave a small projection on the punch. He then made a punch with the projection left a little longer than he had intended, but he concluded to try it out. To his amazement, he found that instead of the slightly changed button that he had expected, he had a tube about ¾ inch long, with the flanged face of the button intact, as shown at *B*, Fig. 5. Lee pondered over the matter, tried more blanks in this die, with the same results, and decided that the explanation was that the metal, being confined on all sides except for the annular opening formed by the opening in the die and the projection of the punch, *had* to go through this space when pressure was applied.

With this principle in mind, he tried several other experiments along the same lines, and finally applied for patents on the process of extruding tubular metal bodies by means of dies of the type shown in Fig. 6. When the patent examiner at Washington read the specifications and saw the drawings, he was incredulous, and before allowing the patents, Lee was obliged to make several tubes for the examiner; after furnishing affidavits as to his work, the patents were allowed. During the next four years Lee worked incessantly on the process, but with little real success. He tried all kinds of steel, dies and presses, and at the end of that time he had spent about thirty thousand dollars, but still the process was not on a paying basis.

At this point Mr. Leslie E. Hooker and three other men bought the patent rights of Lee and organized a company to make a commercial success of the extrusion process. Mr. Hooker proved to be a man who "did things." He had been watching the experimental work for some time, and he had ideas of his own with relation to it. He took out several patents on improvements, and started a factory in Pawtucket, R. I., where at present the extrusion process is being worked successfully. The company is making tubes and shells in large quantities, and as manufacturers and designers are becoming more and more aware of the value of extruded work, the prospects seem unusually bright for the future.

General Outline of the Process

Since George W. Lee stumbled over the extrusion process in 1903, many changes have been made in the details of the methods, but in general the principles are the same. Briefly stated, the extrusion of tubular bodies is accomplished by confining a metal blank within a strong cylindrical chamber whose only outlet is through an annular opening at the bottom, formed by the projection on the punch and the hole in the bottom of the die. The size of this opening may be made of any required dimension, so that tubes and shells of different measurements can be made.

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* For information on the extrusion process, previously published in MACHINERY, see "The Extrusion Process," October, 1911, engineering edition.
† Associate Editor of MACHINERY.

Figs. 7 and 8 illustrate the features of dies for extruding tubular shapes. The containing ring is shown at *A*, the lower die at *B*, and the punch at *C;* part *D* is the former. In Figs. 6 to 9 inclusive, the die rings, dies and punches only are shown, for they are the vital parts of the apparatus. In Figs. 7 and 8, the blanks are shown at *F*, just after the extruding operation has started.

Fig. 7 shows a plain flat blank being extruded, but as the process was developed it was found better in every way to use a cup-shaped blank like that shown in Fig. 8. This shape of blank takes no longer to make than the flat blank, if cut and drawn in one operation. The chief advantage in using the cup-shaped blank lies in the fact that the metal extrudes more easily, for the work is distributed over a longer space. This fact is more readily apparent by noting the differences in the distances traveled by the punches in Figs. 7 and 8. There is, however, a limit to the proportions of this cup, for if made too deep and narrow, the punch will be too weak to stand the strain; if made too shallow, on the other hand, the object of cupping will be defeated. In general, the walls of the cup should be from 3/32 to 1/8 inch; from 3/8 to ½ inch is a proper depth for the cup. In some instances, as in cartridge case making, it is desirable to have the bottom of the tube as thick as possible, in which case the cup is made without reducing the thickness of the bottom. In nearly every tube, however, it is advantageous to have the bottom of the finished tube of the same thickness as the walls of the tube; therefore, after cupping, the bottom is thinned down by stamping, and the top edge of the cup is chamfered toward the inside at the same operation.

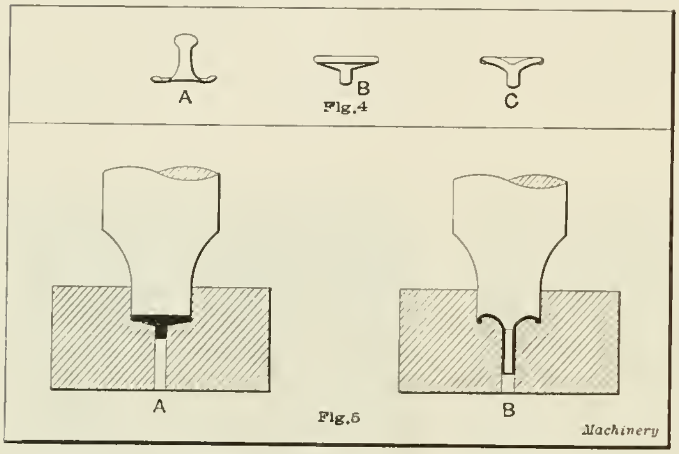


Fig. 4. A, Collar Button; B, Fastener; C, Improved Fastener. Fig. 5. A, Die for Fastener, with Work in Place; B, Die intended to produce a Fastener of Improved Design, showing Piece actually produced

Suppose a shell is wanted with tapering walls, thickest near the bottom, as in the cartridge work illustrated at *P, Q, R,* and *S* in Fig. 11. To produce this effect, as indicated at *K*, the former is made with its sides sharply tapered towards the point, as shown in Fig. 9. Then, when the former enters the die opening, the space around the former is quite large, and the walls of the tube at this point will be correspondingly thick, as shown at *A*. At the end of the stroke, illustrated at *B*, the space around the former is very narrow, because the thick part of the former has entered the hole in the die through which the tube is being extruded. At this point, then, the walls of the tube will be very thin. To be a little more specific, let us assume that we wish to make a shell or tube, six inches in length, the walls of which are to be 1/16 inch thick at the base and 1/64 inch thick at the top. The former is 3/8 inch in diameter at its widest point. As there is a difference of 3/64 inch in the thickness of the walls of the tube, there must be twice this amount of difference in the diameters of the former at its end and base. Therefore, the former for this tube must measure 9/32 inch at the end, to produce the tube shown in Fig. 9.

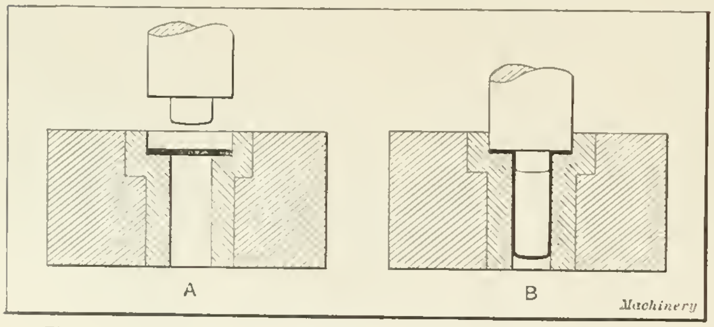


Fig. 6. Lee's Method of Making Tubular Articles, Patented in 1906. A, the Die with Blank in Position; B, the Extruded Shell

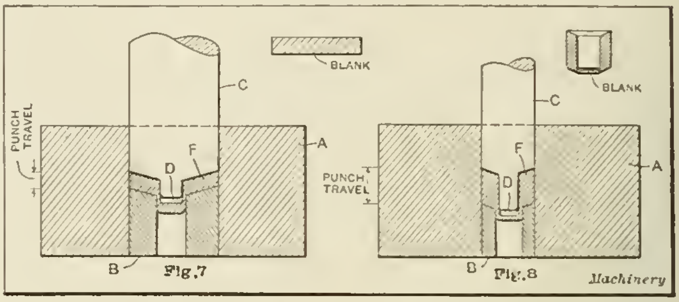


Fig. 7. Extruding from a Flat Blank

Fig. 8. Extruding from a Cup-shaped Blank

Some idea of the speed at which the tubes are extruded from the dies may be obtained by observing the fact that in extruding an 18-inch tube, the punch moves but ½ inch. As most extruding is done without using geared presses, the tube metal moves the 18 inches in a very small fraction of a second, generating a good deal of heat while doing so. The operators of the presses are very careful to keep out of the way of the tubes that are being extruded. Fig. 3 shows one of the smaller extruding presses with the operator feeding the cup-shaped blanks down the slide to the dies.

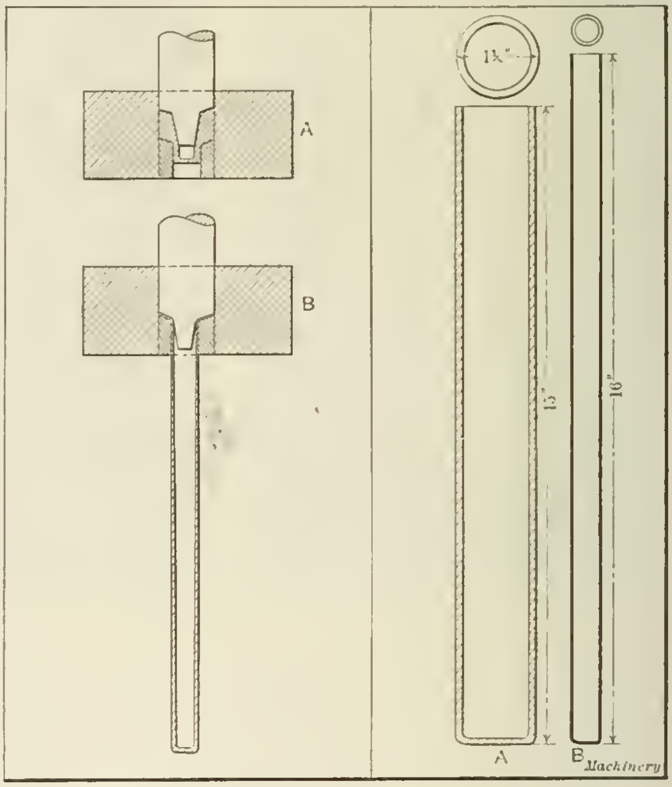


Fig. 9. Making Tubes with Taper Walls

Fig. 10. Comparison of Tube-making Methods

Presses for Extruding

Nearly all types of presses or extrusion machines, as they are commonly called, have been tried—power presses, drop presses, screw presses and even steam hammers. Hydraulic presses have not yet been used to any extent on tubular work, because large sized work has not yet been attempted. Drop presses are not satisfactory on account of the shock of the blow and the consequent shortening of the lives of the dies. The wear and tear on the dies is great, even under the most favorable conditions, so that it is important that everything possible should be done to lighten their work. Screw presses are very powerful, and the shock of the blow is not excessive, but it is difficult to strike exactly the same blow each time, especially with the German type of press using the friction drive; therefore, their use has been given up. Steam hammers, of course, are out of the question for several very apparent reasons.

So far, the most satisfactory style of press seems to be the crank press, of the geared or plain type. There is the danger of springing the shaft, but on the whole this type seems to be as efficient as any. Ferracute presses are used for extruding, and so are Bliss presses. Small tubes may be extruded on Bliss No. 52 presses, and for heavier work the No. 37 Bliss press of the geared type is very satisfactory. These presses have strokes of 1½ inch, which seems to meet all requirements.

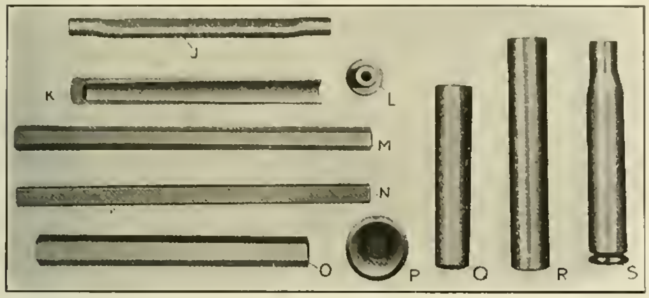


Fig. 11. Miscellaneous Examples of Extruded Work

One of the best presses in use at the Metallic Shell & Tube Co. is a powerful Bliss press that was originally made for a counterfeiter who was getting ready to literally "make money." Through the aid of the manufacturers of the press, the E. W. Bliss Co., of Brooklyn, N. Y., the secret service men put the "money-maker" into the federal prison. The press was sent to the St. Louis Exposition, where it was used in making souvenir medals. Fig. 12 shows this press as it appeared at the exposition, fitted with an automatic feed; with the exception of this feed, the press was purchased by the Metallic Shell & Tube Co., and is in use to-day. From the illustration it will be noted that the press is an ideal one for heavy work on account of its rigid frame and heavy bearings.

Metals Used in Tubular Extrusion

It is almost needless to say that the softer the metal is, the easier it may be extruded. Naturally, then, lead is the easiest metal to extrude, and it is used to a great extent in alloys that contain small percentages of other metals, for making collapsible tubes and similar goods. Pure tin is still more used for the better grade of collapsible tubes. This phase of the extrusion process will be described in a coming number of MACHINERY.

Aluminum comes next in order, and in fact, there is no better metal to extrude, if aluminum will meet the requirements of the work for which the shell is to be used. There is one slight disadvantage in working aluminum—it is impossible to cut and draw thick stock into the proper kind of cup to use as a blank for extruding, which means that another operation will be required. A particularly valuable alloy is one that contains 98 per cent aluminum and 2 per cent zinc. Not only is this a strong alloy, but it can be extruded easily. The best lubricant known in the press-working of aluminum is soapy water.

Pure zinc is a soft metal, but contrary to the general rule, is a poor metal to work in this process. It can be extruded easily enough, for it flows very nicely, but its effect on the former and die is to roughen them in a very short time, and after several hours' work the dies will be unfit for use. Minute particles seem to separate from the zinc and are forced into the surfaces of the dies.

Copper is a very satisfactory metal to extrude. Some of the best examples of extrusion have been produced from copper. The better the grade of the metal, the better it will extrude, although ordinary commercial copper works very well. Lard oil is used as a lubricant. The better mixtures of brass can be extruded fairly well, although not as well as copper. For this reason a metal consisting of 70 per cent copper and 30 per cent zinc is a better metal for this purpose than the "two-and-one" mixture for brass. In short, the more copper in the brass, the better.

Gilding metal, containing mostly copper in its composition, is a good metal to extrude. This metal is used largely by the jewelry trade as a base upon which to gold-plate; hence its name. Pure gold will work well in the extrusion process, but 14-carat gold cannot be extruded at all; it is too tough. The reason for this is not very clear, as copper is used in the 14-carat gold alloy; but the fact remains that gold and the copper, two soft metals in themselves, make a very tough alloy. So far, it has been found impossible to extrude iron or steel, as the dies give out under the extreme pressure required.

The effect of extrusion upon the structure of the metal being worked is beneficial, in that the grain of the metal is toughened and made much stronger. To start with, the metal is soft. After the blanking and cupping process, which operation is shown in Fig. 2, the cups are annealed. When the tubes come through the dies they are as tough and springy as could be desired, and still they are not brittle.

When extruding thin tubes, especially of the softer metals, holes are punched through the bottoms of the cups to let the air into the tubes while they are being extruded; otherwise the air pressure from without would cause a tube with thin walls to collapse, because the interior would be almost a perfect vacuum. Of course, if the bottom of the tube must be kept intact, this method cannot be adopted. The effect of the air pressure is well illustrated by the flattened tube shown at *W*, Fig. 14.

A Modern Extrusion Die

Fig. 15 represents a modern style of die for extruding tubular metal shapes. As will be noticed, the principles are the same as in the original Lee dies, although several details have been changed and a few features added. In this illustration, *A* represents the bed of the press; *B* is a bolster in which the hardened steel bushing *C* is a very hard driving fit. Bolted to the bolster is the die shoe *E* which is shrunk around the die ring *D*. By shrinking the die shoe around the die ring, a very tight fit is assured. Another important reason is that the temper of the high-speed steel die ring can, by being mounted in this way, be drawn just enough to leave the die tough, enabling it to stand the strains incident to its use. The die ring is ground out after hardening and a bushing *F*

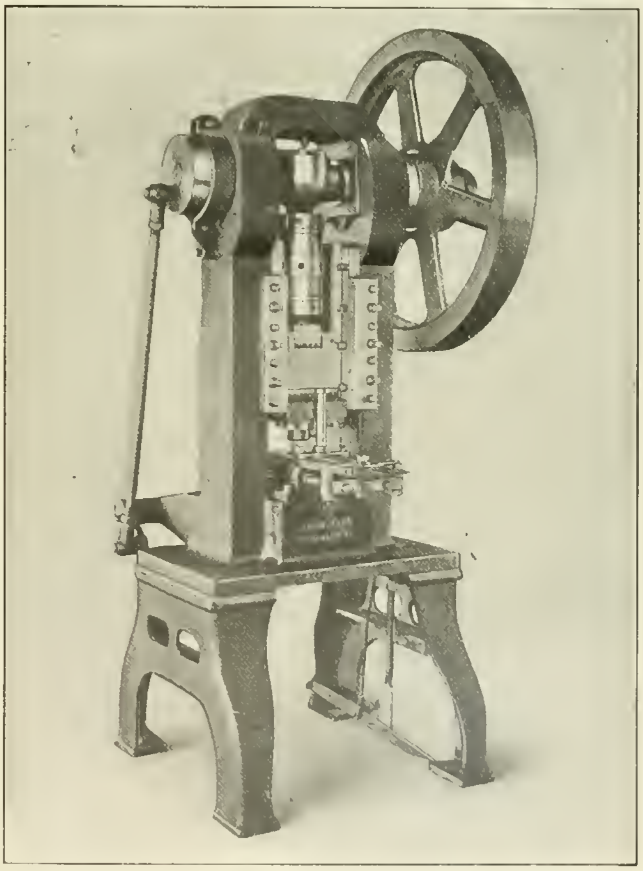
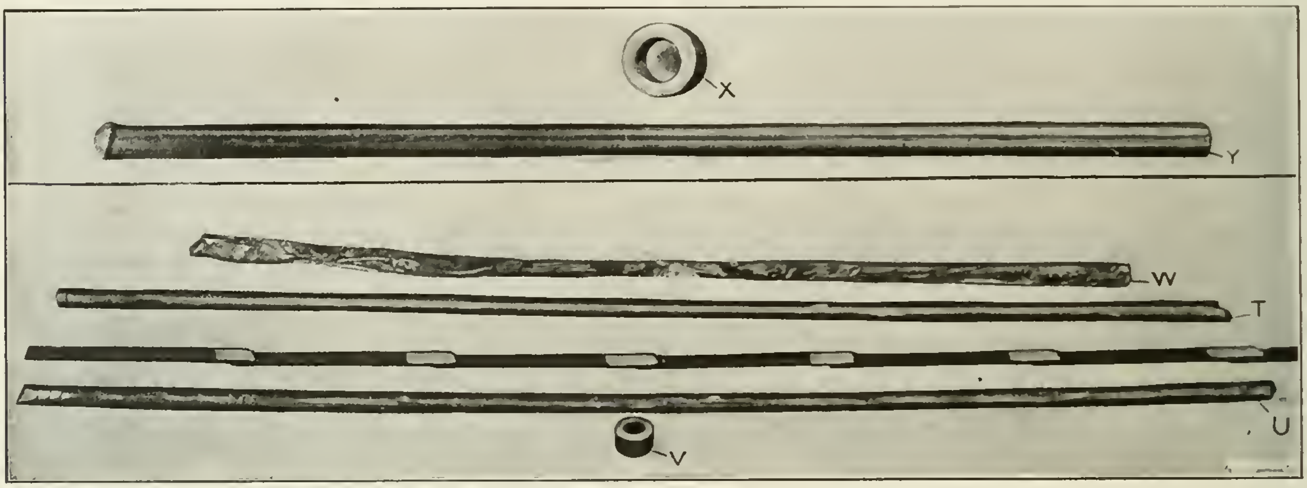


Fig. 12. Bliss Press, made for Coining, but now used for Extruding

is fitted. This bushing is a very important part of the die, for in the old-style dies, when the interior of the die gave out, a new die ring was required. If a bushing now breaks, it merely means that a new one is to be slipped in, without even taking the die from the press. These bushings may be made several at a time and kept in readiness for an emergency. It is very essential that the inclined face of this bushing be polished very smooth, and that the edge of the hole be slightly rounded, so as to help the metal to form itself into the shape of the tube. The size of the hole in this bushing governs the size of the tube, and it must be ground to size and lapped to a smooth finish.

The Punch and Former

Second in importance only to the die, is the punch and former. It is the function of these parts of the tools to force the metal to flow to the hole in the die and to form the inside of the tube or shell being extruded. The punch *G* is really a removable tip to the punch body *I*, being held to it by the taper sleeve or nut *H*. The reason for having the punch in two parts is to make it easier to replace in case of breakage—there are plenty of breakages in extrusion tools. The end of the punch is turned off on a bevel to agree with the face of the die, and this surface must be just as highly polished as that of the die. The outside of the punch must be a close sliding fit in the die ring, for if it is loose there will be danger of its breaking.



Figs. 13 and 14. Lead Tubes for Torpedo Work. Examples of Difficult Extrusion

The former *L* sizes the inside of the tube, and as the metal is constantly slipping past its end, the former *L* is polished very highly, as is also the inclined face of the punch itself. An important feature of the former is its independent movement with relation to the punch. The internal end of the former is threaded into the bushing *J* which is free to slide within the punch body *I*, but is prevented from turning by the screw *K*, engaging a groove in the bushing. When the cup-shaped blank is struck by the punch, former *L* is pushed back to the position shown in Fig. 15. As the metal flows inward, a tremendous pressure is brought to bear on the former in a downward direction, and on the punch in an upward direction. This pressure often breaks the solidly combined punches and formers. In this die, the pressure carries the former and its sliding bushing down into the tube, and by the time the limit of the movement is reached, the extrusion process has had a fair chance to start, and the pressure is consequently diminished.

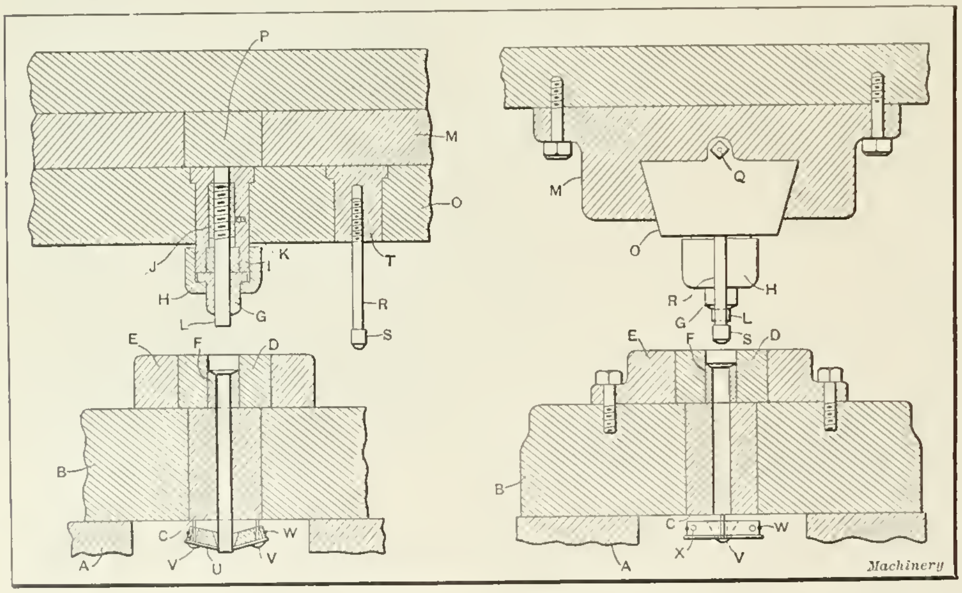


Fig. 15. A Modern Die for Extruding Tubular Shapes

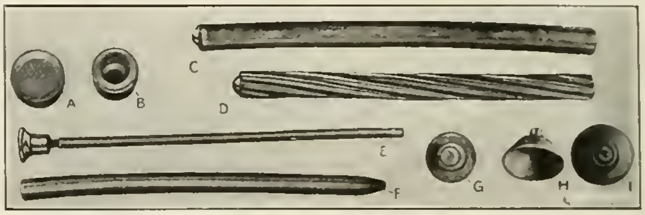


Fig. 16. A, B, C, and D, Steps in Making an Instrument Case by Extrusion; E and F, Extruded Parts for Automatic Pencils; G, Bullet Jacket; H and I, Hat-pin Guards

The Slide and the Stripping Punch

After each extruding operation there is a thin washer-like piece of scrap left in the dies and attached to the tube, for it is impossible to extrude every particle of the metal. The means taken to clear the die of this scrap are interesting. The body of the punch *I* is driven into a slide *O*, which works in the head-block *M*. This block is, in turn, bolted to the ram of the press. The travel of slide *O* is limited by two stops, one of which is shown at *Q*. Into the head-block is driven a block of hardened steel *P*, directly in line with the dies below. When slide *O* is at one end of its travel, the punch is backed up by this block. At the other extreme of the travel of the slide, stripping punch-base *T* comes in line with the die and consequently is also, in its turn, backed up by block *P*. A threaded hole in base *T* receives the stripping punch *R* which at its lower end has a bushing *S*, the diameter of which is midway between that of the hole in the die and that of the inside of the tube. After the tube has been extruded, the slide is moved to its other position, bringing the stripping punch *R* in line with the die. At the next stroke of the press, the stripping punch enters the die, the front end of the bushing severs the tube from the scrap, and on the return, the top edge of the bushing catches the scrap and pulls it out of the die. The slide is then moved back to its original position, and at the next stroke of the press another tube is extruded. Thus it will be seen that every second stroke produces a tube or shell, while the intervening stroke removes the scrap from the die. After the stripping punch becomes filled with these scrap washers, it is unscrewed from the base and cleared of the scrap.

Another improvement on this extruding die is the device beneath the die for preventing the tubes from being pulled up into the die when the stripping punch ascends. This device consists essentially of two semicircular leaves *U*, held together by a spring *W*. These leaves, or gripping jaws, are supported by two pins *V* which allow the jaws to tip slightly downward when pushed from above. Therefore the tubes are permitted to pass downward through the jaws, but the jaws resist any upward pull by gripping the tube and effectually holding it.

After the tubes have been extruded, their forms may be changed by making them square or hexagonal, or they may be straight or spirally fluted. These operations are done by running them through dies, properly shaped, with punches of the same shapes to support the interiors. Round tubes that must be very straight and true are sometimes run through round dies to correct errors. At *M*, *N*, and *O*, Fig. 11, are illustrated tubes of hexagonal and square sections.

Some Examples of Extruded Work

Perhaps the most impressive pieces of tubular extrusion done at the Metallic Shell & Tube Co. factory, are the lead tubes shown at *T* and *U*, Fig. 14. This work really does not require as much skill to produce as the majority of the extruded shapes, but it shows up well. These tubes, which are 36 inches long, are used as containers for the explosive for torpedoes. They are cut to short lengths, and the ends folded over. The blank, after being cupped, appears in front of the tubes. Lead is so easy to extrude that care was not even taken to chamfer the top face of the blank.

A Difficult Piece of Work

For really difficult work in this line, the copper tube *Y* in Fig. 13 is a fine example. It is but ⅜ inch in diameter and is 16 inches long. The walls are less than 0.010 inch thick. Fig. 10 is shown for a comparison of the two methods of making sheet-metal shells with closed ends; *A* represents the shell for a bicycle pump and is about as deep and narrow a shell as can be successfully drawn. To make this shell from copper or brass would require at least twelve operations. Contrasted with this piece of work is the copper tube at *B* which was made in three operations. In fact, it would be impractical to use more than three operations for extruding this tube. It would be impossible to duplicate this tube by ordinary press drawing operations.

Instrument Cases

A very pretty illustration of an extruded product is shown in the aluminum instrument case illustrated at *D* in Fig. 16, together with the successive steps in its making. The first operation consists in blanking the disk *A*. The next operation is to cup this blank by punching the center into a die that also forms the ornamental bead on the end of the tube. Then the blank is extruded to make the tube *C* itself. Finally the tube is trimmed to length and run through the fluting die, which completes the tube, straightening it as well. The fluting die is merely a thin die having spiral grooves in it. The punch, or mandrel, is free to turn as it pushes the tube through the die.

Automatic Pencil Parts

The two parts of an automatic pencil, shown at *E* and *F*, Fig. 16, represent some neat specimens of the extrusion process. The core of the pencil shown at *E*, which has a small hole running through the tube section, was first extruded with the hole clear through the head. Afterwards the piece was put in another die and the head flanged, closing in the end of the hole at the same time. The larger tube *F* was extruded in the usual manner, and the end closed in by another operation.

Bullet Jackets—Hat-pin Guards

At *G*, Fig. 16, is shown a small aluminum bullet jacket which shows the flange of scrap that is left by the dies. In this case, however, the flange is a necessary part of the bullet jacket.

The hat-pin guard, shown at *H* and *I*, is a somewhat unusual piece of extrusion work. The former is made just the size of the hole; the punch is chamfered off to fit the inside of the bell and the die is of the same shape as the under part of the guard. In this case, as with the bullet jacket, there is no scrap and the pieces must be taken from the die either by hand or by an ejector.

Miscellaneous Extruded Work

At *J*, Fig. 11, is shown an electrician's wire coupling used in splicing breaks in a wire. This piece is extruded as a plain round copper tube, and then slightly flattened in the center by a simple press operation. The small bushing at *L* shows that thick walls may be extruded as well as thin ones. At *P*, *Q* and *R* are shown three stages in making a brass cartridge case, as already mentioned. At *S* the end of the shell has been reduced by closing in a press, and the groove has been turned at the base of the cartridge. Cartridge making by the extrusion process will be dealt with more fully in a later article.

* * *

COST AND SIZE OF PANAMA CANAL

The work on the Panama canal is rapidly progressing, and although its cost is now known to be higher than was at first expected, it can hardly be said to be excessive, considering that it opens up an entirely new route which will ultimately affect the shipping conditions of the whole world. The cost of the canal is $350,000,000. It is interesting to compare this expenditure with the capitalization of some of the transcontinental railroads, which are roughly as follows:

Atchison	$580,000,000
Southern Pacific	750,000,000
Northern Pacific	550,000,000
Great Northern	350,000,000
Union Pacific	625,000,000

Hence, it will be seen that the cost of the new canal is only one-eighth of the total capitalization of these roads. It should be remembered, however, that the capitalization of these roads by no means indicates their cost. The capitalization is very much higher than the actual cost, due to the manipulation of railroad stock and bonds by financiers. The comparison is, therefore, not a very accurate one.

The total length of the canal from deep water from the Atlantic side to deep water in the Pacific is practically fifty miles, fifteen miles of which are at sea level. The width of the canal on the level sections and also between the locks, except for the section through the continental divide, is 500 feet at the bottom. The depth on the level portion is 41 feet at mean tide, and the depth of the channel between the locks is 45 feet. Through the lakes traversed, the width of the channel at bottom is not less than 1000 feet for 16 miles, 800 feet for another 4 miles, and 500 feet for about 3 miles. Through the transcontinental divide, a distance of about nine miles, the bottom width of the canal is 300 feet.

* * *

It is a common practice to produce a matt surface on sheet aluminum by dipping in a hot caustic alkali, but instead of a dead-matt surface, one of a mottled appearance often results. A satisfactory solution for producing a matt surface on aluminum is as follows:

Water	1 gallon
Caustic potash of soda	1 pound

This solution is used warm or hot and the aluminum is dipped into it. Hydrogen gas is immediately given off from the surface, and the latter gradually becomes black from the iron left undissolved. After this action has taken place for some time, the aluminum is removed, rinsed in water, and then dipped in the following solution:

Water	1 gallon
Nitric acid	1 gallon

The aluminum is then rinsed in clean water and dried. If the operation is conducted properly, the surface will have a dead and uniform appearance.

The mottled appearance is produced on the surface of the aluminum by not leaving it in the potash or soda solution sufficiently long. The alkali begins to "bite" immediately, and the operator is usually afraid that the surface will be too strongly attacked. However, this is not the case, and the solution should be allowed to act for some time. From three to five minutes is generally required for producing a good matt surface.—*The Brass World.*

DRAWING ROUNDING COVERS IN ONE OPERATION

By M. M.

The accompanying illustrations show a punch and die for drawing rounding covers to the full depth in one operation, without leaving a wrinkle, finishing them four at a time. As is well known, it is a difficult proposition to draw a shell to the shape shown; such a cover cannot be drawn in one operation by the standard double-action method, for the stock would wrinkle and tear, making it necessary to spin out the wrinkles, as the punching would not stamp them out. An additional operation is required to finally stamp them all uniformly.

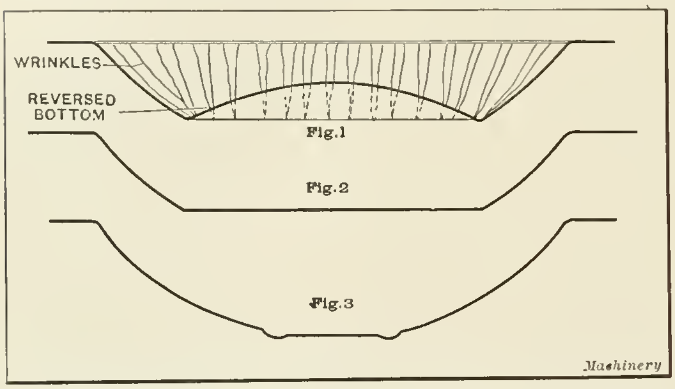


Fig. 1. Cover produced by Old Method of Drawing in One Operation, causing Wrinkles, even with Reversed Bottom. Fig. 2. First Stage in Drawing Cover in One Operation. Fig. 3. Finished Cover

Fig. 1 is a view of the old-style method of making this cover which shows how the bottom has been reversed to stretch the metal and give enough stock for the crown and sides, the latter being very much wrinkled and sometimes "lapping." Considering the fact that these covers are of large size, ranging from 15 to 22 inches in diameter at the edge of the rounding top, and that each time the blanks "lapped" it meant a loss of four, this proved to be a costly method. When they did come through all right, not only did the wrinkles have to be rolled out, but the blanks had to be stamped besides to bead them and reverse the shell.

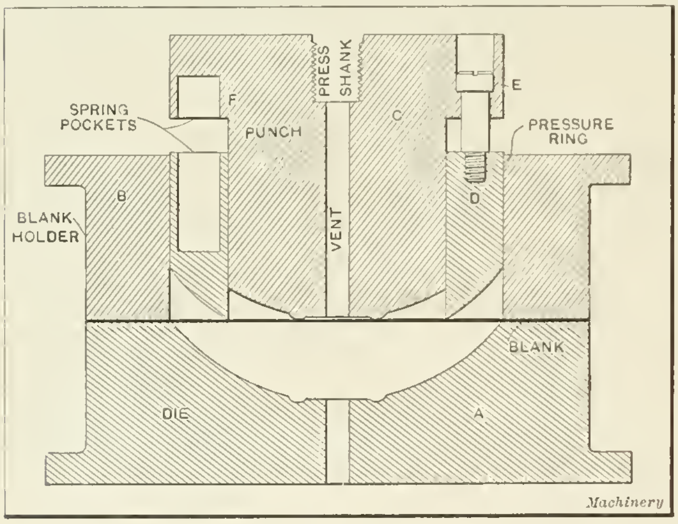


Fig. 4. Cover Blank Gripped by Blank-holder preparatory to the Drawing Operation

To overcome these drawbacks and to eliminate the numerous handlings, the writer designed a triple-acting die for use in a double-action press. This made the complete shell, four at a time, in one operation to the shape indicated in Fig. 3. Fig. 4 is an assembled view of the die, showing all its parts. A blank is shown in position for drawing, being held by the blank-holder and die in regular double-action fashion, with the punch just touching. The die *A* is an ordinary double-action drawing die, made of cast iron, formed to the exact shape of the finished rounding cover, with a vent hole through the center of the bottom through which the ejector works. The drawing faces of both the die and the blank-holder are the exact size of the blank; the blank-holder *B* is of the regulation double-action type, made of cast iron, with an opening through the center to allow the drawing punch to slide through easily. Both the die and the blank-holder are secured to the press by means of a clamping flange. The punch *C*, it will be noted, contains the special feature that made the drawing of the finished shell a possibility. The punch, itself, is made of cast iron and is tapped at its base and thereby secured to the shank of the press. The outside diameter of the punch is just large enough to slide through the blank-holder easily. A shoulder is turned around the body of the punch over which there is a sliding pressure ring *D*, held in position by several shoulder screws *E*, between which are spring pockets containing heavy spiral springs of sufficient strength to draw the shell to the shape indicated in Fig. 2; the punch has corresponding spring pockets. When making the punch, this ring *D* was held back against the shoulder of the punch *C* and both faces were machined while in this position to give the internal form of the rounding cover. The normal position and appearance of the punch and ring are shown in Fig. 4.

The action of the punch and die in drawing the shells is as follows: After the blanks have been placed in position on the top face of the drawing die *A*, the blank-holder *B* attached to the pressure part of the double-action press, descends until it holds the blanks firmly against the die face. The punch pressure ring *D* then comes down, the heavy springs in the pockets being sufficiently strong to perform the first drawing operation which brings the blank to the shape shown in Fig. 2; Fig. 5 shows the punch and die after this operation, when the pressure ring has bottomed in the die, acting as an inner blank-holder while the punch descends still further to form the central part of the blank. The cover finally assumes the shape indicated in Fig. 3, the relative positions of the members of the punch being shown by Fig. 6. Altogether, the action was perfect and no defective shells were produced, the drawing being easy and uniform.

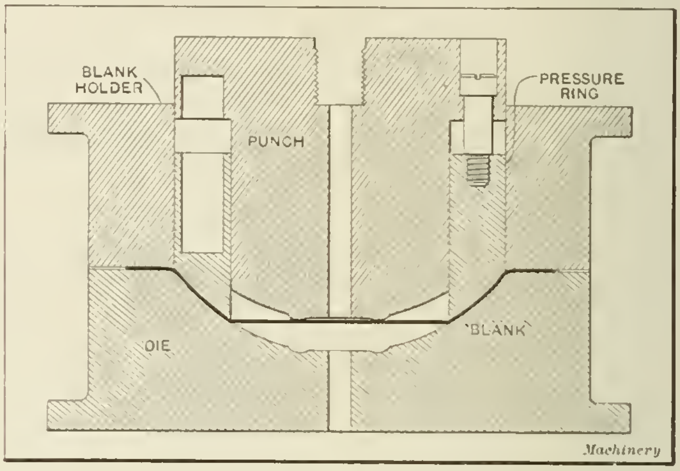


Fig. 5. First Step in the Operation, the Pressure Ring drawing the Blank to the Form shown in Fig. 2

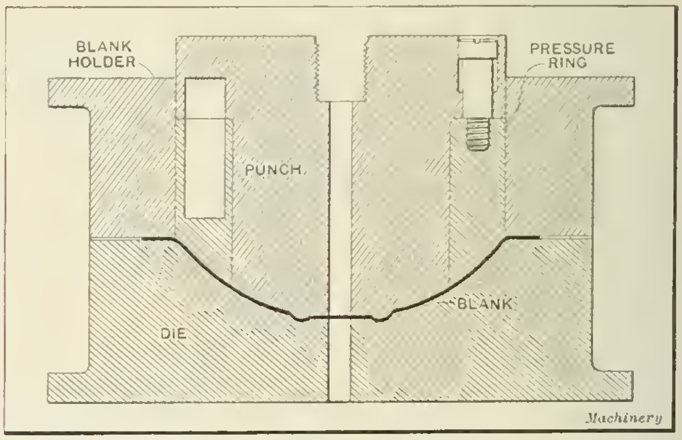


Fig. 6. Final Step in the Operation, the Punch descending within the Pressure Ring to form the Bottom, leaving Blank as shown in Fig. 3

* * *

A reputation for furnishing something good is much better than a reputation for furnishing something cheap.—*Exchange.*

METHODS USED IN MANUFACTURING THE STEPTOE SHAPER[*]

By G. K. ATKINSON[†]

In the June, 1911, number of MACHINERY, several tools and methods used in the manufacture of the shapers built by the John Steptoe Shaper Co., Cincinnati, O., were illustrated and described. In the following article a few more of these tools and methods which are of interest to mechanics in general, will be described.

In Fig. 1 is shown a shaper converted into a surface grinder by removing the clapper box and mounting a heavy slab of cast iron in its place, to which latter an electrical grinder is securely bolted as indicated in the engraving. In the illustration, a vise jaw is shown on the shaper table, the sides being ground parallel. The jaw *A* is held down by the toe-clamps *B*, as indicated, while the top surface is being finished. It is then turned over and the other side is ground. This arrangement provides a very simple substitute for a surface grinder.

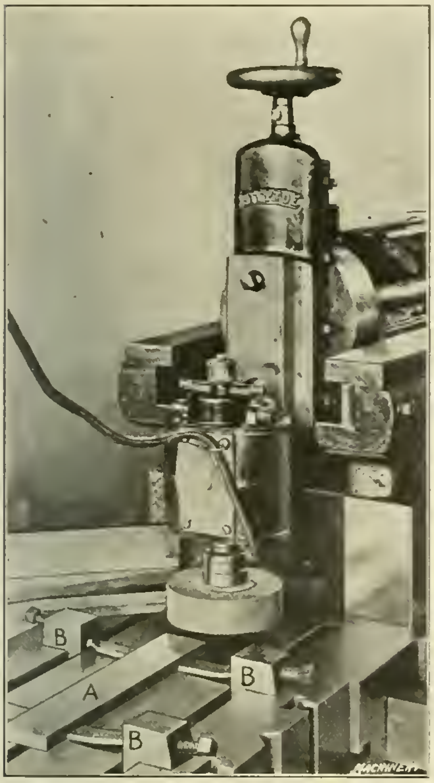


Fig. 1. Shaper converted into a Surface Grinder

In Fig. 2 is shown a keyseating attachment used on the shaper. The cutter bar *A* is hinged at *B* and supported in a guide bushing which is mounted on a pivot bearing in the back of the upright *C* as shown in Fig. 3. On the return stroke, the friction of the bar in bushing *N* causes the clapper block in the tool-head of the shaper to rise, the pivot bearings at *N* permit the bar to swivel, and the hinge at *B* gives it the required freedom to adjust itself. By this arrangement cutter *E* is automatically relieved from the cut on the return stroke. The cutter bar *A* is jointed at *D* and provided with a squared end at *F* for a wrench. On account of being jointed, the cutter bar can be disconnected when chucking or removing the work. The slide *H* is provided with T-slots for holding work which is too large for the chuck. This slide is actuated by the handwheel *I*. The large index collar *J* is graduated to read to 0.001 inch, and is adjustably mounted on the stop-screw *K*.

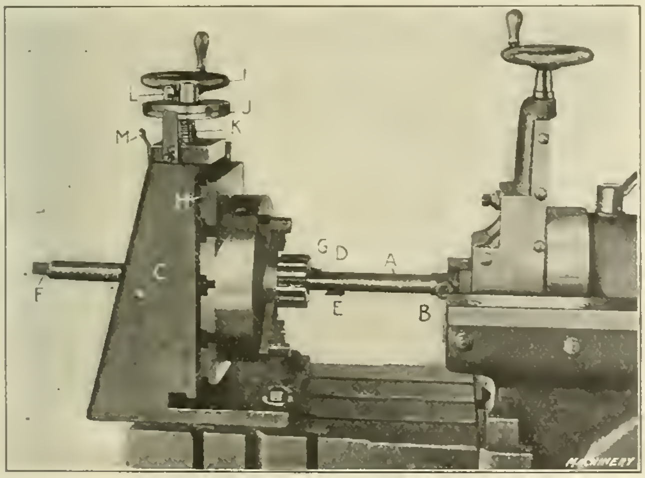


Fig. 2. Keyseating Attachment used on the Shaper

When the device is in use the fixture is bolted to the shaper table as shown, and the cutter bar is placed in a horizontal position by moving the tool-slide on the ram as required. The bar is then disconnected at *D* and the work is chucked as shown at *G*. The cutter bar is then again connected and the ram is run forward until the cutter *E* is just inside the hole. Then slide *H* is raised by turning the handwheel *I* until the cutter comes in contact with the hole. Stop-screw *K* is then run down until it comes in contact with the slide *H*, and the index collar *J* is set at zero. Then the stop-screw *K* is moved up as many thousandths as required for the depth of the keyways, and is fastened by the clamp *M*. The work is then fed towards the cutter by the handwheel *I* until the slide *H* comes in contact with the end of the stop-screw which determines the depth of the keyway.

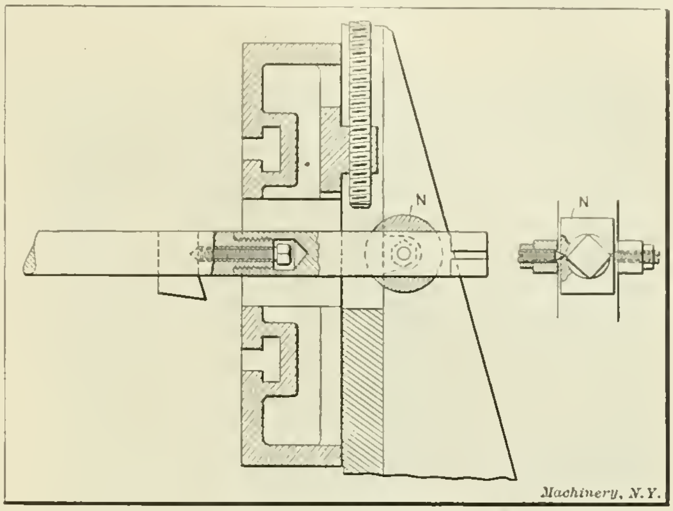


Fig. 3. Detail of Keyseating Attachment shown in Fig. 2

The taper arbors and expanding bushings shown in Fig. 4 are used when turning the bull-wheel bushings. In the illustration, *A* is a cast-iron sleeve which, after being fitted to the lathe spindle, is bored to accurately fit the end *C* of the taper arbor shown. The arbor has a keyway at *C* which engages a key in the sleeve. Bushings *D* are bored one-inch taper per foot to conform to the taper of the arbor, and are then put onto the arbor and turned the proper size to accommodate the different sizes of bull-wheel bushings. After this, they are drilled and split as shown. The end *C* of the arbor is drilled and tapped for a depth of ¾ inch for the draw-in bar *E*, which latter is provided with a handwheel *G* for operating it, and a bushing for centering it in the back end of the lathe spindle.

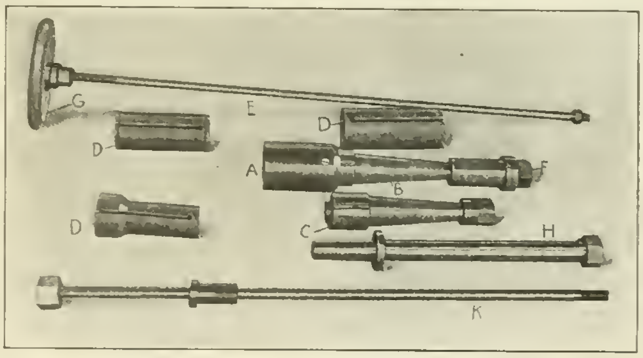


Fig. 4. Taper Arbors and Expansion Bushings

When this arbor is in use, one of the bushings *D* is placed on the arbor *B* and a bull-wheel bushing is placed in position on *D*, and clamped by tightening nut *F*. It is then drawn up snug against the sleeve *A* by turning the handwheel *G*, the outer end *F* being supported by the tailstock center. After the work has been turned, nut *F* is loosened and arbor *B* is drawn into sleeve *A* by the handwheel, thus releasing the work very readily. This arrangement provides for a rigid expanding arbor and one which can be quickly operated.

Gear blanks are first faced on the sides, using a tool-holder with two tools, one on each side. After the blanks are faced in this manner, they are turned to their proper diameter by placing them on the gang mandrel shown at *H* in Fig 4. These mandrels are fitted to the lathe spindle and are held in position by the draw-in bar *K*, being supported at the outer end by the tailstock center the same as arbor *B*.

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[*] See MACHINERY, June, 1911: "Methods Used in Manufacturing the Steptoe Shaper."

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In Fig. 5 are shown two planer tools *A* which are used for various conditions similar to that indicated in the halftone. The shanks of the tools are made of machine steel and the cutters of high-speed steel. Grooves are milled in the sides of the machine, steel shanks and the cutters are fitted into these milled grooves, as shown, and are brazed in place.

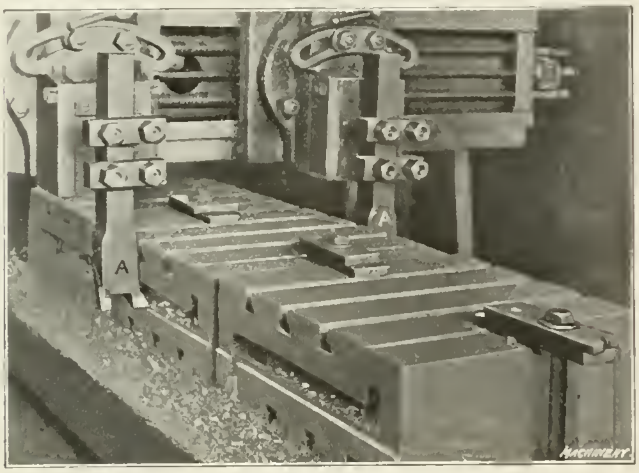


Fig. 5. A Planer Tool for Heavy Duty

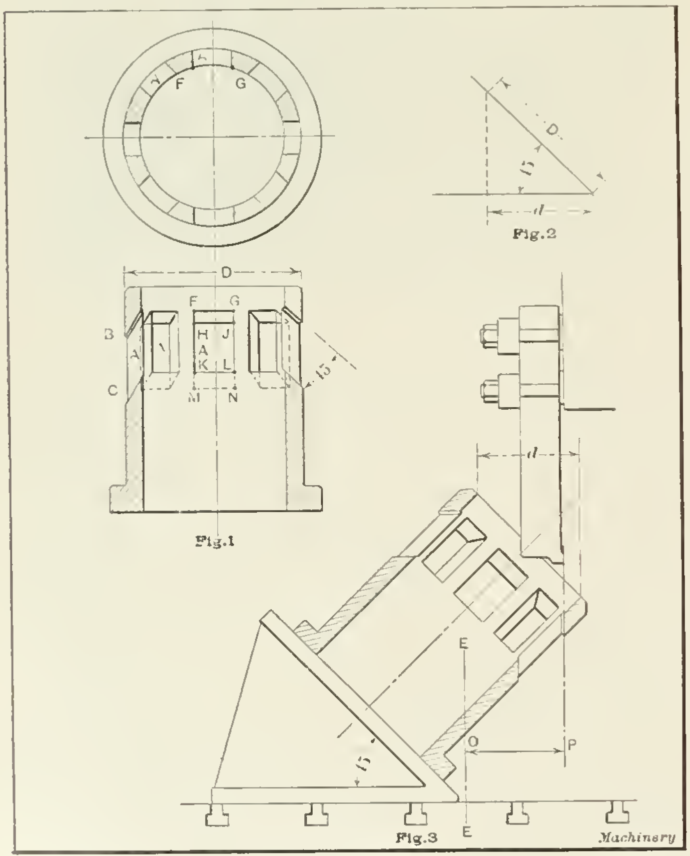
Several other methods are used in this shop which might interest mechanics, but the devices and methods shown constitute the most interesting ones and those which are most likely to be new to the majority of men interested in the manufacture of machine tools.

* * *

AN INTERESTING SLOTTER PROBLEM

By H. A. S. HOWARTH*

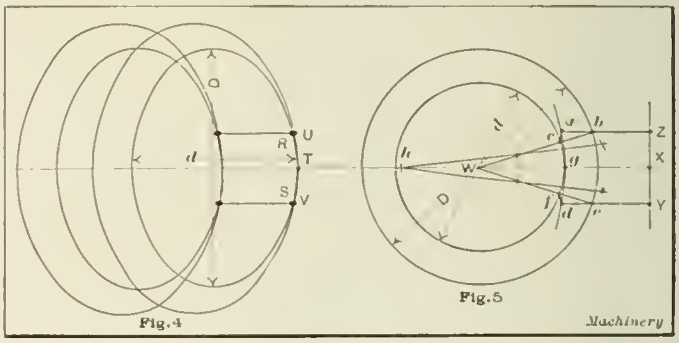
An interesting problem in slotter work recently came to the writer's notice. Some valve cages, as shown in Fig. 1, needed their ports *A* enlarged. This necessitated the machining of the surfaces *B* and *C*. Since these are truly conical, the ideal way to machine them would be to mount the cage on a fixture so that its axis would be at 45 degrees with the vertical, and then set the slotter tool to cut along the vertical element of the surface, rotating the cage, meanwhile, about its own axis. A circular milling attachment mounted on an angle-plate would meet the requirements. It so happened, however, that a fixture for thus rotating the cage was not at hand. Hence, some other method had to be employed.



Figs. 1 to 3. An Interesting Slotter Problem and the Method by which it was solved

Those accustomed to work of this character will see that an approximation of the conical surface can be produced by mounting the cage on a 45-degree angle-plate, and then revolving the angle-plate about a vertical axis *EE* as shown in Fig. 3. The question then arises: How much off the center of the slotter table should the tool be set in order to cut the surface desired? In the case in question this distance was sought by a series of trials, and the resulting surface was not very satisfactory. A simple way to predetermine this offset *OP* is explained below.

Since the tool cuts vertically and the axis of the table is vertical, the surface which will result if the table be revolved will be cylindrical. But when the valve cage is mounted on the angle-plate as in Fig. 3, and one looks down upon it, the port edges *FG*, *HJ*, *KL*, and *MN*, which really lie in circles, are seen to lie on ellipses which are tangent in pairs as indicated in Fig. 4. The curve *RTS* in Fig. 4 corresponds with the port edge *FG* of Fig. 1, and *UTV* corresponds with *HJ*.



Figs. 4 and 5. Methods used for Determining Distance OP, Fig. 3

The inner edge *FG*, Fig. 1, happens, for this cage, to be the most important. Hence the slotter must cut as nearly as possible along the curve *RTS*, which is part of an ellipse. It is evident that the surface cut will not be theoretically correct, but the error cannot be avoided. Curve *RTS* may be approximated by a circular arc whose radius must be determined. The offset *OP* of Fig. 3 equals this radius. The ellipse *RTS* in Fig. 4 has for its major axis the diameter *D* of the cage in Fig. 1. For its minor axis it has the width *d* found as in Fig. 2 by inclining the diameter *D* 45 degrees (the angle of the fixture) with the horizontal, and projecting it.

Now draw two concentric circles as in Fig. 5 with *D* and *d* as diameters. Draw a vertical *ZY* and a horizontal *WX*. Lay off *ZX* and *YX* each equal to half the chordal distance *FG*, which is the port width as found in Fig. 1. Draw the lines *Zba* and *Yed* parallel to *WX*. Connect *bW* and *eW*, thus obtaining *c* and *f*. Draw *ca* and *fd* perpendicular to *WX*, thus obtaining the points of intersection *a* and *d*. The points *a*, *g* and *d*, just found, correspond with *R*, *T* and *S* of Fig. 4. Continuing the construction, find by the usual method the center *h* of a circle that will pass through the points *a*, *g* and *d*. Its radius *hg* is the desired offset *OP* in Fig. 3.

It is now a comparatively easy matter to set up the cage and machine the surface *FGHJ*, Fig. 1, of one port opening. For the next, simply unclamp the cage and rotate it on the angle-plate to bring the next opening into position.

* * *

To show the extent to which autogenous welding has been introduced into Germany, the *Daily Consular and Trade Reports* quotes an authority's estimate that there are upward of 12,000 plants using welding apparatus throughout that country. As a means of furthering this process there is an association at Stuttgart, Verband für Autogene Metallbearbeitung, where courses in the manipulation of welding apparatus are given.

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* Address: Box 174, South Bethlehem, Pa.

MILLING, CROSS-DRILLING AND BURRING ATTACHMENTS—3

APPLICATION TO THE BROWN & SHARPE AUTOMATIC SCREW MACHINES

By DOUGLAS T. HAMILTON[*]

In order to avoid a separate operation in manufacturing parts requiring to be cross-drilled, the Brown & Sharpe Mfg. Co. has designed what is called an "index drilling attachment." This attachment, which is used for drilling cross-holes in studs and capstan-screws, is illustrated in Figs. 16, 17 and 18. In this article reference is also made to Fig. 4, which appeared in the September installment.

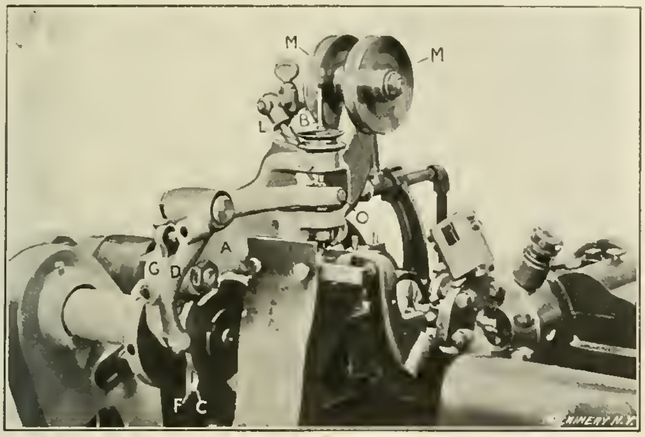

Fig. 16. Front View of the Index Drilling Attachment, placed on a No. 00 B. & S. Automatic Screw Machine

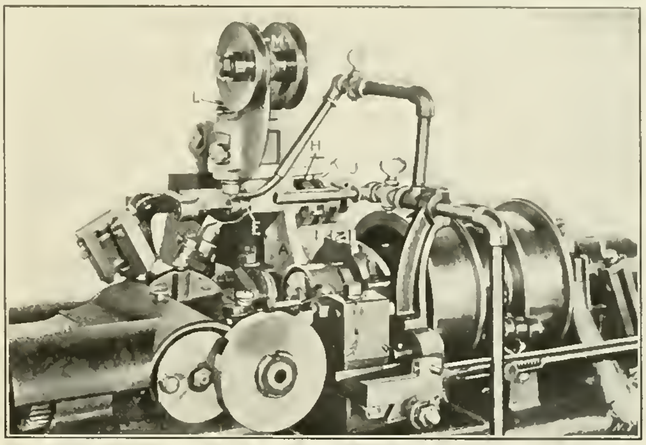

Fig. 17. Rear View of the Index Drilling Attachment in Place on a No. 00 B. & S. Automatic Screw Machine

Index Drilling Attachment

The Brown & Sharpe index drilling attachment, which is shown located on a No. 00 automatic screw machine in Figs. 16 and 17, consists mainly of a cast-iron bracket *A*, fastened by cap-screws to a boss on the machine provided for that purpose. In this bracket are held the work- and drilling-spindles, the latter being held in a vertical position and in line with the work-spindle. The camshaft from which the attachment is operated, is driven by a chain and sprocket, which is shown encased in Fig. 16. A sprocket-wheel for driving the attachment is placed on the front camshaft of the machine, and an idler pulley, fastened to a bracket, gives the chain the desired tension on the sprocket. Figs. 16 and 17 give a general idea of the construction of this index drilling attachment, but for a more detailed description reference should be made to Fig. 18. Similar parts in the three illustrations bear the same reference letters.

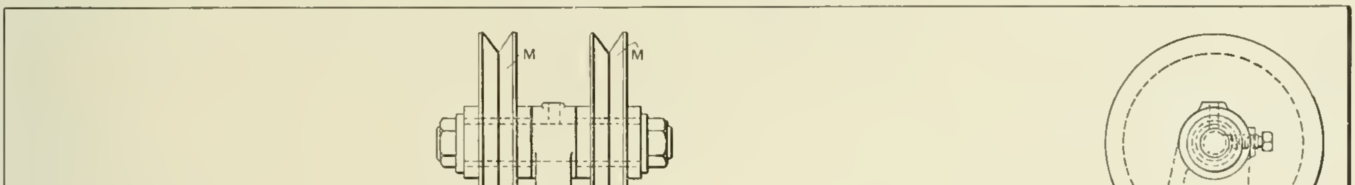

Fig. 18. Assembly View of the Index Drilling Attachment for the No. 00 B. & S. Automatic Screw Machine

The drilling-spindle *B* is driven by a $\frac{3}{8}$-inch round belt from the overhead works through pulleys *L* and *M*, the pulleys *M* acting as idlers, to change the direction of the belt from a vertical to a horizontal position. Spindle *B* is operated by a cam *C* acting through a lever *D*, while the indexing of the work-spindle *E* is accomplished by a cam *F* acting through a lever *G*. The forward end of the lever *G* has teeth cut in it (see Fig. 24) which mesh with the segment gear *H* on the work-spindle *E*, Fig. 18. A ratchet *I*, held to the segment gear by a shoulder screw and nut as shown, and acted upon by a spring, fits in a ratchet disk I_1 (see Fig. 24) which is keyed to the work-spindle *E*. The locking plate *J* has V-notches cut in it, the number of which (usually four) equals the indexings of the spindle required, this plate being used for locking purposes only. A spring plunger *K* fits in the notches in plate *J* and holds it in place until the spindle is again indexed.

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[*] Associate Editor of MACHINERY.

In operation, when the indexing lever *G* is raised by the cam *F*, it depresses the spring plunger *N*, and at the same time rotates the segment gear *H* carrying the ratchet *I*. The spring plunger returns the lever to its normal position when the roll on the lever drops down to the smallest diameter of the cam, and in so doing returns the indexing disk *H* to its normal position ready for the next indexing. The work-spindle is indexed by the ratchet *I* meshing in one of the teeth in the ratchet disk I_1, which is keyed to the work-spindle.

The drilling-spindle *B* is raised and lowered by means of the lever *D*, which is connected to it by two screws *O*, holding two shoes, the latter fitting in milled slots cut in the sleeve *P*. This sleeve is held on the spindle *B* by check-nuts *Q*. The drill-spindle runs in bronze bearings, and is provided at its lower end with three set-screws *R* for holding the drill. The upper end of the drill-spindle fits in a steel bushing *S*, to which it is keyed. The pulley *L* is also keyed to bushing *S*, and as the spindle *B* is provided with a groove, it is possible to rotate the spindle, and at the same time move it up and down by the lever *D*.

Construction of the Index Work-spindle

Fig. 19 shows a sectional view of the index work-spindle, the section being taken on the line X–Y, Fig. 18. The spindle, as has been previously stated, is indexed, but otherwise remains stationary. The chuck *A* is closed by means of the cam *B*, which is fastened by screws to the drum *D*, while the cam *C* operates the lever *M* for opening the chuck. A roller *L*, attached to the lever *M*, and which is guided by the cam-blocks *B* and *C*, operates the lever *M* for closing and opening the chuck.

In operation, as the lever *M* is forced by the cam *C* in the direction indicated by the arrow C_1, it withdraws the clutch sleeve *N* from beneath the fingers *O*, allowing the latter to drop and release their pressure on the sleeve *P*. Now, as the mouth or front end of the sleeve P_1 is beveled to an angle which is greater than the angle of repose, and as the chuck *A* is split and spring-tempered, the withdrawal of the clutch sleeve *N* from beneath the fingers *O* allows the bevel on the chuck to force the sleeve *P* back, thus permitting the chuck to open and the work to be ejected by the plunger *S*. Inversely, as the lever *M* is forced by the cam-block *B* in the direction of the arrow B_1, the clutch sleeve *N* is forced under the fingers *O*, so that their circular bearings or ends rest on the straight cylindrical portion of the sleeve. This action on the fingers *O* causes the sleeve *P* to be pushed forward and butt against the sleeve P_1, forcing it over the tapered portion of the chuck *A*, and thus closing the latter on the work.

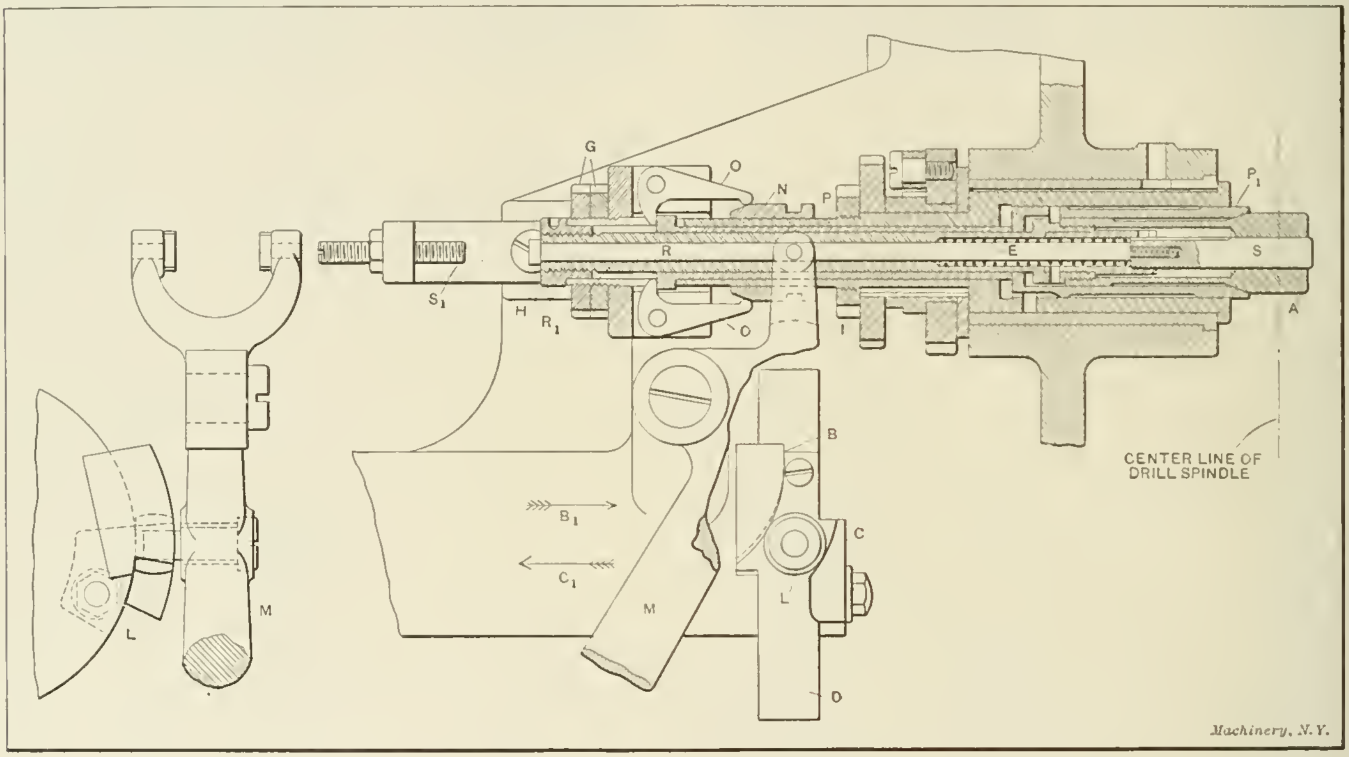

Fig. 19. Sectional View of the Index Drilling Work-spindle

The work, when forced into the chuck *A*, butts against a brass ejector or stop *S* which is screwed onto the rod *R*. This rod passes entirely through the spindle R_1, and is held outward by a coil spring *E*. When the work forces the ejector *S* into the chuck, the head on the rod *R* comes against the stop-screw S_1, which is clamped by the lock-nut shown. The position of the stop-screw governs the distance to which the work can be inserted in the chuck, thus locating the position of the drilled holes. The desired grip of the chuck *A* on the work is obtained by adjusting the check-nuts *G*. The work-spindle can be taken out by removing the nuts *H* and *I* and the lever *M*.

Laying Out Cross-slide Cams for Cross-drilling Operations

The method of laying out a set of cams for a cross-drilling operation is similar to that for any other job, except that there are a number of special points to be considered which relate chiefly to the clearance allowances for the transferring arm in its ascent and descent to and from the work-spindle. Possibly the best way to illustrate the method employed is to take a practical example and describe each step in the calculation. Assume that it is necessary to make the piece shown at *A* in Fig. 20, which is a binding post, made from 9/32-inch brass rod. The turret and cross-slide cams, also shown in this illustration, are laid out in the usual manner, except that sufficient space is allowed, as shown from 86 to 91 (on the cam circumference), for bringing down the transferring arm to grip the work. One hole should be left vacant in the turret, so that the transferring arm can be brought down without coming in contact with any of the turret tools.

Before laying out the lead and cross-slide cams, it is preferable to make a lay-out as shown in Fig. 21, drawing in the position of the circular form and cut-off tools and also the tools used in the turret. If this is done, the amount that the cams are to be cut done below the largest diameter of the cam circumference, and also the clearances necessary for the turret and circular form tools, can be found. After the necessary information has been obtained from this diagram, another diagram, such as in Fig. 4, should be made, so that the rises and the cut-downs on the transferring and advancing cams can be obtained. Of course the example given in Fig. 4 applies more particularly to a screw-slotting job; the method of procedure, however, for laying out the cams used on the index drilling attachment is similar.

Laying Out the Transferring and Advancing Cams

As the method of laying out the transferring and advancing cams has been described in a previous installment (see September number of MACHINERY), it will not be necessary to describe it here. The drawing of the transferring and advancing cams used in connection with the piece shown at *A* in Fig. 20, is shown in Fig. 22. Here the lobes and their uses are clearly indicated. The lay-out of these cams does not differ materially from that for a screw-slotting job except, of course, that the lobes on the advancing cam are made with a dwell, no feeding movement being necessary. To determine the relative heights of the lobes *A* and *B* on the advancing cam, a diagram similar to that shown in Fig. 4 should be drawn, in which the slotting saw should be replaced by the chuck *A* and stop *S*, shown in Fig. 19. The lobe *A*, Fig. 22, should be of sufficient height to force the work into the chuck to the proper distance, and thus locate the stop *S*, Fig. 19, up against the stop-screw S_1.

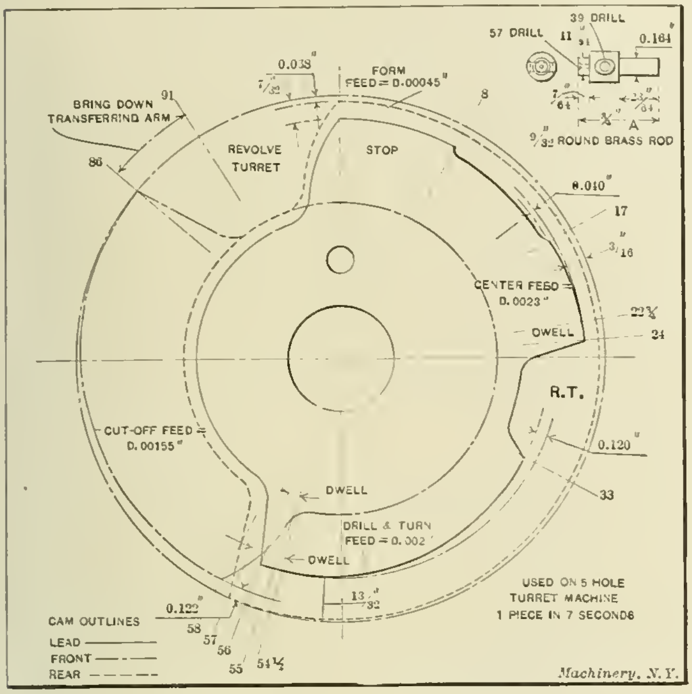

Fig. 20. Lay-out of a Set of Cams for a Cross-drilling Operation on the No. 00 B. & S. Automatic Screw Machine

Laying Out the Indexing and Drilling Cams

In laying out a set of indexing and drilling cams, it is always preferable to start from some predetermined point. The practice usually followed by the writer is to allow 1½ hundredth clearance between the finishing point on the inserting lobe *A* (see Fig. 22) and the starting point *A* on the drilling cam, Fig. 23, and then lay out the corresponding lobes on the drilling and indexing cams from this point. As soon as the advancing roller is on the top of the lobe *A*, Fig. 22, the index drilling chuck should be opened, and closed again before the roll drops off the lobe. About one hundredth of the cam surface should be allowed for clearance, so in this case the chuck should be opened at 4 on the cam circumference. The chuck is opened by the cam *C* on the drum *D*, Fig. 19, in the manner previously described.

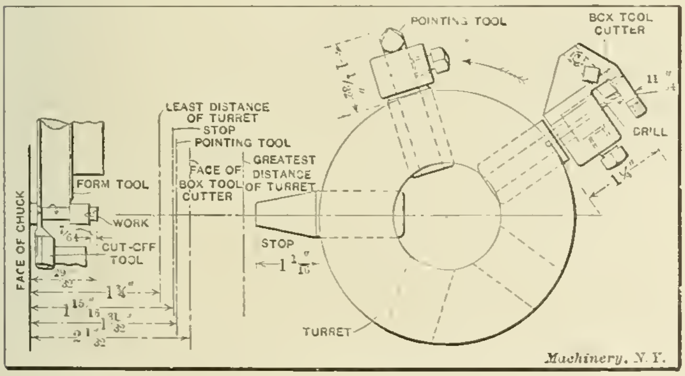

Fig. 21. Diagram for Obtaining the Cut-down on the Lead Cam, and Clearance for Tools

The indexing and drilling cams used for drilling the binding post shown at *A* in Fig. 20 are shown in Fig. 23. Here it can be seen that the drill begins to operate at 5½ and finishes at 52, one one-hundredth being allowed for the drill to make a smooth finish. The order of operations for the lead, cross-slide, advancing, transferring, drilling and indexing cams is given in the following:

Lead and Cross-slide Cams

Order of Operations	Revolutions	Hundredths
Feed stock to stop and chuck	22.40	8
Revolve turret	25.20	9
Center 0.040 inch rise at 0.0023 inch feed, dwell 0.125	19.60	7
Revolve turret	25.20	9
Drill and turn with box-tool 0.120 inch rise at 0.002 inch feed, dwell 0.15	64.40	23
Form with circular tool 0.058 inch rise at 0.00045 inch feed, dwell 0.25	(159.60)	(57)
Clearance	5.60	2
Cut-off 0.122 inch rise at 0.00155 inch feed, and revolve turret	78.40	28
Clearance for transferring arm	14.00	5
Revolve turret	25.20	9
Total	280.00	100

Transferring and Advancing Cams

Order of Operations	Revolutions	Hundredths
Place transferring bushing on work	11.2	4
Drop arm back from work	5.6	2
Lift up transferring arm	20.2	7¼
Clearance	2.8	1
Dwell with transferring arm while placing work in chuck and drilling	187.6	67
Place work in index drilling chuck	21.0	7½
Dwell with arm while closing chuck	11.2	4
Drop back arm	14.0	5
Dwell with arm while drilling	131.6	47
Drop down transferring arm to pick up piece	30.8	11
Clearance	2.8	1
Advance to put bushing on work	11.9	4¼

Drilling and Indexing Cams

Order of Operations	Revolutions	Hundredths
Drill and countersink 0.218 inch rise at 0.0017 inch feed, dwell 0.10	127.4	45½
Lift out drill	9.1	3¼
Push down lever to index	11.2	4
Dwell to allow spring to return lever	4.9	1¾
Index second time	22.4	8
Dwell to allow spring to return lever.	4.9	1¾
Clearance	9.1	3¼
Countersink 0.062 inch rise at 0.0031 inch feed, dwell 0.10	22.4	8
Pull out drill, open chuck, and allow clearance, to drop and raise transferring arm and close chuck	65.8	23½

Referring to Fig. 23, it will be seen that the indexing cam is provided with two projecting lobes *B* and *C*, which are used to force the lever down and thus rotate the indexing disk. These two lobes are necessary because the piece to be drilled has only one cross-hole countersunk on both sides, which necessitates indexing the spindle four times for each piece. Since the indexing and drilling cams rotate at the same speed as the turret and cross-slide cams, the time required for indexing is approximately equal to the time required for feeding the stock, which can be verified by referring to the illustration, the space required being from 61 to 69. Three hundredths of the cam surface is the minimum space which should be allowed, on account of the rolls requiring that space to drop down. A milling cutter at least 1/16 inch larger in diameter than the roll should be used for cutting the cams.

The motion transmitted by the cams to the indexing and drilling levers *G* and *D* is clearly shown by the full and dotted lines in Fig. 24. The maximum travel of the index drilling spindle is equal to the distance *A*, this dimension also being the difference between the largest and smallest diameters of the cam. The distance *A* on the attachments used on the various Brown & Sharpe automatic screw machines is as follows:

No. of Machine	Distance A in Inches
00	9/16
0	3/4
2	1 3/16

The maximum diameters of the indexing and drilling cams for the attachments used on the various machines are as follows:

No. of Machine	Diameter B in Inches
00	4
0	4 1/2
2	4 1/2

The cut-down required on the cam for indexing can be found by laying out a diagram similar to that shown in Fig. 24. When the indexing disk I_1 is provided with six teeth instead of four, the cut-down required will be, of course, proportionately less.

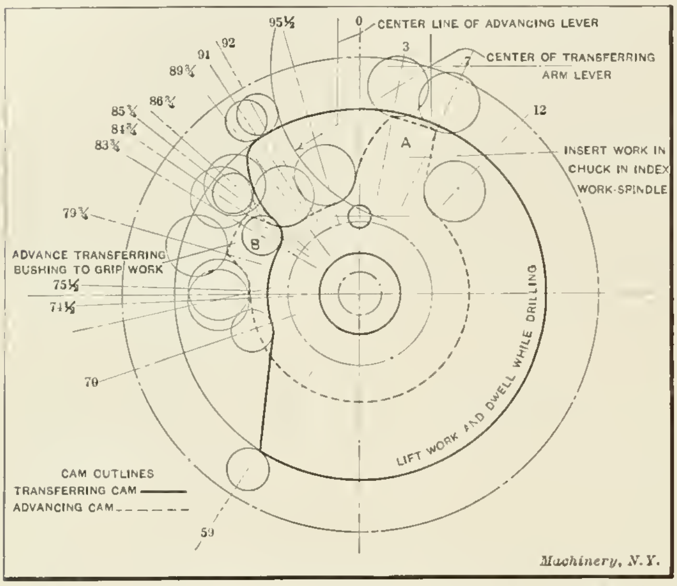
95½
0
CENTER LINE OF ADVANCING LEVER
92
91
3
CENTER OF TRANSFERRING ARM LEVER
7
89¾
86¾
85¾
84¾
83¾
12
A
INSERT WORK IN CHUCK IN INDEX WORK-SPINDLE
79¾
B
ADVANCE TRANSFERRING BUSHING TO GRIP WORK
75½
74½
70
LIFT WORK AND DWELL WHILE DRILLING
CAM OUTLINES
TRANSFERRING CAM
ADVANCING CAM
59
Machinery, N.Y.

Fig. 22. Transferring and Advancing Cams for Lifting and Placing the Work in the Index Drilling Chuck

Speeds and Feeds for Cross-drilling

The speeds and feeds used for cross-drilling do not vary from those used when drilling from the turret, and to obtain the required speed for the drill a grooved pulley of suitable size should be placed on the countershaft. The drilling speeds and feeds for ordinary carbon and high-speed twist drills for drilling different materials were given in the September, 1910, number of Machinery.

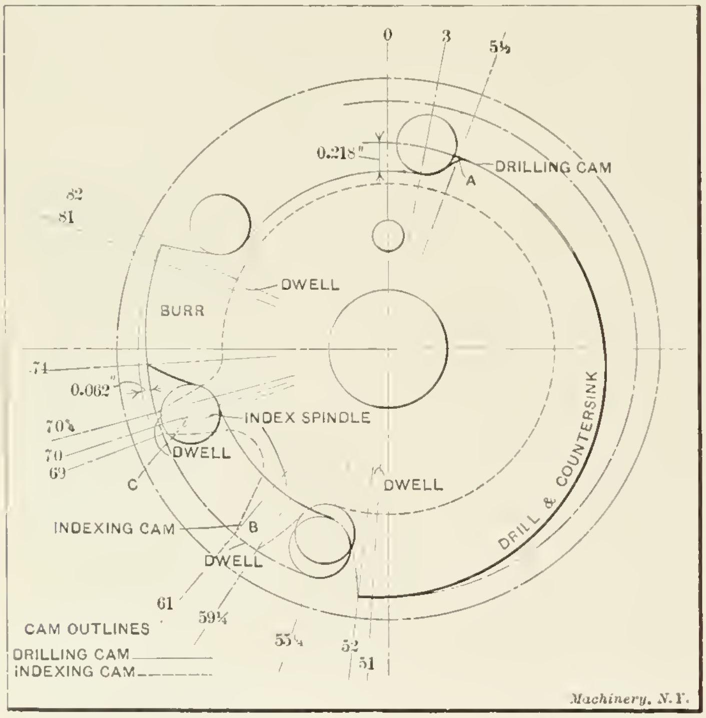

Fig. 23. Indexing and Drilling Cams for the Piece shown at A in Fig. 20

Transferring Bushings

When transferring a piece of work from the work-spindle to the index drilling spindle, it is necessary to have a transferring bushing which will insert the work in the index drilling chuck. The ordinary screw-slotting bushing cannot be used for this purpose, except when the work is sufficiently long and the hole in a suitable place, so that the work can be inserted in the chuck without the aid of a spring plunger. When the work is not of the character specified, it is necessary to use a transferring bushing in which is placed a spring plunger for inserting the work in the index drilling chuck.

At *A* in Fig. 25 is shown a capstan-screw and the transferring bushing used for inserting it in the index drilling chuck. This screw, as shown, has two holes drilled clear through the head at right angles to each other. The transferring bushing consists of a shell *a* which is held in the transferring block. Inserted in this shell is a spring plunger *b*, pressed outward by a coil spring *c*, this coil spring being retained in the bushing by means of the nut *d*. The hole in the spring plunger should be larger in diameter than the body of the screw, so that the work can be inserted easily into the plunger. The type of transferring bushing shown at *A* is suitable for capstan-screws and similar work.

Another transferring bushing for holding a binding post is shown at *B*. This bushing differs from that shown at *A* in that it is provided with a spring chuck as well as with a plunger. The reason for this was that the piece had to be inserted in the chuck to such a distance that it was necessary for the chuck *e* to retreat so that the work could be inserted.

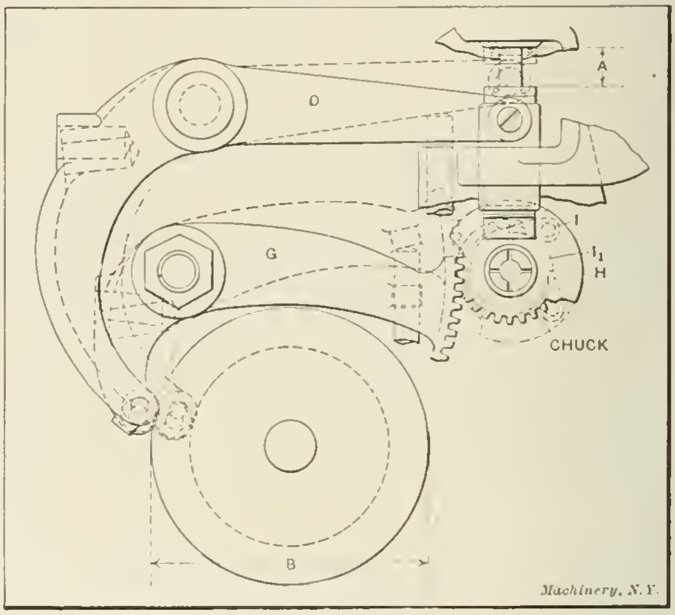

Fig. 24. Diagram illustrating the Movement of the Indexing and Drilling Levers

This transferring bushing was not a success on account of this combination arrangement of spring chuck and plunger. Difficulty was encountered with the spring chuck *e*, because of the variations in the diameter of the stock. When the stock was much greater in diameter than the hole in the chuck, the chuck was forced back into the holder so that the work was not held, as the plunger *f* kept it out.

Owing to the short amount of grip on the work, it had to fit snugly in the bushing, or it would drop out while being transferred from the work chuck to the index drilling chuck. To overcome this difficulty several methods were adopted. First, the spring *g* was made stiffer, so that when work slightly larger than the hole in the chuck was encountered, it could be inserted without pushing back the plunger. This overcame the difficulty of placing the work in the chuck *e*, but when the latter was transferred to the index drilling chuck, the work could not be ejected from the chuck. The spring *h* was made stiffer, but this brought about the same conditions as before, and prevented the work from being located properly in the chuck *e*.

This type of bushing was finally discarded and the one shown at *C* was adopted. This bushing consists of an outer sleeve *k*, as before, in which is screwed a stationary holder *l*. A chuck *m* is made a sliding fit on holder *l*, and also in the sleeve *k*, and is pressed outward by a spring *n*. This spring acts against a washer *o*, which is beveled, as shown, to reduce the friction, thus preventing the spring from being twisted in the holder when work of larger diameter than the chuck is encountered, causing the chuck to rotate. The hole *p* in the holder is made slightly larger than the diameter *Q* on the work, while the hole in the bushing *m* is made slightly larger than the largest diameter of the work. The holder *l* is slabbed on both sides on the front end, as shown in the end view, and the index drilling chuck is cut out so that this holder can be inserted in it, thus carrying the work right into the chuck. This bushing proved very satisfactory, both as regards gripping the work and inserting it in the chuck, and was used on the piece shown at *A* in Fig. 20.

A transferring bushing of a different type is shown at *D*. This bushing, instead of passing over the work, has a plunger *r* which is inserted in a hole in the work. This plunger is slotted, as shown, and a flat spring *s* is held to it by a screw. Spring *s* is curved and rounded so that it fits snugly in the work. The plunger *r* is held out by a coil spring *t*, and is retained by a pin *u*. A small pin *v*, driven into the plunger and fitting in a slot cut in the bushing, prevents the plunger from rotating. As shown in the illustration, this bushing is not tapered on the shank, but is perfectly straight, so, obviously, a special transferring block had to be made to hold it.

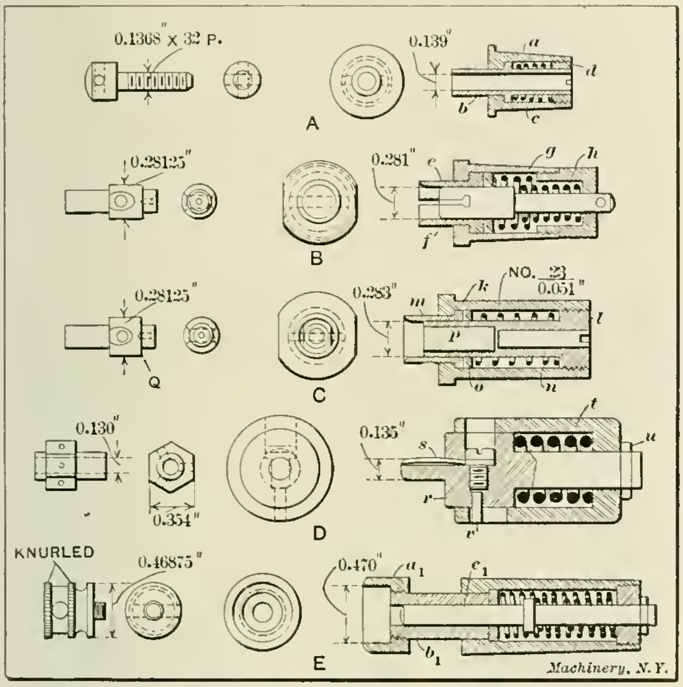

Fig. 25. Representative Types of Transferring Bushings and the Work they were designed to hold

Another type of transferring bushing is shown at *E*. This bushing has a marked resemblance to that shown at *B*, but gives satisfaction because of the character of the work. The hole in the chuck a_1 could be made larger than the diameter of the work, and still the latter would not drop out; thus the difficulty of inserting the work in the chuck is overcome. The hole in the plunger b_1 to which the chuck is attached is made larger than the teat or threaded part on the work. A spring plunger c_1 is used for inserting the work in the index drilling chuck. Obviously, there are a number of different types of transferring bushings used, but as those shown incorporate the principal features of bushings of this type, it would seem that any further descriptions are unnecessary.

* * *

A new "regular" airship service has been announced in Germany. Excursions will be made by the Zeppelin airship *Schwaben*, which will make its headquarters at Baden-Baden. From here trips lasting from one-and-one-half to two hours will be made to different parts of the Black Forest and the Rhine Valley. The fare will be 200 marks ($47.60). The well-appointed cabin of the airship accommodates twenty-four persons, and large observation windows give good views of the country traversed. Cold meals are furnished on board. The *Schwaben* is 475 feet long, has three engines developing 375 horsepower, and its average speed is 33 miles an hour.

THE CORRECT USE OF HARDENING-ROOM TERMS*

There are many terms and expressions in the hardening-room which are loosely used, and in some cases confusion of thought results. Some expressions which are incorrect in themselves have so passed into current use that they must, perhaps, be tolerated and made the best of. For example, when a man says that his tools are "too hard" he almost always means that they are too brittle. Surely the hardness is a good thing, and for most purposes a tool cannot be *too hard*. Even a punch, which under existing circumstances ought to be tempered until it can just "be touched by a file," would be much better if it could be made glass-hard and at the same time so tough that it would not break or chip. As a matter of fact, the punch must be tempered until it loses some of its hardness, not because it is *too hard*, but because it is *too brittle*. It would be better if the brittleness could be removed without impairing the hardness. The loose expression has established itself because the ideas of hardness and brittleness are so intimately associated in men's minds that frequently they can hardly be dissociated. There are times, however, when the expression which is so frequently misused is really required in its correct sense; for example one sometimes uses a lead or copper hammer instead of a steel one, because the steel hammer would be *too hard* and would bruise the work.

Carburet, Carbonate, Carbonize, Carburize

The words "carbonize" and "carburize" are sometimes used interchangeably, but each has its distinct meaning, as also have the words "carburet" and "carbonate."

A dictionary definition of "carburet" is "to combine chemically with carbon" and it is generally applied to gases; for example, carbureted hydrogen, or marsh gas, is a compound of carbon and hydrogen represented by the chemical formula CH_4. "Carbureter" appears in the dictionary as "an apparatus for charging hydrogen, coal gas, or atmospheric air, with carbon by passing it over a liquid hydro-carbon."

The verb "to carbonate" is now obsolete, but once it was in general use meaning "to burn to carbon." In Fraser's Magazine, III, 1831, reference is made to some witches who "were carbonated because they unreasonably resisted drowning in the mill-race." Happily the practice here referred to is even more obsolete than the word used to describe it. The word "carbonated" is largely superseded by "carbonized," which is defined as "converted into mere carbon, reduced to charcoal, or coke." Bone dust and leather scrap are frequently used for casehardening, sometimes in the raw state, sometimes after they have been carbonized.

When mild steel articles are heated in casehardening material they are frequently spoken of as being carbonized, but this is a misuse of the word. It is correct in this case to say the articles are carburized. In casehardening there are two processes, the first consisting of imparting carbon to the surface of articles made of iron or mild steel, so that they acquire a skin of high-carbon steel. This is the process of carburization. Work which has been thus carburized may then be hardened by quenching it in water from a red heat, as if it were made of carbon tool steel.

Hardening and Tempering

Although the mistake is rarely made in the hardening-room itself, it is surprising how often engineers speak of "tempering" when they mean "hardening." The process of hardening consists of raising the steel to a proper red heat, and then cooling it rapidly by quenching in water, or by other means. The tempering is a further process of heating the steel to a much lower temperature than for hardening, and the effect is to toughen the steel, and also, unfortunately, to soften it somewhat. The first process is sometimes erroneously called tempering, and more frequently this word is applied in general terms to the two processes together, but it is clearly wrong to do this. The distinction is made not simply by a purist in the use of correct language, but because the processes are so distinct that it is very frequently necessary to distinguish between them.

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* Abstract of an article by Shipley N. Brayshaw in the *Engineering Magazine*, September, 1911.

SPINNING KETTLEDRUM SHELLS*

A pair of kettledrums is considered indispensable to a first-class orchestra; sound effects can be produced with them that are unattainable with other instruments, and the kettledrummer is one of the highly skilled musicians, although his antics in a difficult composition sometimes cause more amusement than admiration.

The kettledrum is an instrument consisting of a hemispherical copper shell with a skin stretched over the open end to form the head, and is usually mounted on a tripod base. The shell is made from one piece of copper, which in years gone by was beaten into the required hemispherical shape with hammers. The cost of a pair of drums made in this way was high, amounting to $400 or $500. Thanks to improved methods of forming the shells, the cost has been greatly reduced, a pair now being worth about $75, which is an amount easily within the reach of almost any good orchestra.

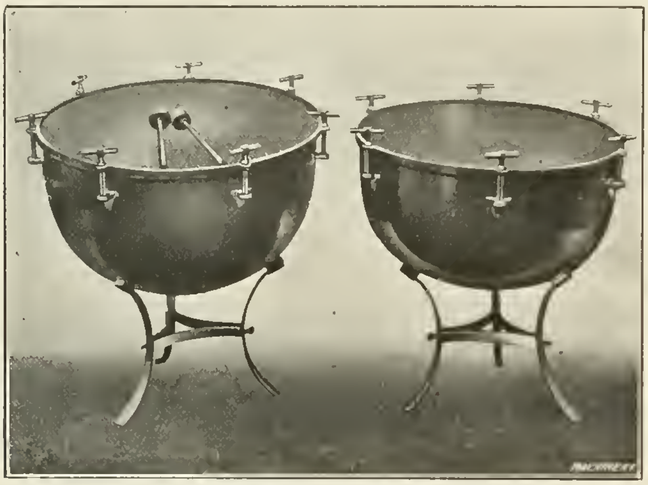

Fig. 1. Pair of Kettledrums with Spun Copper Shells

The illustration Fig. 1 shows a pair of kettledrums with spun copper shells made by Mr. John J. Pole of Geneva, N. Y. Mr. Pole has developed an effective and interesting metal spinning practice in his efforts to make these instruments. He is an amateur in the sense that he never served an apprenticeship in any mechanical trade, and his success is more remarkable because of certain physical infirmities in youth that prevented him from acquiring an education. He was born in England and came to America about twenty-five years ago. Being fond of music he became interested in musical instruments of all kinds, and was for several years a piano dealer in Geneva.

Fig. 2. Pole's Metal Spinning Shop

The need of a pair of kettledrums for an orchestra composed of musical friends led to his efforts to make them. His first pair was made with wooden shells; these were useful, but their chief value was in proving certain theories he had formed as to the possibility of making successful drums from other materials than beaten metal, and further experiments convinced him of the possibility of making the shell from spun copper. He knew nothing of metal spinning and could find out little about it by visiting nearby shops, but with the information that could be obtained and his own ideas he built a lathe and started to spin shells from flat copper plates. The first attempts were rather costly failures, but success finally crowned his efforts.

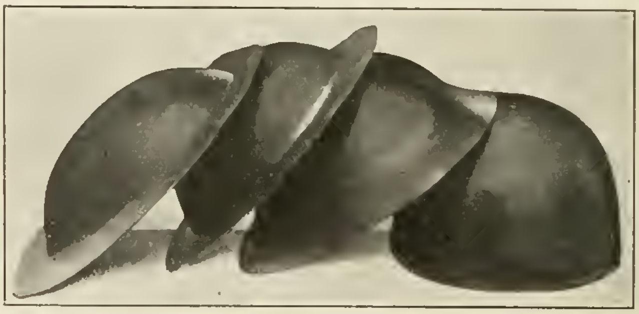

Fig. 3. Showing Steps in Process of Spinning Kettledrum Shell

Fig. 2 shows the little spinning shop that Mr. Pole has built back of his home on Sharon St., and beside it at the left is his annealing furnace. This is provided with gas burners and simple appliances for annealing the shells, all of home-made construction.

The shells are spun in the lathe, which was made by Mr. Pole as were also the chucks and tools. Fig. 4 shows the wood chuck, mounted ready for use, in which the shape is started, the flat plate being forced into the shallow recess with wooden levers supported on the curved rest. The rest is provided with a row of holes in which pins are placed to act as fulcrums. The headstock is of cast iron, but the frame and legs are made of hard wood solidly bolted together. Power is furnished by a gasoline engine. Fig. 3 shows the progression of the process of spinning a kettledrum shell, the first piece at the left being the shape produced in the wood chucks, while a finished shell is shown at the right.

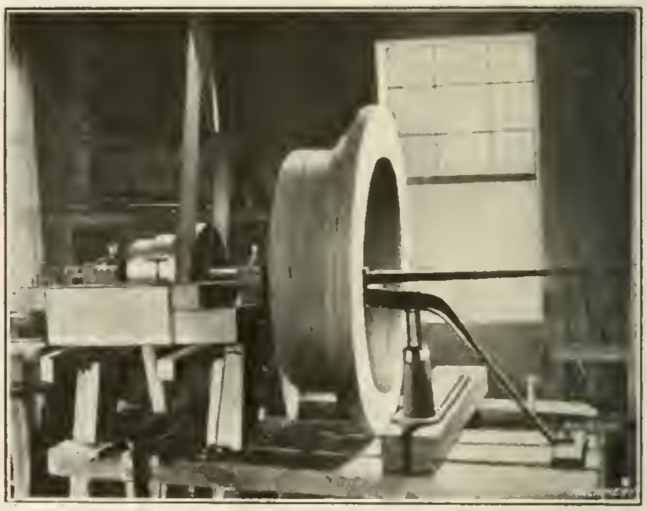

Fig. 4. Spinning Lathe with Large Wooden Chuck on Spindle

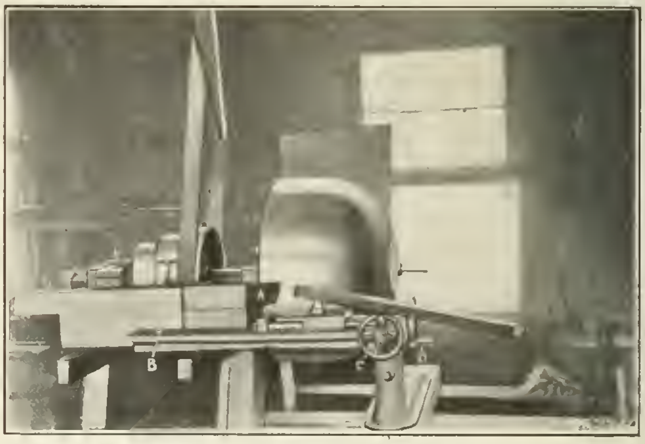

Fig. 5. Spinning Lathe with Metal Chuck on Spindle ready for Forming a Shell

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* For further information on metal spinning, see MACHINERY, June, 1911, "Gold and Silver Spinning," and articles there referred to; also Reference Book No. 57, "Metal Spinning."

The most difficult part of the process is rolling over the outer part of the plate, which forms the upper part of the shell, without producing wrinkles. The thin metal tends to buckle under the pressure of the tools and will do so unless firmly supported by a rest interposed between the shell and the chuck. The second step in the spinning process is performed on the same lathe, using hollow cast-iron chucks of the form shown in Fig. 5. This view also shows the compound iron rest and the wooden piece *A* with tapered end that supports the inside of the shell as it is being laid over against the chuck by the tool. The iron rest is pivoted at *B* and is provided with a handwheel *C* that is used to force the tool against the work. Another handwheel *D*, at the end, adjusts the rest longitudinally with the shell, and provides means of placing the fulcrum at the exact spot wanted. Wood levers are employed chiefly for rolling over the shell, but steel bars with shaped ends are also used for finishing.

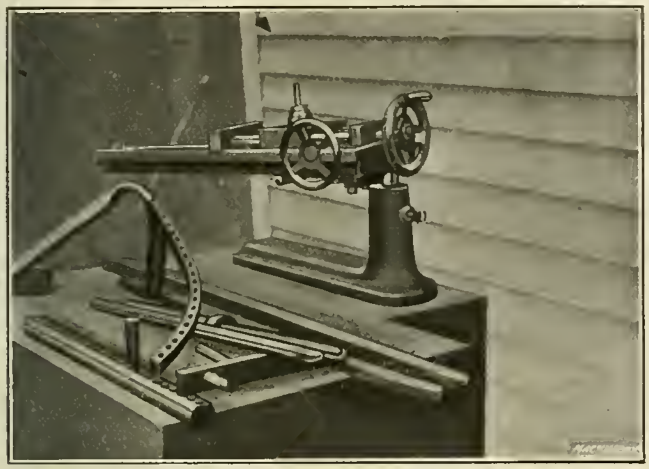

Fig. 6. The Rests and Principal Tools used for Spinning Shells

The adjustable wooden support or rest *A* is an important part of the equipment. It slides in a channel or box beside the headstock and is frictionally held by a screw whose handle shows in front of the second step of the cone pulley in Fig. 5. Very little pressure suffices to hold the rest when the metal is soft, but as it grows harder with working, more friction is required and the operator tightens the screw as the spinning proceeds. In spinning light work, the common practice is to hold a stick behind the metal back of the tool, but the frictionally held rest is far superior. Since Mr. Pole devised this rest he has never had a piece break on the edge and he has found that the metal can be worked fully twice as much without annealing, as it can without the firm back-rest.

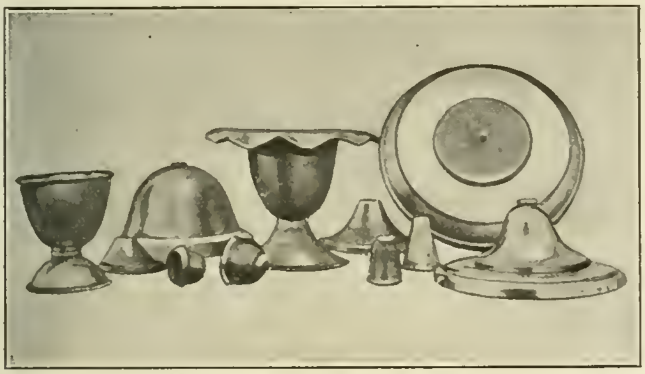

Fig. 7. Samples of Spun Art Work

As the shell is formed against the iron chuck the end of the wooden support *A* is gradually forced back out of the way, but all the time the metal is held between it and the end of the tool. In this manner, the metal is forced to compress without buckling and to lie smoothly on the chuck. So perfectly does it embrace the chuck body that it makes an airtight fit, and it is necessary to work the tools so as to let the air escape before finally closing down the shell, as the imprisoned air would distort the shape and cause trouble. The collection of tools and rests shown in Fig. 6 comprises practically all the appliances employed in forming the shells in the lathe, excepting the back-rest *A*. The edge of the shell is rolled over inwardly after the completion of the spinning process, to stiffen it and form a bearing for the calfskin head, this being another and distinct operation.

Mr. Pole has worked up a considerable business in the manufacture and sale of his kettledrums; he also does spinning work to order. Samples of some of the shapes produced are shown in Fig. 7. F. E. R.

* * *

SYSTEMS OF DIMENSIONING DRAWINGS

By I. E. HALL*

A comparison of a number of working drawings used in various shops throughout the country reveals the fact that all drawings are not dimensioned by the same system; the systems used may be divided into four classes: *viz.*, the metric system, the decimal system, a system with all fractions expressed as common, and a system combining both common and decimal fractions. Users of these various systems claim merit for the one of their own choosing, but a careful study of the situation seems to point out that the fourth system is the best all-around one for working drawings.

The first-named—that is, the metric system—possesses the advantages peculiar to the entire metric system of measurements, and is especially valuable when drawings are to be sent to foreign countries. Its disadvantages, though, are more numerous; for instance, all raw stock such as bar metal, lumber, wire, screws, piping, hardware, etc., are sold with sizes designated by the English system. The use of the metric system, of course, involves the continual calculation of equivalents in inches, which naturally is a fertile field for mistakes. Another strong objection to the common use of the metric system is the fact that the greater number of mechanics' measuring tools, such as scales, rules, calipers, gages, etc., are marked in inches, and there again much figuring is left for the workman to do—a proceeding which is always admitted to be bad practice.

That there could be any serious objection to a straight decimal system of dimensioning drawings might seem rather odd to the novice, but such an objection does exist in the fact that no distinction is made by the figures—that is, there is nothing to distinguish between the dimensions which must be followed to one-thousandth inch, and those whose exactitude is not of much importance, and where a rigid adherence to the decimal figure is a waste of time. A striking example of this point was brought to the writer's attention on one occasion during the manufacture of a number of brass disks for a carbureter. The drawings in question showed a number of disks, some 1/8 inch and some 5/32 inch thick. For the proper working of the carbureter, the 5/32-inch disks were required to be within one-thousandth inch of the dimensions given on the drawing, while the 1/8-inch disks could have varied 1/32 inch without causing trouble. As the workman who made these parts was not familiar with the assembled product, he turned both sizes of disks to 0.125 inch and 0.15625 inch, respectively. Of course, no harm was done, but the time spent in carefully turning the 1/8-inch disks to exactly 0.125 inch was in a sense wasted and when the time was multiplied several thousand times the total was considerable. Strictly speaking, 1/8 inch is merely another way of writing 0.125 inch, but in common shop practice it is different, as sizes called for in common fractions are laid out with the ordinary machinist's scale, which is cheaper and quicker than working to the micrometer, when extreme accuracy is not required.

The third system, that of using common fractions entirely, is used exclusively in trades where it is almost impossible to work closer than 1/64 inch, such as wood-working, leather work, masonry, etc., and if decimal fractions were given it would be obviously impractical to have them followed any closer than could be read on the ordinary scale. With the exception of the trades mentioned, or similar ones, the evidence seems to be in favor of the mixed system, as being the most economical and providing fewer chances for error than any of the other methods, which fact seems to be well supported by its wide use throughout the machine shops of this country.

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NOVEMBER, 1911

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MACHINERY is published in four editions. The practical work of the shop is thoroughly covered in the Shop Edition, $1.00 a year, which comprises approximately 700 reading pages. The Engineering Edition—$2.00 a year, coated paper, $2.50—contains all the matter in the Shop Edition, about 300 pages a year of additional matter and forty-eight 6 x 9 Data Sheets filled with condensed data on machine design, engineering practice and shop work. The Foreign Edition, $3.00 a year, comprises the same matter as the Engineering. The Railway Edition, $2.00 a year, is a special edition including a variety of matter for railway shop work—same size as Engineering and same number of Data Sheets.

THE EXTRUSION PROCESS

Some of the most interesting developments of metal shaping during the past few years have been in press working and extrusion. The distinction between the two processes is defined by the difference in action of the metal worked with reference to the punch, or plunger, and the die. In press work the metal is extended or compressed while confined on both sides by the punch and die, and its shape is defined by the dimensions of the manipulative parts. In the extrusion process the flow of metal once started in conformity with the shape of the punch and die continues outside of their confines to a distance limited only by the quantity of material in the blank and the power of the press. The metal is squirted like so much wax, and can be made to have any required cross-sectional shape.

The article on extrusion in the October number, engineering edition, and the one on the subject in this number, treat of two distinct developments. The first had to do principally with the extrusion of soft metals or metals made soft by heat into solid bars of various cross-sectional shapes. Heavy powerful hydraulic presses capable of exerting many tons pressure are required for extruding brass or bronze shapes. The second article treats of the cold extrusion of copper, tin, zinc, aluminum and their alloys, by ordinary crank presses. While extrusion of special shapes by the hot process is of great interest and value, the ingenuity and wide field of application of the second process easily gives it the first place in general interest. Like so many other valuable processes the first hint of its possibility seems to have resulted from an accident, and again like so many other developments a great deal of time and money have been required to perfect it.

* * *

UNPROTECTED POWER TRANSMISSION CHAINS

A machine designer worthy of the name will carefully provide oiling facilities for every bearing, and if the machine is exposed to flying dust he will provide guards to exclude the dust from the bearings. In view of the care generally displayed to provide safeguards for ordinary bearings, the recklessness with which machinery power transmission chain is exposed to the elements is hard to understand. It is one of the anomalies of machine construction that should disappear.

A machinery transmission chain consists essentially of a series of journals and bearings. These bearings work through an arc of limited extent, usually under high unit pressures, every time they pass over the sprockets. They require lubrication, and are injuriously affected by dirt the same as any other bearing. Why then should the transmission chains of auto-trucks be allowed to run without a case or any protection whatsoever from the mud and dust of the streets? The practice is indefensible and should be abolished. An uncovered chain is noisy and soon becomes inefficient because of wear.

A well-known manufacturer of machinery chain published the results of a test made on two chains, one working in a case in an oil bath and the other under ordinary conditions. The encased chain ran 6000 miles under heavy load and the elongation in 90 inches was only about 1/16 inch, or less than 0.001 at each link. The other chain elongated 1 inch after driving 3000 miles. While the unprotected chain was still in fair shape, it was not as efficient as when new, the links having worn out of pitch. A chain deteriorates more rapidly after it has worn appreciably out of pitch than before because of the tendency to mount the sprocket teeth. An unprotected chain is an offense against all the moral precepts of machine design.

* * *

ADVANTAGES OF HERRINGBONE GEARS

A valuable characteristic of helical gears working on parallel shafts is the absence of sliding action, the larger part of the load being transmitted by the tooth surface at or near the straight line joining the centers where the action of mating teeth is an almost pure rolling contact. They differ from spur gears in this respect: the latter have a mixed tooth action, beginning with sliding contact at the moment of engagement, changing to rolling contact at and near the line joining the centers, and ending with sliding contact when they pass out of engagement.

Spur tooth action wears the teeth most on the addendum and dedendum parts, tending to leave a hump on the pitch circle sections. The same action takes place with helical gears, but the rounding off of the flanks and faces serves to relieve them and thus reduce the friction of approach and retreat. When thus relieved, the pitch circle sections carry the load with a minimum of sliding action and friction. Hence while spur gear teeth tend to wear out of shape and become noisy, helical teeth wear into better shape when properly proportioned, and become more efficient.

A drawback to the helical gear is the end-thrust resulting from the angularity of the teeth. The end-thrust can be balanced by using a gear of the opposite pitch on the same shaft, when the end-thrust of the right-hand gear balances that of the left-hand gear. This combination, called the "herringbone" gear, is well known, being much used for heavy power transmission, especially in rolling mill machinery.

The herringbone gear, as commonly made, costs about twice as much as an equivalent spur gear and is somewhat difficult to assemble so that each gear will carry half the load. These drawbacks have overshadowed its advantages for ordinary uses, and as a result its use is almost unknown in the general run of machinery. But the advent of the hobbing process of cutting helical gears, which for the Wuest design enables integral herringbone gears to be cut very cheaply, has made them available on the score of cost wherever spur gears are commonly used. Their advantages are such that machine designers cannot afford to longer neglect them.

Take for example planetary gearing. The planetary train can be designed to give almost an infinite velocity ratio in a very small compass and with a few gears, but the frictional losses are so great with spur gears that it has been used only for hoisting and other mechanisms in which efficiency is a consideration of lesser importance than self-locking or large velocity ratio characteristics. We believe that with herringbone gears and annular ball bearings the planetary gear can be used advantageously in place of worm-gearing, being practically as compact for a velocity ratio of 10 to 1 or more, noiseless and more efficient. The working parts of the herringbone planetary gear under heavy load are in rolling contact, whereas in the worm-gear they are in sliding contact, which means loss of power, heating and destructive wear. Let us try out the planetary gear under new conditions and find out its possibilities.

* * *

SAFETY RULES AND DEVICES

In the following pages will be found a number of articles and rules for safety of life and limb in machine shops. We need make no apology for giving up such an amount of space to this important subject. Americans have been reckless and prodigal in the development of their national resources and likewise reckless and prodigal in the sacrifice of lives and limbs. The time has come to conserve not only our natural resources, but human life as well. Aside from sentiment, we all must recognize the great economic waste that grows out of injuries in manufacturing.

The subject of safety is so broad that we must look for specialization in the various lines of engineering. We can formulate certain basic rules for safety provisions, but the conditions must vary so widely between the mine and the machine shop that the expert, competent to provide for the former, would be incompetent to provide for the latter, and *vice versa*. We have, therefore, in the articles referred to, confined the subject mainly to machine shops and immediate surroundings.

In considering the general subject of safeguarding, we are impressed with the belief that it should be a part of general education to learn to avoid dangerous situations. The apprentice should be taught that all moving machinery is dangerous. While he must acquire familiarity with it and be ready to do his work in situations that perhaps would be dangerous to the amateur, he must not feel contempt for the elements of danger. His attitude toward a moving machine should be much the same as toward an open flame, steam pipes or electric wires. He can use the fire, the steam, or the electricity safely when properly directed, but when wrongly directed it is likely to do him bodily harm. Another thought is that he should be taught that it is discreditable to get hurt, and doubly discreditable to hurt someone else. To neglect reporting dangerous conditions makes the persons having knowledge of them morally responsible.

* * *

THE PNEUMATIC TIRE

The invention of the pneumatic tire by Dunlop effected the greatest improvement in road vehicles since the advent of springs. The bicycle was not a popular machine until it was provided with pneumatic tires, these converting it from a "boneshaker" to a comfortable vehicle that old and young could ride with pleasure. The pneumatic tire is one of the chief factors in the success of the motorcycle and automobile, but unfortunately is their most serious weakness.

No invention is more greatly needed to-day than a puncture-proof pneumatic tire that will be resilient as well as reliable. Numerous pneumatic tires have been made puncture-proof, or practically so, but only at the expense of resiliency. The high speeds at which the motor cars are driven make highly resilient tires absolutely essential, and the history of spring wheels and cushion tires does not seem to indicate that any acceptable substitute for the air cushion will be found. The millionth patent recently granted by the United States to an Ohio inventor was for a puncture-proof tire, but unfortunately it belongs to a class of tire inventions which have been much exploited but very unprofitable to users.

The Westinghouse air cylinders may be a practical solution of the problem, the pneumatic cushion being transferred from the wheel to cylinders which take the place of the usual leaf spring. A weakness of this form is that the wheels are fitted with solid rubber tires which are practically unyielding and must, therefore, surmount every obstacle in the road. The efficiency of the pneumatic tire is partially due to the fact that its surface is yielding. Small obstacles are thus embraced, and not surmounted, as must be the case with all solid tires.

THE PREVENTION OF INDUSTRIAL ACCIDENTS*

In the Bulletin of the Bureau of Labor, No. 78, for September, 1908, Frederick L. Hoffman, writing on industrial accidents, says: "Upon a conservative estimate, the total mortality from accidents in the United States among adult male wage earners is between 30,000 and 35,000, of which it should not be impossible to save about one-third and, perhaps, one-half, by intelligent and rational methods of factory inspection, legislation and control. In addition there were approximately not much less than two million non-fatal accidents, that not only involve a vast amount of human suffering and sorrow, but materially curtail the normal longevity among those exposed to the often needless risk of industrial casualties."

We do not have in the United States complete records showing the probable percentage of accidents which could be avoided if proper measures were taken, but we can make a fair estimate by comparison with other countries where accident statistics are available, and also by quoting such statistics as have been compiled in this country by individuals whose work has been devoted to the prevention of accidents in industrial plants. In Germany, where excellent precautions for preventing industrial accidents are taken, about fifty-eight per cent of the accidents are due to negligence of employer or employe, while forty-two per cent may be regarded as the inevitable risks of employment. In other words, more than one-half of all accidents could probably even there be avoided if both employer and employe would use the utmost care and vigilance.

In the United States in one plant where the yearly average was 200 accidents, the result of greater attention given to preventive measures reduced the number of accidents during the past year to sixty-four, and of these accidents only thirty-eight were of a character to be considered as wholly non-preventable or accidental in the most literal sense of the word. Compared with the previous yearly average of 200 accidents, this would indicate that in the average American shop only about twenty per cent of the accidents belong in the non-preventable class, while possibly about eighty per cent and certainly at least seventy per cent could be eliminated if greater attention were paid to safeguarding the machinery, instructing the employes, and in other ways removing the possibilities of accidents. The estimate above is based on actual results obtained in one plant in the United States as stated by Mr. John Calder in a paper read before the American Society of Mechanical Engineers, February 14, 1911.

That there is a crying need for paying more attention to this subject, and that more concentrated efforts for the prevention of accidents should be made, is, therefore, beyond question. Aside from the humanitarian aspect of the matter, the financial loss alone due to accidents is so great as to warrant the most complete precautions for their prevention.

Causes of Accidents

Mr. Calder, in the paper previously referred to, attributes industrial accidents to the following principal causes: Ignorance, carelessness, unsuitable clothing, inefficient lighting, dirty and obstructed work places, defects of machinery and structures, and the absence of safeguards. To these may be added lack of good air—this on account of the stupifying effect of impure air on the mind. Until recently little regard has been paid to the causes underlying accidents, except to the absence of safeguards, but any well-considered action for the prevention of accidents must be based solely on a study of the causes. A complete review of the causes of accidents, as enumerated in Mr. Calder's paper, was given in the March, 1911, number of MACHINERY, engineering edition.

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* The following information relating to this and kindred subjects has previously been published in MACHINERY: "American Museum of Safety Granted a Charter," June, 1911; "Industrial Safety Association," April, 1911, engineering edition; "The Mechanical Engineer and Prevention of Accidents," March, 1911, engineering edition; "Industrial Accidents and Employers' Liability," December, 1910, engineering edition; "The Cost of Accidents in the Industries," September, 1910, engineering edition; "Don'ts for the Prevention of Accidents in the Machine Shop," July, 1910; "When to Safeguard Machinery," February, 1910, engineering edition; "Practical Safeguards in the National Cash Register Company's Plant," January, 1910, engineering edition; "Progress in Safeguarding Machinery," November, 1909; "Safety Device for Electric Cranes," July, 1909; "Accident Prevention at the Plants of the United States Steel Corporation," February, 1909, engineering edition; "Prevention of Accidents in the Foundry," November, 1908; "Safety Device for Buzz-planers," November, 1908; "Liability to Accident at Different Ages," July, 1908; "Exposition of Safety Devices," May, 1908; "Liability of Employers," December, 1907, engineering edition; "Safeguard in Machinery," December, 1907; "Liability of Employers," November, 1907, engineering edition; "Visit to the Exposition of Safety Appliances," March, 1907; "An Exposition of Safety Devices," October, 1906.

It is often assumed that with advancing age the liability to accidents increases. According to a compilation by Sir John Brunner, first published in the London *Times*, and covering an investigation extending over fifteen years, this assumption is erroneous. The percentage of accidents per year to men between eighteen and twenty-five years of age is almost four times as great as that to men of fifty-six years or more, and there is an almost regular decline in the percentage of accidents with advancing age, from eighteen to fifty-six years.

The liability to accidents has also some relation to sex. Women are more liable to such accidents as are caused by their clothing and their hair being caught in machinery. Incidentally it may be mentioned that the danger of women's hair being caught in machinery can be effectively safeguarded against by the wearing of close-fitting caps completely covering the hair.

Prevention of Accidents and its Relation to Machine Design

The relation of the design of machinery to the prevention of accidents is of especial interest to the readers of MACHINERY. We have on several occasions in the past made editorial comment on this subject. Safety of operation should be placed on a par with mechanical efficiency, and all the required safeguards should be provided on the machines at the time when they are designed and constructed. It is very difficult to provide effective safety devices on machinery that has not been originally designed for them. The designers can cheaply and effectively provide guards in the original design of the machine. These guards can be so designed that they will not only constitute a valuable selling point, but will add to the pleasing appearance of the machine as well. On a machine built without safeguards, it is sometimes almost impossible to provide effective guards for gearing and other dangerous moving parts, because of lack of clearance, whereas in the original design suitable guards could have been provided without appreciable cost, and without perceptible change in the design.

As pointed out in an editorial in the November, 1909, number of MACHINERY, purchasers of machine tools can materially accelerate the movement for the safeguarding of industrial workers by insisting on efficient guards on all new machines. The negligible additional cost of machines provided with efficient guards is made up for many times by the greater freedom from accidents with the consequent decrease of liability on the part of the employer, and the elimination of compensation payments or law-suits.

A very important point in the designing of safeguards is to make them of such a character that there will be no temptation on the part of the workman to remove the guards, and leave them off permanently. The guards must not be cumbersome in any way, they must not make the operation of the machine any more difficult, and they must not reduce production. This last requirement is one in which both employer and employe are equally interested. The former will have a tendency to begrudge the introduction of safety appliances, if he suspects that they interfere with rapid production. The worker, again, if he be a piece-worker, is as anxious to turn out a good day's work as the manufacturer, and if he is hampered in this, he will discard the safeguard at the first opportunity. The designer must, therefore, make a careful inquiry into the conditions under which an employe has to work, so that he can devise safety appliances which enable the worker to proceed with the same efficiency with or without the safeguard.

Compensation in Cases of Accident

Closely allied with the subject of the prevention of accidents is that of the payment of compensation to the victims of industrial casualties. This is a matter that is still handled in a very unsatisfactory manner in the United States. In most of the industrial countries in Europe, the question of compensation in cases of accidents is taken care of by definite laws, which are working to satisfaction. It is generally believed that such laws involve undue expense to the employer, but the experience of Great Britain seems to disprove this theory. In the October 28, 1910, number of the *Practical Engineer*, London, it was stated that the average annual expense per capita in the metal trades in England for efficient system of insurance against accident, has been estimated at about one-half cent per day. It is also stated that a satisfactory feature of the working of the laws in Great Britain has been to increase the number of compensation disputes settled out of court, thus saving the expense of litigation and avoiding delay.

It is evident that it is the industry as a whole and not the individual employer that will bear the expense, but it is necessary in any well-ordered community to have what might be called an "automatically" working law of compensation, providing for those who are injured in the performance of their duty. In this connection it is of interest to again quote the opinion stated by Mr. W. B. Dickson, first vice-president of the United States Steel Corporation, to which we referred in the December, 1910, number of MACHINERY. In a paper read before the American Iron and Steel Institute, Mr. Dickson said: "Personally, I believe that compensation to injured workmen is a legitimate charge against the cost of manufacture, and that the victim of an industrial accident, or his dependents, should receive compensation, not as an act of grace on the part of his employer, but as a right."

The figure of one-half cent per day per employe would, of course, be somewhat higher in the United States owing to the generally higher level of prices and the consequent higher rate of compensation required; but on the same basis as the British liability laws, one cent per day per employe should usually cover the employer's expense for the required insurance. Figures compiled in this country by the Fidelity & Casualty Co., of New York, covering the years from 1893 to 1900, at a time when much less attention was paid to the safeguarding of industrial workers than is now done, indicate that for one-hundred dollars of wages paid, the average loss due to employer's liability was about 36 cents. This would average somewhat less than one cent per day per employe.

These are then the two main questions that confront the industries to-day with regard to the safety of the worker—the prevention of accidents, as far as it is possible, and a fair system of compensation to be paid to the victims of such industrial accidents as cannot be avoided.

That the importance of these two questions is fully appreciated by the employers in the United States at this time is well evidenced by a resolution adopted on the strength of an inquiry among several thousand employers of the United States. Mr. Ferdinand C. Schwedtman, in a paper presented to the National Machine Tool Builders' Association at Atlantic City, New Jersey, in May, 1911, quoted a resolution adopted at the annual meeting of the National Association of Manufacturers, as follows:

> "Be it resolved, that the present system of determining employers' liability is unsatisfactory, wasteful, slow in operation, and antagonistic to harmonious relations between employers and wage-workers; that an equitable, mutually contributory indemnity system, automatically providing relief for victims of industrial accidents and their dependents, is required to reduce waste, litigation and friction, and to meet the demands of an enlightened nation.
>
> "Be it further resolved, that prevention of accidents is of even greater importance than equitable compensation to injured workers."

This resolution conveys the attitude of probably ninety-nine out of one hundred employers.

History of the Movement for the Prevention of Accidents in the United States

Up to about five years ago the efforts for the prevention of accidents were unorganized and spasmodic. The safeguarding of machinery was looked upon as a kind of philanthropy rather than as a duty. It is significant that it was chiefly in cases where property as well as persons were liable to injury that preventive measures against accident were generally and effectively undertaken. The absence of safety devices has been almost entirely due to lack of interest on the part of the employer. Men in secondary positions of authority have often refrained from exercising all possible precautions for safety for the reason that these involve additional expense of which the management might not approve, or at least because they realized that they would get no credit from the men higher up for taking precautions. This condition is now slowly changing. It is desirable that foremen and sub-foremen should be encouraged to see that all precautions for the safety of the employes are taken. In most industrial plants the enforcement of the rules relating to safeguarding will be part of the duties of these men.

The first organized effort in this country might be said to have been made by the American Society of Social Service, which held, from January 28 to February 9, 1907, an exposition of safety devices for protecting the lives of workmen and of devices pertaining to industrial hygiene, care of health, and safety of the general public. This exposition was the first of its kind in the United States, although as far back as 1889, similar expositions were held in Germany and in the next following years in Vienna, Amsterdam and other European cities. The leading spirit in the new undertaking was Dr. William H. Tolman. In 1908 a second exposition was held from May 13 until June 1. At this time many exhibits of special interest to machine tool builders were shown, in particular some selections of large photographs from the Brown & Sharpe Mfg. Co., and from the various plants of the Niles-Bement-Pond Co., showing installations for safeguarding the workmen in these establishments, as well as machines built by these companies provided with proper guards over gearing, emery wheels, etc.

During the past year the organized efforts have been still further increased. An association organized under the name of the Industrial Safety Association has been formed, which is closely associated with the body known by the name of the American Museum of Safety, which latter has been granted a special charter of incorporation by the legislature of the state of New York. Of this association Dr. F. R. Hutton is the president. A detailed statement of the objects of the association and its plans of work was given in the April, 1911, number of MACHINERY, engineering edition.

Another indication of the attention that is being paid to this important subject is that the accident insurance companies are taking active steps to collect and distribute such information relating to the practical prevention of accidents as is available. At least two of the leading insurance companies have published important additions to the literature relating to the prevention of accidents.[*]

MACHINERY has taken an active part in the work for the prevention of industrial accidents since the very inception of the movement. A great number of editorials and other articles have been published urging manufacturers and machine designers to give proper attention to this important subject, and we believe that the wide publicity thus given to the organized efforts made has materially aided the advance of the movement. The editor of MACHINERY, Mr. Fred E. Rogers, has been a member of the committee of the American Museum of Safety from the beginning, and is one of the charter members of the incorporated association. In order to further extend the useful work that MACHINERY has been doing along the lines of the prevention of accidents to industrial workers, a study of the means for the prevention of accidents in the machine shop has been undertaken and contributions on this subject have been requested from engineers and mechanics in this country and abroad. The most important contributions on the subject are published in the following pages, where many valuable hints for the workers themselves as well as for those responsible for the safe working of factories or other industrial undertakings will be found. Many of the recommendations that are made can be adopted without very great expense, and in some cases where local conditions may be such that the expense would be considerable, it will be found that proper safeguarding will pay for itself in the long run. Should it be found, in older installations, that some of the methods recommended are too expensive for adoption, it should at least be remembered that whenever new machinery is built or additions to the plant considered, the new construction should be provided with the proper safeguards.

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[*] "Safeguards for the Prevention of Industrial Accidents," published by the Aetna Life Insurance Company, Hartford, Conn., price $0.50; and "The Prevention of Industrial Accidents," published by The Fidelity and Casualty Company of New York, price $0.25.

SAFETY DEVICES AS APPLIED TO MACHINE TOOLS[*]

By CLARENCE BOLTON[†]

In the following article a number of simple guards and safety devices which can be applied to machine tools without incurring any great expense are illustrated. Most of these require but little description, and are intended merely to aid the designer by giving him an idea of the type of guard or device to be used. Obviously, the suggestions given may not apply directly to any specific case, but the principle involved can easily be adapted to the different requirements in individual shops. Figs. 1 to 5 shows types of covers ordinarily applied to gearing. In general, the shape of the cover takes, as nearly as possible, the form of the outline of the gear. The method of supporting the cover will depend entirely on the circumstances. In Fig. 2, for example, the cover for the three gears shown is supported by the stud of the idler gear, as indicated.

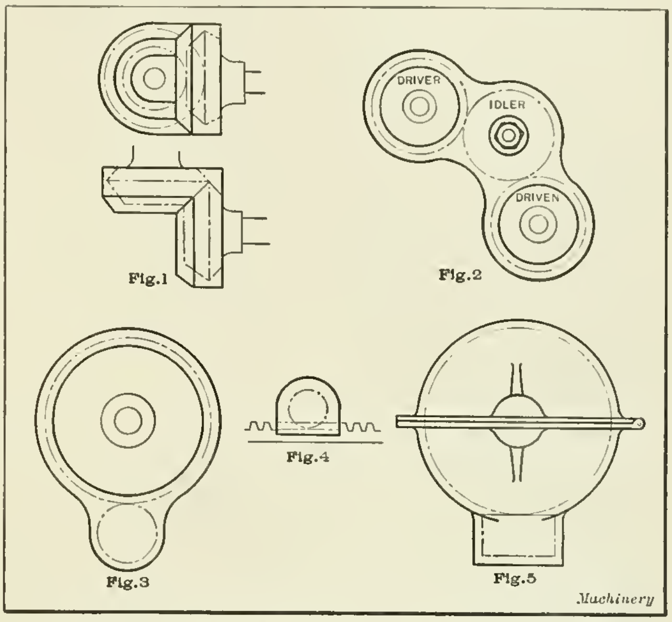
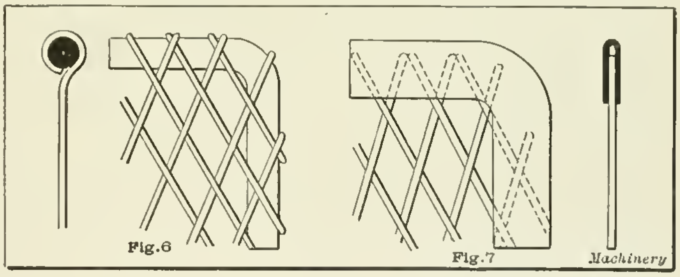


Fig. 1. Cover for Bevel Gears. Fig. 2. Cover for Train of Spur Gears. Fig. 3. Cover for Spur Gear and Pinion. Fig. 4. Cover for Rack and Pinion. Fig. 5. Cover for Worm-drive

The covers for gearing present the neatest appearance, and are undoubtedly strongest, when made of cast iron. In some cases, however, they would be too costly and massive if made of this material, and then sheet-iron or wire-mesh guards can be used. Types of guards of this kind are shown in Figs. 6 to 11, inclusive. In the guard shown in Fig. 6, a strong wire frame is used for supporting the wire mesh. In Fig. 7 a sheet-iron frame is used as the support, being bent over the ends of the wires. In Fig. 8 a sheet-iron guard is used, reinforced by a strong wire frame. In Fig. 9 the reinforcement or stiffening of the sheet-iron plate is obtained by pressing a rib into the sheet iron. In Fig. 10 a sheet-steel frame is employed to which the wire mesh is attached, and this frame, in turn, is strengthened by a wire about which the sheet steel is coiled. In Fig. 11 is shown an angle-iron frame supporting the wire mesh.



Figs. 6 and 7. Methods of Attaching Wire-mesh Guards to Frames

Whenever it is possible to provide a door in covers over parts to which it is necessary to have access, this should be done. There are various methods for applying doors to machine frames and covers. The simplest method of arranging a door is shown in Fig. 12. This door is opened by raising it by the handle sufficiently to permit it to open. The required amount of play is left at the hinges to compensate for this movement. In Fig. 13 is indicated a type of hinge cast in a spiral shape. This is known as the "rising hinge," and it always returns the door automatically to a closed position, thus preventing accidents which might occur by the door being left open.

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[*] For information previously published on safety devices, see MACHINERY, January, 1910, "Practical Safeguards in the National Cash Register Co.'s Plant."

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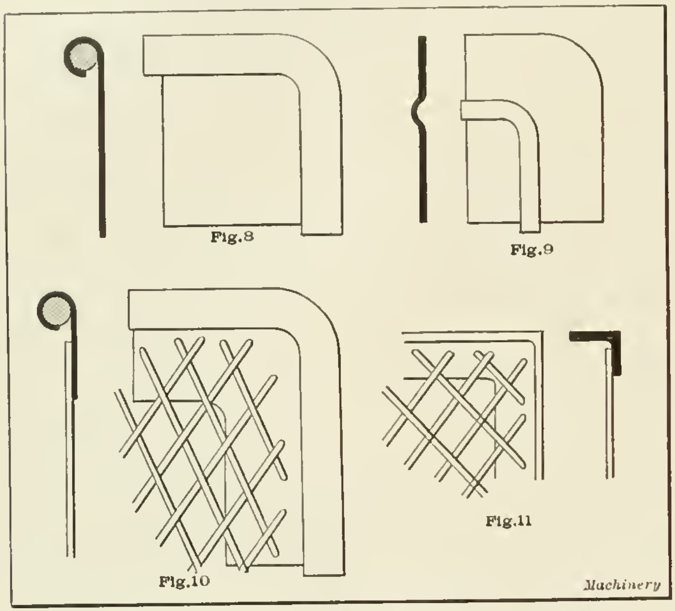

Figs. 8 to 11. Types of Sheet-steel and Wire-mesh Guards

As far as possible there should be no projections on the surface of covers, frames, etc. In the case of doors and covers, these should be as level and flush with the surrounding surface as possible. Safety set-screws should be used wherever feasible. Rotating parts, such as chucks, that cannot conveniently be covered with a guard, should always be fitted with safety set-screws.

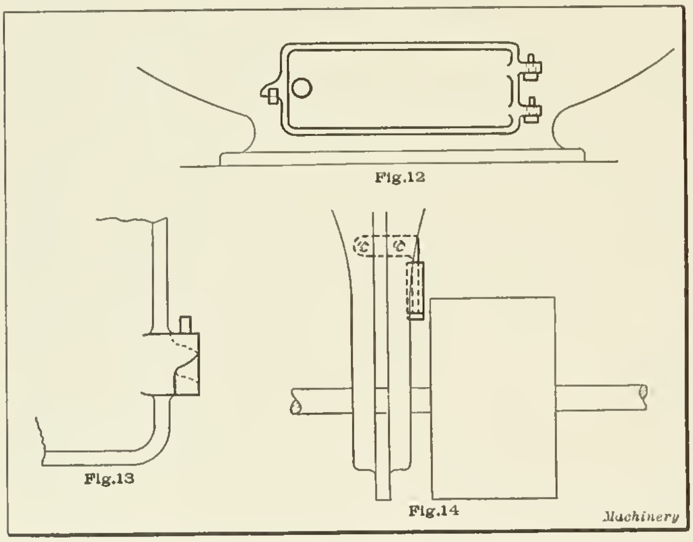

Fig. 12. Ordinary Type of Door used on Covers or Machinery Frames. Fig. 13. "Rising Hinge" used for automatically Closing Door. Fig. 14. Guard for Preventing Belt from Slipping in between Pulley and Hanger

When tapping castings, the tap is likely to stick in the casting and force it to rotate, sometimes causing injury to the hands. An arrangement for preventing this is shown in Fig. 16. The device shown is an adjustable support. The two standards *A* support two arms *B* which are adjustable on the standards. The clamping device is made of two strips *C* and *D*, holding the casting while it is being tapped. These strips slide back and forth on arms *B*.

The device shown in Fig. 14 prevents the belt from slipping into the narrow space between the pulley and the hanger. This device consists simply of a bracket screwed to the hanger and carrying a guard which regulates the position of the belt. Wide belts running over machines are very dangerous. A cheap and effective guard is shown in Fig. 15. Here a sheet-steel cover is supported from the ceiling and encases the pulley, while a board guards the remainder of the drive as indicated. A safe and satisfactory system of driving polishing wheels from below is shown in Fig. 17. This is especially suitable where boys are employed. This drive obviates all belt risks, and at the same time permits the belts to be inspected much better than when the drive is overhead.

The following illustrations show some special machine-tool guards. The punch press undoubtedly is one of the most dangerous tools around the machine shop. It is very seldom efficiently guarded, although many simple methods can be adopted. The guarding of the space between the punch and die is, of course, of prime importance. A couple of brackets screwed to the frame and supporting a sheet-iron plate with an aperture on the under side, large enough to push the stock through, is simple and yet very effective. A guard of this type is indicated in Fig. 18. Movable guards, such as plates with a horizontal reciprocating motion, timed to push the fingers away, or guards provided with a vertical motion and descending upon the hand previous to the cutting action, are also used. The flywheel and driving belt should also be guarded, as they have caused many accidents. A simple method of providing a cover for them is also indicated in Fig. 18.

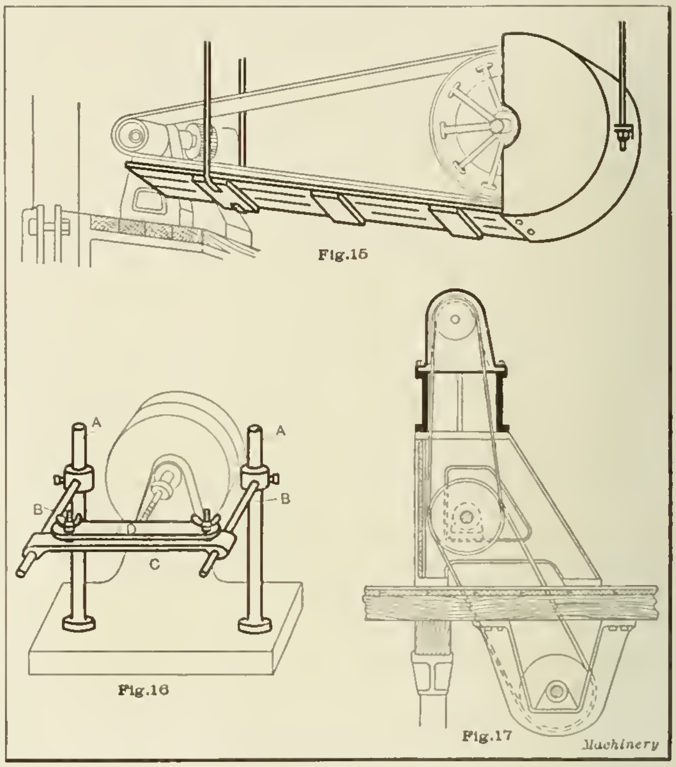

Fig. 15. Guard for Overhead Drive with Wide Heavy Belt. Fig. 16. Holder for Preventing Rotation of Castings when Tapping. Fig. 17. Safe Method of Driving Polishing Heads from beneath

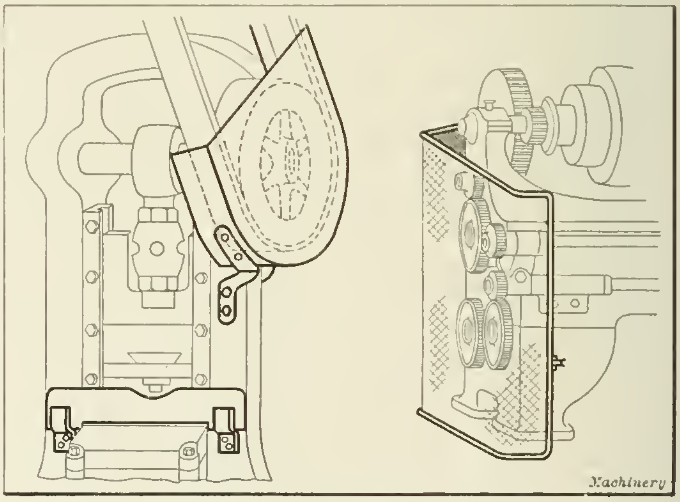

Fig. 18. Guards for Punch Press Fig. 19. Guards for Change Gears

In the case of change gearing on a lathe, cast-iron covers cannot always be used to advantage, but a guard made of wire mesh, as shown in Fig. 19, is very useful. The milling cutter guard shown in Fig. 20 was originally patented by Messrs. Alfred Herbert, Ltd., Coventry, England. It has been found quite satisfactory and has been approved by the official inspectors of factories in Great Britain. The firm owning the patent has, however, withdrawn its rights, so that this guard can be freely used by the public. In Fig. 21 is shown an emery-wheel gear-tooth grinder provided with a cover. This cover has a loose side or door fastened by thumb-screws and hinges. In this way the removal of old wheels and the mounting of new ones can be done without removing the guard proper.

A cover for a cold saw is shown in Fig. 22. The cover is screwed onto the handle which supports the saw, and thus prevents the hand from coming in contact with the saw or getting trapped in the chain. Covers for ordinary emery grinders are very numerous. One of the simplest types is shown in Fig. 23. This cover has the advantage of being adjustable as regards its height and position. It is made of a steel stamping with a nut and bolt support.

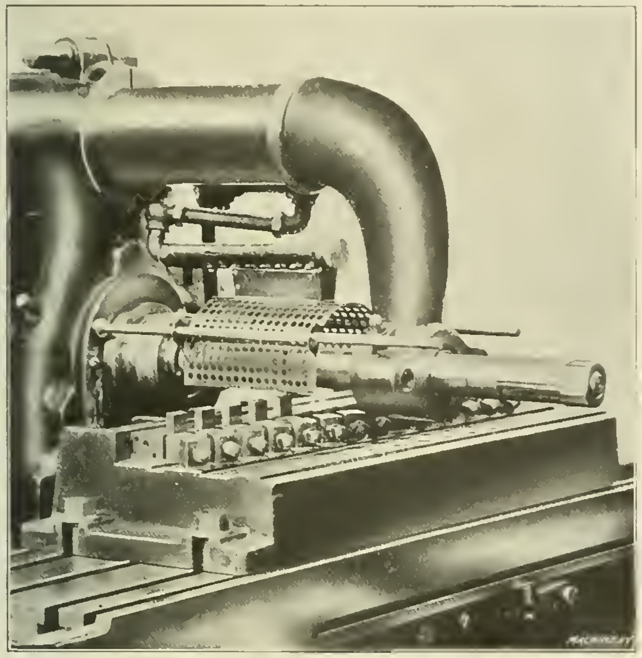

Fig. 20. Milling Cutter Guard

Exposed driving pulleys and speed cones of a drilling machine are extremely dangerous, especially when a man has to work behind them or when they face toward a passage. In Fig. 24 is shown a method of encasing them with a cage having an angle-iron framing. A door is provided to facilitate the changing of speeds.

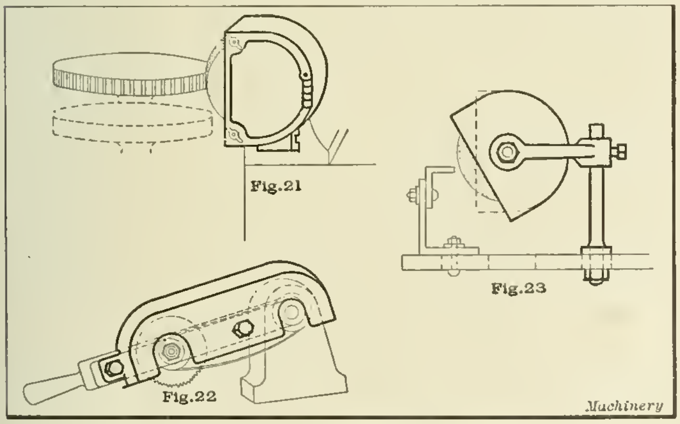

Fig. 21. Cover for Emery Wheel Fig. 22. Cover for Cold Saw and Chain. Fig. 23. Adjustable Emery-wheel Cover

General Rules for Avoiding Accidents in the Machine Shop

Precautions which may be taken to avoid accidents have been reiterated so many times that it seems hardly worth while to repeat them. There are a few rules, however, which, it seems, cannot be stated too often. Every mechanic knows that the loose pulley should be kept well lubricated, as many accidents have occurred through the loose pulley sticking to the revolving shaft and unexpectedly starting the machine. Another precaution to take is never to ascend a ladder over a machine unless it is provided with floor spikes or shaft hooks. Emery wheels cause a great deal of trouble and many accidents are due solely to lack of understanding and carelessness. Do not bear too hard on an emery wheel. You will not remove more metal by doing so, and the wheel will simply be clogged and glazed, and have a tendency to break. It is an unwise saving of time to be afraid to take sufficient pains to see that an emery wheel is properly secured. No one should ever be required to work at a dry polishing lathe or emery grinder which is not provided with dusthoods and efficient suction for preventing the dust from filling the room. The dangers due to breathing the impure air in a grinding room not provided with an efficient suction system are greater, in many respects, than those due to smaller accidents from which the victim may soon recover. A man may never recover from the injuries caused by the grinding dust constantly entering his lungs.

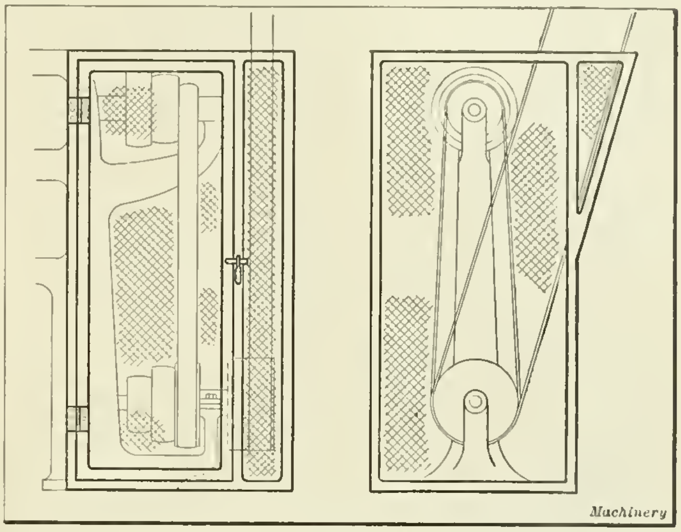

Fig. 24. Guard for the Driving Pulleys of a Vertical Drilling Machine

* * *

The recent breaking of a large reinforced concrete dam which released a flood of water that wiped out the town of Austin, Pa., calls the attention of the engineering world to the uncertainty of concrete construction on the one hand and a serious defect of the common form of masonry or concrete dam on the other. To insure the soundness of concrete structures whose integrity depends on perfect homogeneity it seems that the work once started should continue day and night without cessation until completion. This, aside from the difficulty of securing perfect mixing and the best materials, makes the erection of sound monolithic concrete work no easy matter. The second trouble is due to water percolating into the strata beneath the dam foundation. The common form of masonry or concrete dam which resists displacement and overturning by reason of its sheer weight, is generally secure if water can be kept from beneath, but "there's the rub." The percolation of water under heavy pressure into many soils or even into some rocks is beyond the power of engineers to prevent. The greater the area of the base of a dam on a permeable foundation, the more likely it is to be displaced by the hydraulic pressure beneath it and against it. The old "bear-trap" dam built of logs, plank, brush and dirt was constructed on sound principles. The inclination of the dam face is at an angle that insures stability. The pressure of water normal to the face resolved into its vertical and horizontal components, yields a horizontal force less than the product of the vertical component and the coefficient of friction of soil or rock. No anchors are required and seepage cannot seriously affect its stability. But, unfortunately, the principle of this form of dam cannot be used where most needed because of the great cost entailed in building high dams.

ACCIDENTS IN THE MACHINE SHOP*

SUGGESTIONS AND RULES FOR THEIR PREVENTION, COLLECTED FROM VARIOUS SOURCES

The rules for the prevention of accidents in machine shops naturally divide themselves into two main classes—those which primarily concern the employer, and those which must be observed by the machine operator in his effort to guard himself against injury. The employer must provide the required safeguards; the employe must use care in operating his machines without taking unnecessary chances. In the following, the rules and suggestions given are classified, in the first place, with regard to these two main classes. It must be remembered, however, that there can be no hard and fast line drawn between the duties of the employer and those of the employe in the prevention of industrial accidents; a spirit of cooperation should always be present. The rules are further classified with regard to the specific subject to which they pertain—arrangement of machines, operation, etc.

1. SUGGESTIONS AND RULES FOR THE SHOP MANAGEMENT

The first thing to do in the prevention of accidents is to get a clear idea of the particular dangers that need to be guarded against. The arrangement and erection of machine tools comes first in order, as it determines the conditions under which the operator works and has much to do with his safety. The particular dangers met with must then be taken care of; these include the risks arising from projecting keys and set-screws, unguarded gears and belts, dangerous position of machines, as for instance, a planer placed so that at full stroke it might crush anyone who passed between it and a wall or bench. Bearings must be so placed that to oil them does not involve a risk, etc.

Instructing Employes

A very important consideration is that of the instruction of employes in regard to the dangers against which they must be on their guard. Apprentices in machine shops should especially be given better supervision than is now the case, and they should be systematically and thoroughly instructed as regards the dangers of machinery. But in addition, all employes, especially new employes, must be carefully instructed in the language they understand, regarding the work they are to do, and particularly regarding possible dangers of the employment. The dangerous parts of the machinery about which they must work must be pointed out to them, and they must be cautioned about the same.

When printed rules are used, each foreman must make it his business to know that every employe has read the rules, and understands them, and is familiar with the danger of his work. If an employe is changed to other employment, the same care with regard to instruction must be used. No employe must be allowed to remain in a department who cannot be made to fully understand the instructions.

In many cases, an important part of the instruction given is to show the men how to place themselves so that they can move out of danger if anything should slip or break.

There are certain employes who, through stupidity or carelessness, are frequently injured. Such employes should be put on a job where they cannot get hurt. Slow-thinking and ignorant men should not be put on jobs where it requires a quick, bright man. A large number of accidents are caused through ignorance or lack of intelligence on the part of workmen.

Arrangement of Shop and Machinery

In many shops the men have to spend much of their time looking out for their own safety. If the management, therefore, wishes to increase the efficiency of such shops, it must arrange the machines and place the equipment in such shape that the workmen can work in safety, and not have to waste their time in self-protection.

Cleanliness, fresh air, warmth, and good ventilation, with a few other humane thoughts for the benefit of the workingman, will assist in keeping the number of accidents down to a minimum, as the average workman will be far more careful, and will produce better work, in a shop where he feels that some care and thought is given to the conditions under which he works.

Plenty of light, natural or artificial, should be provided around each machine, and in all stairways and passageways. Statistics show that light has a very important place in protection—darkness is always dangerous. The light in a shop may be greatly increased by keeping the electric globes clean and the windows washed. If workmen cannot see, they must feel, and it is this that costs so many fingers and sometimes lives. Clean windows and floors and whitewashed ceilings and walls (and even machines painted white) would prevent many accidents.

Economy of floor space, while important, can be carried too far. Ample room should be provided around each machine for the free movement of the operator and his work.

The traversing carriage or table of any machine should not be allowed to run out within a distance of less than eighteen inches from any fixed structure not being a part of the machine, if the space over which it runs is a space over which any person is liable to pass, whether in the course of his employment or otherwise. A planer, for example, should never be placed so that the platen, under any circumstances, could crush a man between it and a wall, post or other fixed object. Nor should a planer be so set that the platen will need to travel over a gangway, especially if the gangway is used for moving trucks or heavy castings or forgings along it. Someone may be easily crushed between the platen and the object moved along the gangway.

When drop hammers are located near an aisle where persons pass along to the rear of the hammer, a shield must be provided to stop flying scales.

Where necessary, there should be sufficient room for the operator to pass right round his machine without endangering his person by coming into contact with belts, gears, etc.

All benches in the shop should be so arranged that there will be no danger of the workman being jammed between his work or the bench and moving parts of machinery, cranes, shop cars, or trucks.

Heavy machines should not be placed on light platforms or galleries.

All passageways and gangways should be kept smooth and in good repair, and free from all obstructions over which the men may stumble and fall. The foreman should constantly watch the passageways and see that they do not become crowded. All passageways where men must pass in the regular course of their work must be sufficiently wide to insure safety.

Turnings and metal chips should not be allowed to accumulate in any part of a machine shop, especially not in the vicinity of machine tools.

The floor of the shop should not be littered up with defective and discarded castings. Finished work and jigs not in use should be removed promptly.

The floors of the shops should be kept in good condition. Tracks for shop truck or railway tracks should not project above the surface of the floor.

Oiling of Shafting and Shafting Guards

All machines and shafting (line and counter) should be periodically and systematically oiled, the frequency of oiling depending upon the extent to which the machine and shafting are used and their duty. The oiling of shafting must be done by special men, who must be required to wear tight-fitting clothing, and use long-stemmed oil-cans where possible. Where practicable, oiling should be done when the power is off. The ladders used by oilers must be equipped with steel points at the bottom. A ladder must not be allowed to lean against shafting which is in motion if it is possible to avoid so doing. Where a lineshaft is close to a wall, a workman must never place a ladder against the wall and thus put himself between the shafting and the wall. Working in a cramped space like this, close to a rapidly revolving shaft, is always dangerous.

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* In the preparation of the following collection of suggestions and rules for the prevention of accidents in the machine shop, use has been made of material contributed by V. Brockbank, Handsworth, England; J. E. Cooley, Hartford, Conn.; James H. Carver, Schenectady, N. Y.; George W. Burley, Sheffield, England; H. S. Busey, Baltimore, Md.; B. Bendix, Pittsburg, Pa.; Jos. M. Burnett, Windsor, Conn.; T. S. Bentley, Ilford, England; S. Victor Brook, Middletown, Conn.; J. E. Andrew, Bristol, Conn.; A. G. Bennett, Philadelphia, Pa.; F. J. Badge, Brooklyn, N. Y.; G. W. Akerlow, Bridgeport, Conn.; Martin H. Ball, Watervliet, N. Y.; William F. Arzinger, Jersey City, N. J.; W. B. Bolles, Tacoma, Wash.; Wm. Chas. Betz, New Britain, Conn.; Wm. H. Addis, Springfield, Ill.; J. D. Chambers, Tacoma, Wash.; A. L. Campbell, Detroit, Mich.; F. W. Brady, Scranton, Pa.; H. B. Cohstock, St. Paul, Minn.; Wm. W. Cowles, Poughkeepsie, N. Y. Use has also been made of collections of rules and regulations published by the Illinois Steel Co., and the International Harvester Co.

Shafting within twelve inches of the floor should be encased. Shafting higher than twelve inches and not more than seven feet from the floor should be railed off or otherwise guarded. The ends of shafting, where exposed to contact, should be protected.

Countershafts should not be placed directly over the operator, but should be placed back of the machine. All overhead hanger-bolts should be inspected frequently.

All pulleys, collars, etc., should be examined periodically for security of holding, while the former should also be examined for truth of running. Any defects should be remedled at the time of discovery.

Stairs and Railings, etc.

Stairs should not be built at a sharper angle than 50 degrees. When an angle over 50 degrees is required, ladders should be used instead. The sum of the riser and tread should equal about 17½ inches. All stairways must be equipped with handrails, and the rails must be kept smooth and free from nails and splinters.

Railings should be at least three feet six inches high. Pipe railing should be made of not less than 1¼-inch pipe. Angle railing should be made of not less than 2 x 2 x ¼-inch angle iron. All railings ten feet above the floor should be made of metal, and should have a toe-board at their base. Angle-posts should be chamfered.

Counterweights on doors or machines should be so situated or guarded that they cannot fall on anyone should something break. Door counterweights should be boxed in.

Where a machine is located so that the operator must stand near a swinging door, a stop must be so placed as to prevent the door from striking him.

All swinging doors should be equipped with windows, properly guarded, and of sufficient size to make it easy to see a man approaching from the opposite side. A size of window which has been found adequate is 8 x 24 inches, with one window provided for each of the two swinging doors. Both sides of the door must be provided with light, either natural or artificial. The windows must be kept clean.

Avoid hinged skylight windows, as the danger due to falling glass has often been demonstrated.

All portable ladders, where practicable, should be equipped with metal points or spurs at the bottom, and with hooks at the top.

Safeguards for Machines

All moving machine parts, where dangerous and where exposed to contact, must be properly guarded, and all projections of any nature on moving parts, where exposed to contact, must be properly protected.

Collars used on shafting should have safety flanges high enough so that the head of the set-screws will not project above the flange. All set-screws should be placed in safety collars, countersunk, or covered by a guard.

Set-screws with heads projecting from the moving parts of a machine should be replaced with headless or socket set-screws, when no other protection is provided.

Chucks or other revolving parts with projecting screw heads should be avoided wherever possible.

Exposed holes and recesses in rapidly rotating parts of a machine should be plugged or covered. If necessary, means can be provided for removing the plugs or covers.

All screws and bolts on parts which have to be reversed frequently should have locking nuts placed on them to prevent their slacking back and falling out; or, in place of these, some other effective method of fixing and locking them in position should be resorted to.

Lead-screws placed in the front of the lathe should not have a spline cut in them. Men standing close to the machine often have their overalls wound up on the lead-screws and are in danger of injury.

All gears and gearing should be either enclosed or guarded wherever possible. In cases where it is necessary to remove the gear guards for the purpose of changing the gears, the guards should be replaced immediately after the gear-changing operation and before the machine is set in motion.

Handles on the ends of feed-screws and shafts should, preferably, be of the loose type, connected to the screw or shaft by means of a claw clutch or similar means, so that the handle can, when not in action, be slid off the screw or shaft. This prevents any accidental movement of the handle by the operator.

Power-feed to milling machines should be obtained through the medium of the main driving spindle, or, if obtained independently from the countershaft or feed motor, provision should be made whereby the feed will be stopped at the instant that the cutter ceases to rotate.

Wherever practicable, cutters in a milling machine should be provided with guards. This is seldom done in America and is considered impracticable by many, but in England where it is used to a considerable extent it has not been found to involve serious drawbacks.

Guide ways should be provided for the counterweights on boring mills.

Shapers and boring mills should be provided with a brake in addition to the ordinary shifter, so as to make it possible to stop them quickly.

Drilling machines, especially where girls are the operators, should be well protected from revolving spindle parts, as there is a possibility of entangling the hair when the operator leans over toward the work.

Emery or abrasive wheels over five inches in diameter should be provided with metal guards.

Emery wheels over eight inches in diameter should have a safety taper of three-fourths inch to the foot, should be equipped with safety collars, and with substantial tool rests.

All cup wheels should be guarded.

Emery wheels which are used almost continually should have a guard over the wheel connected to suction pipes, for the removal of dust. The dust is more dangerous than the more remote possibility of breakage.

For the shop print (mounted or unmounted), a hook or fixture should be placed in such a position that the operator can readily see it without leaning over the machine.

When repairing machine tools, changing dies, gears, etc., all power to the machines should be shut off and the belt thrown off, if possible.

When making overhead repairs, a sign which can be clearly seen from all sides should be placed on a stand about six feet high or suspended by wires at the same height. A good sign which can be clearly seen from all sides can be made of tin, triangular in shape, painted red and having the word "danger" in large letters.

Each punch press, stamping or cutting machine, or drop hammer, must be provided with a hook for removing the material from the dies of the machine.

All punches, hammers and other machines which are set in motion with a tripping device must be securely locked or blocked when not in use or when being adjusted or repaired.

All punch presses, where practicable, must be so shielded as to prevent the operator from putting his fingers under the punch when in motion.

Lights at machines should not be suspended by wires from the ceiling, but should be held in adjustable brackets or stands.

Where incandescent electric lamps are used, metallic reflectors, guards, and means for quickly adjusting the light to suit the work should always be provided. No makeshifts should be permitted.

The switch box of every motor driving a machine or group of machines should contain at least one extra fuse, for an emergency.

Where a group of machines is driven by an electric motor, the switch should be placed within easy reach of each machine. Before starting or stopping the motor timely notice should always be given.

Where electricity is used, all switches, transformers, fuses, motors, rheostats and controlling apparatus should be marked plainly with the voltage and amperage of the current passing through them when in operation. In addition, the word "danger" in large letters should be placed on any parts carrying over 200 volts, for while a shock of 200 volts may not be dangerous, it is generally quite disagreeable.

Belts and Pulleys

Belts and pulleys should be so located, wherever possible, as not to be dangerous to employes, or should be properly enclosed, fenced, or otherwise guarded. Belt and gear guards, covering belts and gears, are now being made extensively of sheet-metal, bent to suit conditions, made in box forms, and oxy-acetylene-welded at the angles. These, when painted, make very neat appearing guards. In place of the above, wire mesh or expanded metal is sometimes used, held at the edges or corners, by small rolled metal angles.

Bare pipe railing, used as a belt guard, is to be used only where the location of the belt is isolated—where there is but little traffic, and the probability of catching anything in the belt is remote. Wire netting should be made of wire not less than No. 12 gage, and not more than 1½-inch mesh. Steel casings should be made of not less than No. 10 gage plate.

In the lacing of belts the joints should be made close and smooth, and the laces or hooks should not be placed too near the edge of the belt. With high-speed machines it is best to make the belts endless. All hand-operated belts should be laced with raw-hide. Where practical, special men should be given the work of making, repairing, lacing and putting on all belts.

Whenever possible, belts should be placed overhead and as far away from working places as possible. Belts running in opposite directions should not be arranged in close proximity to each other.

All belts running through floors, or low, should be encased or guarded. All heavy, high-speed belts should be guarded.

Belts near female workers, where the hair is in danger of being caught by static electricity, should be guarded.

Belts should be examined periodically for joint efficiency and tension.

All loose pulleys must be furnished with a permanent belt shifter, so located as to be within easy reach of the operator. The loose pulley and the shifter must be so constructed as to make it impossible for the belt to creep from the loose pulley back onto the tight pulley. The belt shifter should not be placed where it can come in contact with the driving belt in any position. Sometimes the driving belt will touch the shifting lever when it is in the "off" position, and the lacing or joint will jerk the shifter and start the machine.

In putting on belts, the poles used in many shops certainly lessen the danger considerably. Pulleys on a main shaft should never be placed so close together that a belt if thrown off is liable to be caught between them. In crowded shops this is sometimes unavoidable, but it is seldom necessary to have the space on both sides of a pulley so limited that the belt cannot safely be thrown off. A guard should then be fixed to prevent the belt from coming off on the side which is cramped. As a general rule in placing pulleys on either the main- or counter-shafting, place them so that there is at least a space of one-and-one-half times the width of the belt between the pulleys. Be sure that all bushings are of the same length as the bushed pulley.

When two pulleys must be close together, or when a pulley is nearer to a hanger than the width of its belt, a hook should be so placed as to catch the belt, if it should run off, and prevent it dropping to the shaft or becoming wedged.

A good many countershafts are so arranged that they cannot be oiled without throwing the belt off, and this causes the oiling to be shirked. All loose pulleys should be designed so that they can be oiled without disturbing the belt.

Shifters on belt-driven tools, and controllers on motor-driven ones, should be within easy reach of the operator, if possible. See that there is plenty of clearance near the controller handle.

Cranes and Hoists

No person except the duly appointed operator should be allowed to operate a crane.

All cranes should have, in plain view, signs showing their capacity.

A substantial foot walk of steel construction throughout, provided with rough surface and located not less than 6 feet 6 inches below the roof truss, should extend the entire length of one or both bridge girders. Where the walk is on one girder only it should be on the driving side. This foot walk should have a railing at least 3 feet 6 inches high, and a guard or toe-board at least 6 inches high along the exposed edge of it, to prevent tools and other objects from falling off. There should be at least 18 inches clearance between the railing and the nearest part of the trolley, and on the driving side there should be at least 18 inches clearance between the railing and the shaft. The inside of this walk should be brought up against the bridge girder to prevent material falling between the walk and the girder. Where there is a foot walk on one bridge girder only, there should be a platform provided at one end of the bridge and opposite the foot walk, for use in inspecting and repairing the trolley. Where practicable, there should be a platform on the ends of the trolleys. The foot walk, where practicable, should be carried around instead of over the bridge motor.

The operator's cage should be made of steel and should be absolutely fireproof. A safe, convenient arrangement should be made for passing from the cage to the foot walk. Wherever possible, this should be within the cage proper, but if it is necessary to place a ladder for this purpose on the outside of the cage, an auxiliary platform—with railing and toe-board—should be provided to prevent anyone falling from the ladder to the ground. Where the cage is open, a toe-board at least six inches high should be provided around the floor of the cage.

Stairs and ladders on the buildings for the purpose of getting into the crane should, where practicable, terminate in a platform with regulation railing and toe-board.

A box, or other receptacle, should be placed on the cage or on the runway in which to keep oil cans, tools, etc.

All crane cables should be six strands, 37 wires, with hemp core for ordinary service, and iron core for cranes handling hot metal. Sheaves and drums should be not less than thirty times the diameter of the cable.

All chains should be made of wrought iron. In replacing links only those made of wrought iron should be used.

Only fully guaranteed, long fiber, manila rope should be used.

All slings used on hoists should, where practicable, be made of wire cable instead of chain, as cable gives warning of weakening by broken strands.

All hoists should be equipped with the best and especially approved wire rope. No chain ought to be used.

The drums should have flanges on each end not less than 1 inch thick, and should project at least 2¾ inches from the drum body.

All pneumatic lifts, blocks and tackles, small hand cranes, etc., when not in use, should be placed in such a position as not to interfere with the passages.

Elevators

All elevator doors should be of the automatic drop type, that is, they should close as soon as the platform leaves the floor.

The platform of an elevator should be entirely enclosed with wire panels, as should also the shaft.

The top of the shaft should be roofed with only a hole cut in it for the lifting rope, so that in case any parts should fall from the running gear, they cannot fall down the shaft.

2. RULES AND DON'TS FOR EMPLOYES

By far the greater proportion of accidents are caused by momentary thoughtlessness or carelessness. To avoid accidents, it is necessary that the workman concentrate his attention solely on his work. Try to cultivate a habit of always considering, before acting, what the result of any particular motion or operation will be. A man should learn to always keep in mind what would happen if "that timber should slip" or "that rope break." The most important is to teach yourself to use your own eyes and brain as regards your safety.

Many unnecessary risky things are done by many men simply because they have formed a careless habit. When lifting heavy pieces with crane, hoists or jacks, or in other ways, some workmen subject themselves to unnecessary risks by placing the hands or feet, and sometimes their whole body, where injury is sure to result if one of the parts bearing the load should slip or break. In cases where it is necessary for men to work under parts suspended, blocking should be used for protection.

It is inadvisable to scuffle, fool, or play practical jokes in the shop. Many serious injuries have been caused by this practice.

Where there is not plenty of room between machines, one should not try to pass. To avoid danger, go where there is sufficient space to pass.

Operators of machine tools should, as far as it is possible and practicable, wear closely-fitting clothing, so that the risk of any revolving projection catching in any part of the operator's clothing and thus causing injury is reduced to a minimum. In particular, do not wear overalls with ragged sleeves.

Rules for Lathe Operators

Do not try to hold a drill and dog by hand, between centers, when the drill is over ¼ inch in diameter.

Do not put any other than a light-weight chuck, faceplate or special fixture on the lathe spindle, with the belt or controller "full on."

Keep clear of a fast-running lead-screw, if it has a keyway running along its length.

If you use a pneumatic hoist when taking out a piece of work held between centers, run the center nearly out, and carefully adjust the hoist before pulling the center entirely out. If the work is in the chuck, then, by aid of the tail-center, push a block of wood up to the job, to steady it, before adjusting the hoist.

Be careful of heavy projecting arms on any piece of work, especially when polishing.

Use large centers on heavy jobs.

Slender pieces, held between centers, especially brass or composition metals, should have the tool at least on the center, and never above.

Chuck wrenches should not be left in chucks, when not in use.

Do not forget that the thread-tool and carriage will rapidly reach the tailstock after reversing. You may hurt yourself trying to stop the damage you see it making.

In the lathe, always file left-handed near the dog or lathe chuck. Never use a file without a handle. When filing, always have the sleeve of the left arm rolled up far enough to avoid all danger of catching in the revolving parts.

Do not start a chuck on the spindle with the machine running; do it by hand. It is also better to start the chuck, when removing it from the spindle, by hand rather than by power.

Do not touch a running gear with your fingers under any circumstances.

Do not rest your hand idly on the compound rest; it may be squeezed between the rest and the chuck jaws.

Heavy pieces of work, or pieces of work revolving at a high speed, should be carefully balanced. This applies specially to lathe work.

Lathes, used for turning off the surfaces of electric motor commutators, for example, requiring a high speed, should be fitted with a mica shield placed on the tool-holder and bent over in an arc, so as to cover the point of the tool on the work, thus preventing chips from flying into the workman's face.

In the case of ordinary back-geared engine lathes, milling machines, drilling machines, etc., no attempt should be made to put the back-gearing into action when the machine is running, as this is dangerous to both man and machine.

Keep the countershaft well oiled to prevent the lathe from starting up when the belt is on the idle pulley.

Rules for Milling Machine Operators

Do not put on or take off the milling machine arbor nut by applying the power of the machine.

Do not wipe chips from revolving cutters with the finger or with a measuring scale, and use a brush only on the "off" side of the cutter. In general, do not clear chips away from the work or cutter while the machine is running. Even if a brush is used it is very easy to injure the fingers.

Do not leave a wrench resting on the vertical drive-pulley of a vertical miller. This is a thing that is often done. When the machine is started the wrench is hurled past (at best) the operator's head.

Do not reach across the table while the cutter is running, to regulate the oil-feed; step around to the proper side. Reaching over a revolving cutter with your arm, or assuming positions with the arm near a moving cutter, is always to be avoided.

Using a dull, thin cutter, especially on very hard material, is dangerous.

Rules for Drill Press Operators

In drilling large holes, the work should always be clamped or strapped to the table of the machine or held securely in some other way. Bolt down all work that cannot easily be controlled by hand.

Oil or chips should not be wiped from the drill or work when the machine is running.

Drill operators, both male and female, should wear a cap to prevent the hair from catching in the spindle. Grave accidents have happened to women in this way.

When drilling see that the spindle has no backlash.

If the drill gets "caught" in a piece of work on the drill-press table and the work is whirled around the table, do not try to stop it with the hands, but shut off the power of the machine immediately.

If a drill slips in a chuck while drilling, do not try to tighten the chuck by clasping it in the hand while it is in motion. Stop the machine and tighten the chuck properly with a spanner wrench.

Do not insert the drill drift for removing the drill until the machine comes to a full stop.

Heavy jobs, not being worked on parallel blocks, etc., should not be left lying on the drill-press table while working on another job.

Make sure that circular tables are tightened, before beginning to drill.

Using waste, a file or any piece of metal, to pull chips from a fast running drill, should be avoided. Use a pine stick.

Do not remove parts of a broken drill with a center-punch and hammer. It is dangerous for the eyes.

Make no adjustments in the drill grinder while the machine is in motion.

Rules for Planer and Shaper Operators

Place safety dogs at each end of the planer table to prevent its running off.

When shifting a planer dog be sure that you have plenty of time to do it.

Do not reach under the cross-rail, when the bed is in motion.

Keep your fingers away from the rack feed, if it happens to exist.

When the stroke allows the work to project above the cross-rail, be careful with the planer dogs and yourself, when the bed is in motion.

Do not put the hand between the table and the lower framework of the machine when it is in motion.

On shapers, never take a chance on wiping a chip from the tool when the machine is in operation.

Be sure that the shaper vise is clamped securely to the table to prevent it from being brushed onto the floor.

Do not put a tool in place or take it out with the machine running.

Be sure that a vise, capable of turning or swiveling, is tightened, before you begin to cut.

Do not try to hold a piece, say 18 inches high, in a vise whose jaws have a depth of 2 inches, and then try to take a heavy cut.

Have plenty of room between the ram, at its maximum rear stroke, and any immovable object.

Be sure that the last man using the shaper tightened the head. You may injure yourself, trying to prevent damages.

When a shaper head has been set over, on a short stroke, outside the housing, do not shift to a long stroke before satisfying yourself of clearance between the head and the housing.

Rules for Slotter Operators

Not frequent, but serious accidents occur, due to forgetfulness, when the ram nearly touches the work on the down stroke.

When the ram is up and you are about to start the machine, be sure the tool clears the work. Better lower the ram before putting in a tool.

If you have left a tool in the air for a time on the up-stroke, and then return to the machine, do not start it until you are sure that no movement of the table has occurred.

On the slotter, use a long-handled brush for cleaning away dust or oil from the lines on the work.

Rules for Boring Mill Operators

Tools or metal pieces of any sort should not be left in the T-slots of boring mill tables. They might fly out.

Do not reach under the cross-rail while the table is in motion.

Pulling up chuck-jaws while the table revolves is dangerous unless the table runs very slowly.

When the work nearly reaches the limit of the swing, accidents sometimes occur between the work and the housing.

Rules for Grinding Machine Operators

Heavy spectacles should be worn by emery-wheel operators for protection of the eyes.

Before using an emery wheel, test the soundness of it by tapping it. If there should be a crack in it, it will sound "dead" for a short distance about the crack.

Do not use a grindstone that is badly out of true. Be sure that the tool rest is as near to the stone as possible.

A piece of leather should be attached to the top of the opening of the hood of each emery wheel and so adjusted as to extend down close to the surface of the wheel. This serves to confine the sparks and dust to the hood and to protect the eyes of the operator.

On emery wheels sixteen inches or more in diameter, the rest should not be set more than two inches below the center of the wheel. On wheels less than sixteen inches in diameter the rest should be placed less than two inches below the center. In all cases the rest should be high enough to make it certain that the work will not get caught in such a way as to break the wheel.

In putting a wheel on an arbor, care should be taken to see that the wheel does not bind; it should never be forced on, but should be an easy fit.

Mounting wheels between flanges that bear unevenly when the nut is tightened, is dangerous.

Screwing nuts against wheels not having flanges is not allowable.

Do not allow the arbor to become loose, due to wear.

Keep the wheel true with an efficient wheel dresser.

In nearly all cases it is unnecessary for the operator to stand directly in line with the wheel when grinding, although most operators do so. They subject themselves to unnecessary risk from flying particles entering the eyes. They are also in a place where they will breathe most of the dust, and where, if the wheel should burst, they are sure to receive serious injury. At first it would seem somewhat unhandy to stand at one side of the wheel, but soon the habit will be formed, and it will be found just as convenient as standing directly in front of the wheel.

Rules for Punch Press Operators

When using a punch press, always lock the press and try the trip before changing or setting the dies.

Under no circumstances put your fingers under a shear or punch-press when the power is on. In removing material from the die of a stamping or cutting machine, or punch press, always use the hook provided.

Adjusting or setting dies, or in any way working with the hands between the punch and die, is very dangerous, unless the balance wheel is at rest.

General Rules for Machine Operators

Do not wear jewelry on your hands in the shop.

Before starting, the operator should look carefully over the machine each morning to see if everything is in good working order.

In general, never wipe on or near the running parts of a machine when it is in motion. Shift all belts with a rod rather than by hand. On motor-driven machines take care where the hand is put when throwing the switch.

Do not try to feel the edge of your tool during the reversing stroke on a slotter, planer or shaper; rather stop the machine.

Do not measure or caliper work while the machine is in motion.

Do not start the machine until you are sure that the work is securely clamped in place.

Do not try to tighten the clamps or set-screws while the machine is in motion.

Do not attempt to set the cutting tools while the machine is in motion.

To prevent injury from the end of a rod extending from a screw machine, cut out a piece of light colored cardboard not less than four inches square, make a small hole in the center, and force it onto the end of the stock. This will attract attention.

If waste is caught on a nut, tap or screw do not attempt to withdraw it while the machine is running.

Pieces of steel which may get into the eye should be removed at once to avoid serious injury.

General Rules for the Machine Shop

See that the handles on such tools as files, chisels, hammers, etc., are kept tight and in good repair.

When doing special work above other workmen, notify those underneath; and when doing special work underneath other workmen, notify those above.

When erecting large pieces of machinery, do not throw nuts, bolts or tools from man to man; hand them back and forth.

Do not drop articles from the top of large machines, as they may injure a workman beneath.

When stripping or erecting machinery, before removing one part see that all other parts are held safely.

Avoid the use of nearly stripped bolts and nuts.

When chipping, provide yourself with a mask and eye shield, and see that the tools are not battered, thereby preventing chips from injuring you.

When the head of a cold chisel or punch begins to overlap, grind off the edges, as they may otherwise cause injury to the hand. Do not make a center punch by grinding a round file down to a point. Owing to the brittleness of the file it is liable to break off when struck with a hammer. Do not use an old file as a cold chisel.

When it is necessary to cut off the heads of rivets or to chip brittle substances like cast iron, place a shield to protect other workmen from the flying pieces.

See that the path of your hammer is clear before starting to swing a sledge.

When you complete a job, do not leave tools or material lying overhead. Tear down all temporary scaffolds as soon as you are through with them. Do not allow boards with nails sticking up to lie around anywhere. Many men have been injured by a piece of board lying on the floor with one or more nails in it with the point upward; usually such pieces can be put in a safe place with but little trouble, if the habit is formed.

After repairing machinery, always replace safeguards before leaving the job.

Do not pile any material so high that it is liable to fall.

Leaving articles on large wheels, when stationary, is dangerous.

In storing long bars or poles or pipes, they must never be stood in a perpendicular position, but always given slant enough to make it certain that they will not fall over.

If it can be avoided never stand with your face in line with swiftly moving revolving parts.

Do not use defective machinery and tools until repaired.

Do not use weak or defective ladders, or those that have been spliced to increase their length.

When babbitting boxes for bearings, see that there is no moisture in the mold previous to pouring, as this would cause an explosion. To prevent moisture from being entrapped, heat the piece before babbitting.

When casehardening with cyanide, keep all wet and damp articles away from the heated liquid.

As a last rule: Form careful habits. These will be a protection both to you and to those who work around you.

Belting

Never throw a belt that you are not familiar with over by hand. Examine it first carefully.

Do not attempt to stop a machine by grabbing the belt.

When belts are laced with wire lacings, or any lacings containing metal, take care that no projecting ends are left. Inspect the lacings occasionally to see that the metal lacings have not worn so that they leave a projecting end on either the inner or outer edge of the belt.

When it is necessary to put on a belt, stop the machinery or reduce the speed one-half.

When an overhead belt is caught and begins to wind around the shaft, do not try to release it, but get away from it and have the power shut off immediately. If the belt on an overhead pulley is thrown on by the hand, always pull the belt towards you.

When putting on a belt connecting the countershaft to the main line, put the belt on the countershaft pulley first and then throw it onto the main line pulley.

When throwing off belts, never allow two belts to occupy the same space between two pulleys on the driving shaft.

In replacing an overhead belt upon a pulley while it is in motion, a pole should be used, and the length of the pole should be nearly equal to the distance of the pulley from the floor, thus forcing the man to hold the pole at his side instead of in front of him. A short pole held in front is dangerous. If the belt is too high to be handled with a pole, and it is necessary to use a ladder, the ladder should be placed on the side of the pulley opposite the belt.

Do not lean the end of the ladder against a moving shaft, but rest the end on a stringer or beam.

Do not place a ladder between two shafts to adjust a belt; place it on the outer sides.

After having tightened the clutch fingers, or other parts of a countershaft, do not leave any tools on the stringers overhead as the vibration will cause them to fall down.

Cranes and Hoists

When transferring a chain hoist about the shop, extreme care should be taken not to collide with the moving parts of some machine or with some workman who may not be aware of its approach.

Do not exceed the safe load given by the maker for cranes or jacks.

Do not work underneath loaded cranes unless absolutely necessary.

Do not carry a load on the crane directly over the heads of other workmen.

Do not place the hands on top of the parallel blocks when the crane is lowering a piece onto the machine table. If it is necessary to move a block, do it either with a hook or by placing the hands at the sides in such a way that if the load is lowered suddenly or anything slips, the hands are clear.

Subject cables, chains and slings to frequent inspection.

The shop man is often at a loss to know how large a chain, rope or cable he should use to handle a given weight. The following simple rules which may be stored inside the hat-band where they may be easily found when needed, are, therefore, given. They are intended for ordinary chain, rope, or cable in good condition, with a reasonable factor of safety: For chain, square the number of sixteenths contained in the diameter of the stock that the links are made of, and multiply by 70; the result is the safe load in pounds. For instance, chain made of ¼ inch stock will carry $4 \times 4 \times 70 = 1120$ pounds, and ½ inch chain, $8 \times 8 \times 70 = 4480$ pounds. For rope, square the number of eighths in the diameter and multiply by 30, which gives the safe load in pounds; thus ¾ inch rope will carry $6 \times 6 \times 30 = 1080$ pounds. For wire cable, square the number of eighths in the diameter and multiply by 100; thus ½ inch cable will carry $4 \times 4 \times 100 = 1600$ pounds.

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A WORLD MOVEMENT

Word has just been received of the establishment of the fifteenth Museum of Safety and Industrial Hygiene, this time in Austria. Budapest, Milan, Paris, Moscow, Amsterdam, Copenhagen, Zurich, Munich and Berlin are among other cities where similar museums exist, nearly all of which are generously supported by the government. These institutions are the culmination of years of thought, effort, and scientific demonstration of simple practical methods for preventing accidents. In each case the inception of this work was due to a few earnest and devoted individuals, undaunted by captious criticism, who, by their energy and persistence, brought the work to such a point that the government gladly took it over. Berlin, Munich, Paris, Amsterdam and Milan have outgrown their present buildings and are planning immediate enlargement. In Amsterdam, the city is giving the Safety Museum the site, the state the building, and private subscriptions its maintenance.

The American Museum of Safety, 29 W. 39th St., New York, is non-commercial; it is not a show-room for patented devices; it does not sell or take orders for any of its collections; all demonstrations are made by its own staff, and there is no charge for space. Its object is to study and promote means and methods of safety and industrial hygiene, with their application to any and all public or private occupations, and to advance knowledge of kindred subjects; its special charter authorizes it to establish and maintain a museum, library and laboratories and their branches, wherein all methods and means for improving the general condition of the people as to their safety and health may be studied, tested and promoted, with a view to lessening the number of casualties and avoiding the causes of physical suffering and of premature death; and to disseminate the results of such studies, researches and tests, by means of lectures, exhibitions and publications.

It is cheaper to prevent accidents than to pay for them; the Museum of Safety, through its three-fold departments of prevention, industrial hygiene and mutuality, prevents accidents, lessens law suits for compensation, and creates mutuality between employer and employes. Now let us conserve human life.

The Dresden international exposition on accident prevention and industrial hygiene, now drawing to a close, has set the seal of world approval on these problems. The apathy and indifference of our government towards these questions, evidenced by its refusal to participate in this exposition is deplorable. The Germans, who are so keen in the scientific solutions of these questions, were bitter in their denunciation of the United States because it declined to be identified with this humanitarian movement. As they so justly remarked, "What subject touches the government more closely than the safety of its citizens and the conservation of their health?" Therefore our indifference towards these vital subjects is incomprehensible to them.

The success of this exposition was largely due to individual effort and the generous financial support of industrialists like Lingner, who, at his own expense built and equipped the great central building called "Der Mensch," in cooperation with a corps of scientists, statisticians and doctors. No pains were spared to make the exhibits simple and convincing; the success was unparalleled, as never before in the history of expositions has a work been carried to such perfection. Dresden has set an example which will be difficult to surpass. Up to September 1, four millions of people enjoyed the privileges of studying at this monumental school of life and labor. In fact, there is such a popular demand that these collections should not be dispersed, but find a permanent home, that it has been decided to found for them an institution, which will become, in Dresden, another Museum of Safety and Industrial Hygiene.

The American Museum of Safety is dependent on memberships and subscriptions; it is imperative that this life-saving work should be housed in its own building, so as to provide for immediate expansion, as it has already outgrown its present quarters. To make this a monumental institution for America, that shall rank in scientific research and practical results with the great continental museums of safety, every American should take a personal and patriotic interest, by becoming a part of it.

If every citizen would give the price of one brick toward the construction of this building, it could be begun at once. No contribution is too small; in this way all can become an integral part of a great educational institution for the safety of the people, which should be the first of its kind in the world.

* * *

A machine is never made with brains; therefore, it is up to the operator to do the thinking and lend a guiding hand.

FIRE PROTECTION IN FACTORIES

AS ILLUSTRATED BY THE WARNER BROTHERS CO.'S PRIVATE FIRE DEPARTMENT SYSTEM

By CHESTER L. LUCAS*

The subject of protection against fire in machine shops and factories seems to be a neglected one. The importance of the matter frequently manifests itself by the occurrence of disastrous fires, but as regards the small factory, at least, the lesson seems difficult to learn. One of the best protected factories against fire, is the Warner Brothers Co.'s shops in Bridgeport, Conn., where the property of the company and the lives and interests of its employes are effectually guarded by a private fire department competent to put out small fires, and to hold in check larger fires until the arrival of the municipal fire department. Through the courtesy of Mr. F. E. Warner, of the above company, and Mr. J. W. Keppy, master mechanic of the factory and chief of the company's fire department, the following description of the system, and the photographs of its leading features, are presented.

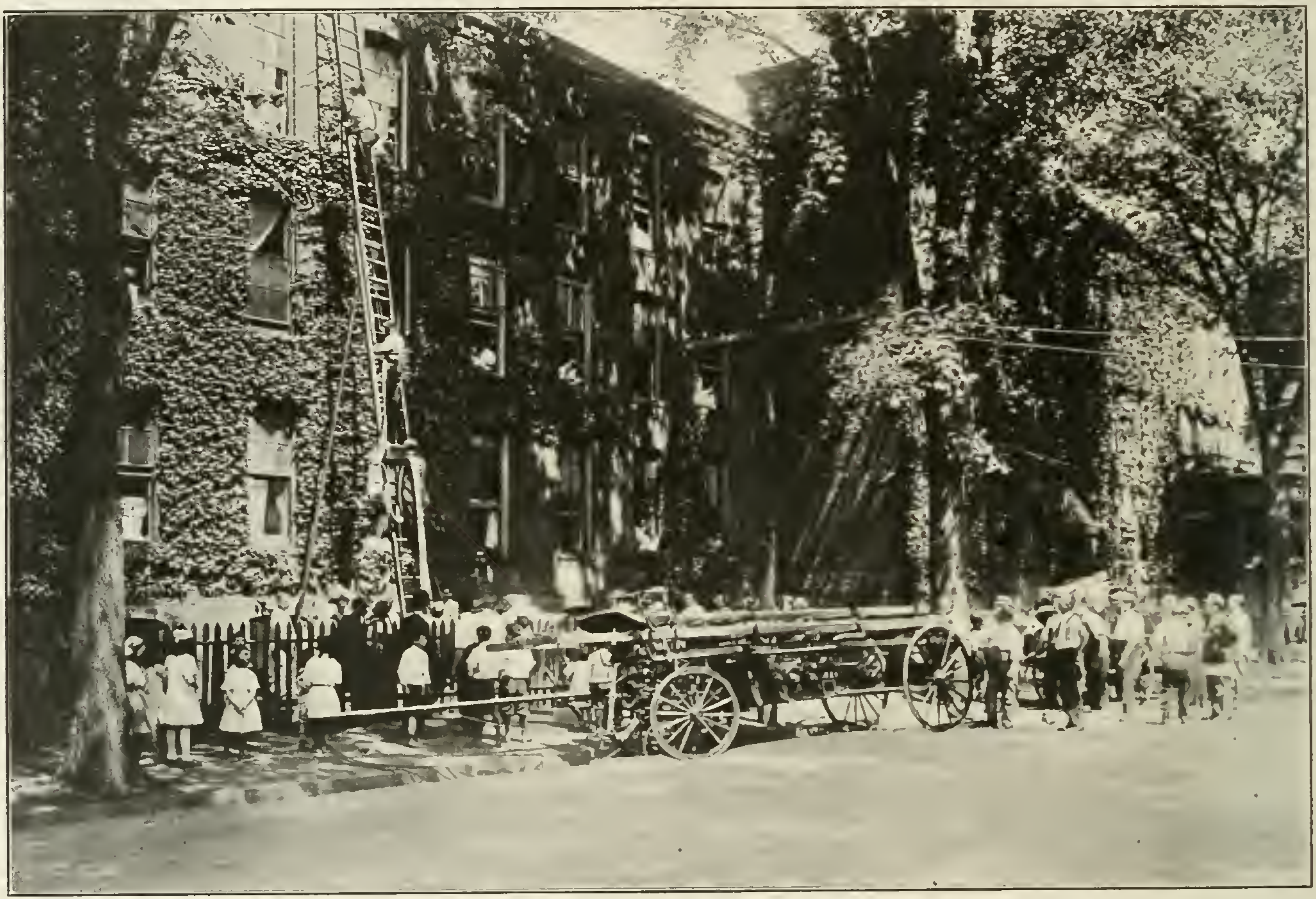

Fig. 1. In less than Three Minutes the Private Fire Department had their Men and Apparatus on the Scene, with a Ladder up and a Line of Hose ready for a Stream of Water

In this factory, the headquarters of the fire protection system are located in the office. Upon the walls are drawings, showing the entire plant in perspective, the underground conduits and piping, the watchmen's circuits, and the color scheme of the piping throughout the factory. Copies of these drawings are also posted in the engine-room and other places where they may be studied by those who should familiarize themselves with these details. The perspective view of the plant shows the location of each building, the entrance and exits, stairways, and in fact every detail of the property. Fig. 2 is a reproduction of one of this drawings. Every building is numbered, and known by its number. A drawing of the conduits and underground piping of all kinds, fire supply, water, sewer, gas and heating, is also posted in the office. This drawing also shows all hydrants, manholes and outside valves, enabling the men to locate the lines easily in case of such trouble as breaks in the pipes and the like.

Standard Pipe Colors

The color scheme employed for designating the different kinds of pipe lines is very complete. It is carried farther than is customary in most shops. Too much cannot be said in favor of using colors for the various classes of pipes, for it is obvious that much time is thereby saved when tracing or inspecting piping, and many accidents have been averted in cases where the workmen were inclined to be careless.

Fig. 3 represents the color chart for piping, copies of which are posted in the drafting-room, pipe shop, and engine-room. On the original charts, the piping is colored according to the adopted system for the shop piping. In Fig. 4 is shown a corner of the shop with a number of different kinds of pipes painted in accordance with the system. Thus, the steam pipes are black, the sprinkler pipe is red, the soil pipe is green and red, the electric lines are yellow, and the watchman's station is yellow and black. The fire pail is, of course, red. While apart from the subject, the orderly arrangement at the end of the lathe in this illustration is commendable—the racks to contain the chucks, back-rest, and faceplates, and the tool-chest above.

A list of the standard pipe colors in use in the Warner Brothers Co.'s shops is as follows:

Use	Pipe	Fittings
Hot Water	Blue	Red
Cold Water	Blue	Blue
Sprinkler	Red	Red
H. P. Steam	White	White
L. P. Steam	Black	Black
Exhaust Steam	Black	Red
Returns	Black	White
Blower, air	Brown	Brown
Exhaust, air	Brown	White stripe
Gas	Brown	Red
Oil	Drab	Drab
Conductors	Green	Green
Soil	Green	Red
Vent	Green	White
Light Conduits	Yellow	Yellow
Power Conduits	Yellow	Red
Bell Wires	Yellow	Green
Fire Alarm	Red	Yellow
Watchman's Clocks	Yellow	Black
Telephone Conduits	Yellow	Brown

Watchmen

The night watchmen in this factory carry no lanterns. Two or three incandescent lamps are placed in each department to furnish light enough to enable the watchmen to walk through and find their stations. Of course if the necessity arises, the entire room may be lighted by throwing in the proper switch. With a lighted lantern in a watchman's hands, there is at least some danger from fire, but the most important reason for not carrying a lantern is to prevent a person without the factory from tracing the watchman's movements by means of the lantern. A case recently occurred in eastern Massachusetts that brought this point into the limelight. In this instance the watchman was shot by a robber, who, outside of the factory, could get no better assistance in aiming than that provided by the lantern in the watchman's hands. The watchmen have regular routes, and register at numbered stations at intervals. It requires half an hour to cover each beat. The watchman then rests for half an hour, following this order all night. The Echo magneto system is used for recording the watchman's work. The watchmen have stated ground to cover between certain periods, and it is easy to locate them at any time, should they be needed.

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* Associate Editor of MACHINERY.

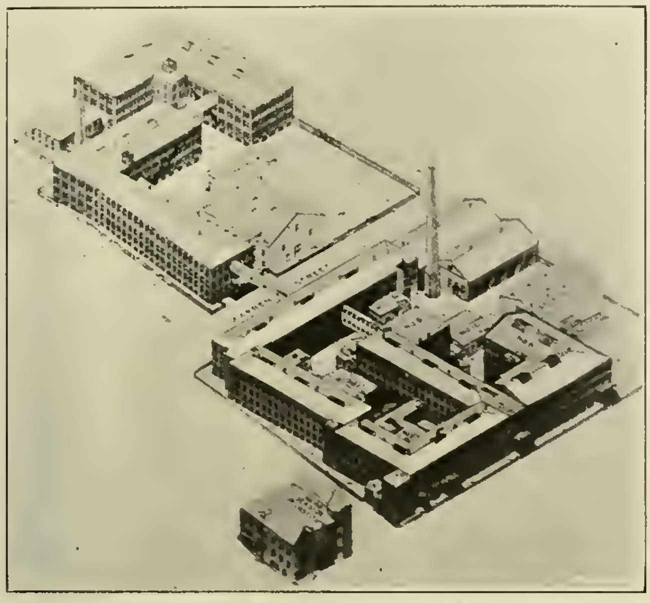

Fig. 2. Perspective View of the Plant showing every Building on the Property

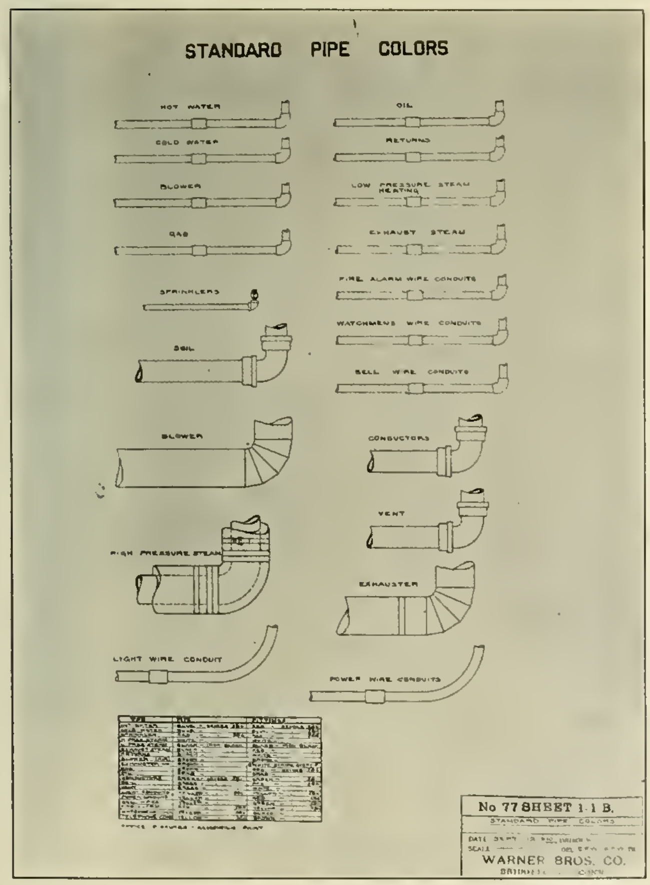

Fig 3. Charts showing the Standard Colors for Piping are hung in the Engine Room and Pipe Shop

A large keyboard in the main office (shown in Fig. 6) contains duplicate keys for every lock in the plant. Nearby is a list, enabling any key to be located in a few seconds, if an emergency should arise. For instance, in case of fire, it might be important that certain drawings, partly completed and on the drafting boards, should be removed from danger. If the drafting-room were locked, the duplicate key could quickly be found in the office, and the room entered without delay. Master keys that will unlock any gate in the plant are carried by Mr. F. E. Warner and Chief Keppy, of the private fire department, who live but a stone's throw from the factory.

Care of Waste and Paper and Cloth Scrap

A source of many fires is traceable to improper methods of keeping cotton waste, especially after it has been soiled. In this shop, the supply of waste is kept in sheet-iron boxes, the covers of which are kept closed. All soiled waste is burned each night under the furnaces. A large amount of strawboard clippings and cloth trimmings are left over from the manufactured product. Unless properly disposed of, there would be considerable danger in case of fire, for strawboard, particularly, is very inflammable. As there is more or less value in this material, the trimmings are baled and sold to paper manufacturers. The baling press is shown in Fig. 5; though very simple, it is powerful, and with its use over a carload of strawboard clippings is baled each week. After laying a strip of burlap in place in the baling press, the strawboard or cloth is thrown into the chute from the floor above, the lid is put in place, and the pressure applied. An eight-inch pinion on the same shaft as the driving pulley engages the five-foot gear shown, winding up the chain which runs over a sheave whose shaft presses upon the top lid of the press. As soon as the bale is compressed, the wires are fastened in place, and the bale removed by swinging the front of the baling chamber out of the way.

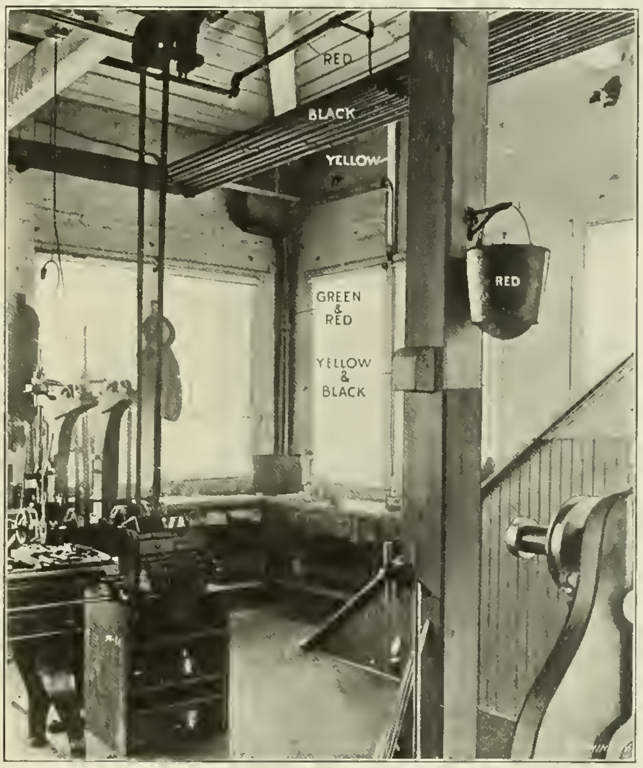

Fig. 4. A Practical Application of the Color Scheme of the Piping

Cleanliness is one of the first requisites of fire protection. The yards are covered with fine gravel and kept scrupulously clean. All hydrants are painted with their proper color and numbered. An improved type of outside fire escape is used. This differs from the ordinary type in that the descent is more gradual, and more like that of ordinary stairs, thus lessening the danger from crowding and falling when leaving a building in case of fire. This type of fire escape is especially to be advocated where many women are employed.

Fire Pails—Extinguishers—Sprinklers

Fire pails are hung at intervals throughout the factory. Fig. 7 shows the type of fire pails used. They are painted a bright red and have rounded bottoms, thus discouraging their use for any other purpose. These pails are hung upon posts about fifty feet apart, except where there is apt to be special need of them, in which case they are placed closer. Fig. 7 illustrates a particularly dangerous spot in the tool-room (and such a spot there is in every tool-room), at the forge, where there is a fire most of the time. Water is a poor weapon against oil or japan fires, and for this reason pails of sand are kept on hand in the japanning rooms. Fig. 8 shows a few of these sand pails, always at hand where oil or japan are used to any extent.

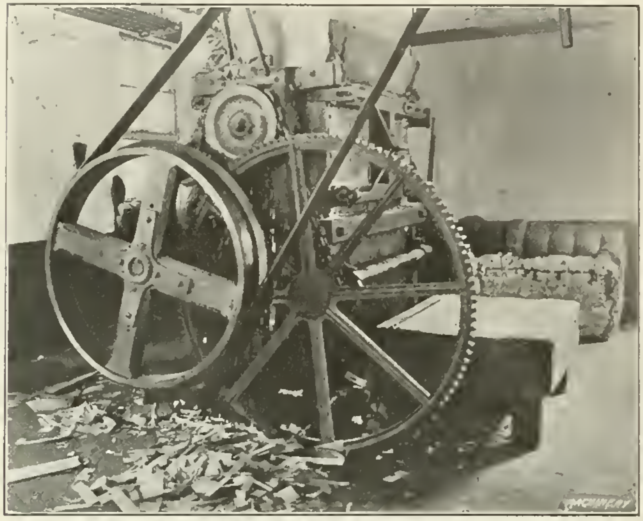
Fig. 5. Strawboard Clippings and Cloth Trimmings are baled and shipped without Delay

On the right of the exit in Fig. 9 is one of the numerous fire extinguishers that are placed upon the walls at intervals throughout the factory. These extinguishers are of the "Pyrene" make, and are said to be very effective in putting out fires of any kind, oil and japan fires included. All parts of the factory are protected with automatic sprinklers. It is unnecessary to describe this important protective device. The sprinker heads are regularly tested, and an even pressure is maintained by an auxiliary pump in the engine-room. The laws relating to sprinklers vary in different states, but in Connecticut the sprinkler heads must open upward, thus taking care of ceiling fires as well as floor fires. This provision also does away with accidental sprinkler action, caused by hitting the sprinkler head with a ladder or a belt pole.

Systematic Action in Case of Fire

If a small blaze should break out in any department, the instructions are to get as many fire extinguishers as are necessary to put out the fire, also using the pails of water or sand that are provided for the purpose. It is specially ruled by the chief that one extinguisher shall be held in reserve, for in the excitement, all of the extinguishers might be emptied at once, leaving none for an emergency.

Of course, if the fire bids fair to be other than a small one, an alarm must be pulled in at once from one of the numerous signal boxes, and all enclosing fire doors shut at once, before attempting to cope with the fire. The fire doors are covered with heavy sheet iron and run upon slanting overhead tracks. The doors are balanced with heavy iron weights much the same as windows are balanced. The weight ropes are attached to the doors with fusible links. Thus, should a door remain open during a fire, the link will melt as soon as a very slight heat reaches it, and the door will close at once. To demonstrate this point, a lighted match held under the link caused the link to melt and the door to close.

Small signal alarm boxes are placed upon the walls throughout the factory. An alarm given from one of these boxes is transmitted to the engine-room. The engineer promptly blows the factory whistle, and by means of a set of push-buttons, he sends the alarm to an indicator box at the apparatus house. The first fire department officer who reaches the apparatus house takes charge of the men and directs them to the fire. As soon as an alarm of fire rings, the operatives file from the buildings by means of the numerous exits. The exit doors that lead from the shops are lettered and numbered with very large, plain lettering, as shown in Fig. 9. The words "No. 23, 3rd floor" signify that this is the exit from the third floor of building No. 23.

The Private Fire Department

The Warner Brothers Co.'s fire department was organized in 1886 to protect the property of the company and the lives of its employes. The department is composed of fifty men, equally divided into two companies, hose and ladder. These companies are shown in Figs. 10 and 11. In selecting members, consideration is given to physical condition, steadiness in the work and proximity of residence to the factory. This last requirement is necessary on account of the importance of responding to fires that might occur outside of the factory hours. Each member is provided with a badge which must be worn at all times while within the factory. In addition,

Fig. 6 A Large Keyboard in the Office contains Duplicate Keys for every Lock in the Plant

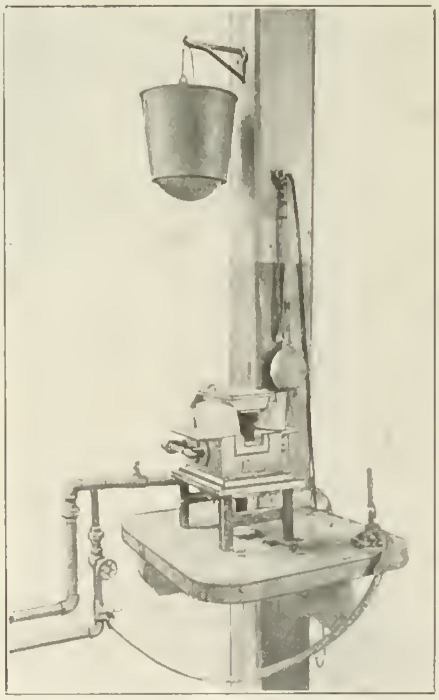
Fig. 7. Fire Pails are always at Hand where there is Special Danger from Fire

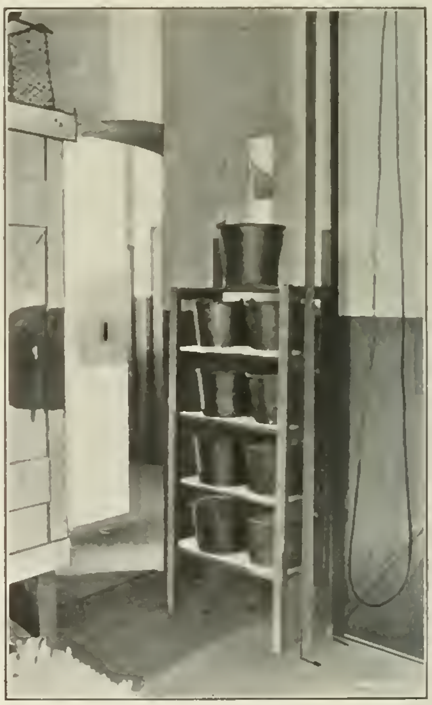
Fig. 8. Fire Doors separate Departments and Sand Pails are provided where Oil or Japan is used

each man is given a uniform that is to be used when on parades, or on other representative occasions.

Although these firemen receive no additional pay for this special duty, they get many benefits that they would not otherwise receive. In dull times the fire department members are always employed. They have formed a mutual benefit association among themselves that tends to bind them together, and protects them in times of sickness. In addition, the Warner Brothers Co. pays each fireman ten dollars per week, if incapacitated while attending to his duties as fireman.

The most important feature holding together the fire department and cultivating the spirit of loyalty, is, however, the Seaside Institute. Originally, the Seaside Institute was opened for welfare work among the operatives of the Warner Brothers Co.'s factory. It was given by Dr. Warner, the founder of the business, and is maintained by the company as a place for recreation, baths, etc., without cost to the employes. Inside and outside, the Seaside Institute much resembles a club house, and, indeed, it is a club for the employes, male and female. On the top floor of the Seaside Institute, several rooms are given over to the fire department. There is an assembly room, where the members hold their monthly meetings. There is also a smoking room and a billiard room, where the winter evenings may be spent in recreation. Besides these rooms, there is a large auditorium in which lectures and entertainments are given, and by removing the seats, dances and card parties can be held. All of these features help to make the men proud of their organization, and throughout the factory it is considered an honor to belong to the fire department.

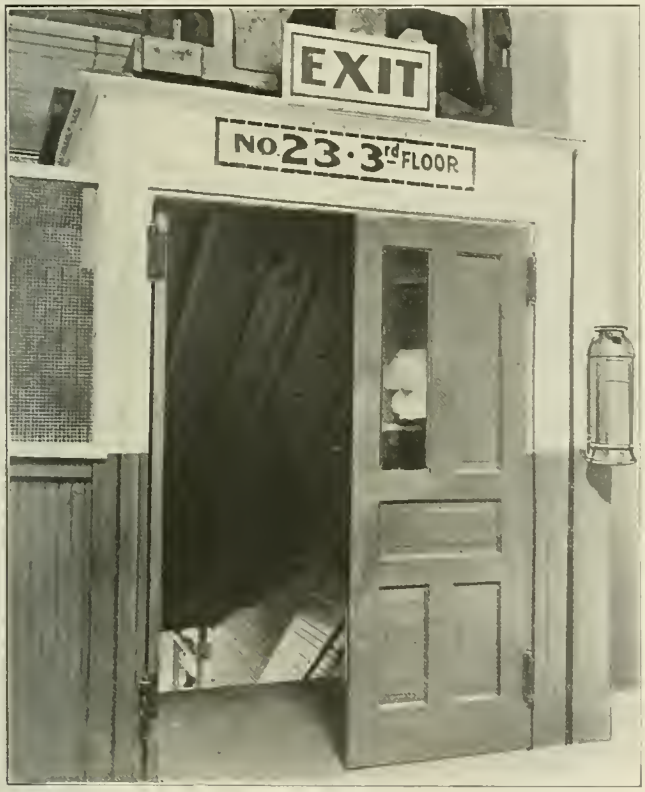

Fig. 9. The Exits are plainly numbered with the Building and Floor Numbers

The company has presented the fire department with a large silk banner, which is carried in parades. To further promote the welfare of the men as a body, the department frequently visits other fire companies. On September 2, this year, they journeyed to Allentown, Pa., to visit the Good Will company of that city.

A fire department of this kind would not long remain strong, nor do efficient work, without good officers. Since its organization over twenty-five years ago, Mr. J. W. Keppy has been its chief. There are also captains and lieutenants for each of the companies. A booklet is printed containing by-laws by which the department is governed.

Fire Drills

In order to keep the fire department efficient, alarms are pulled each week at unexpected times. As these alarms may be sounded at any time between 7 A. M. Monday morning and 12 o'clock Saturday noon, the men are never sure that the alarm is not for a genuine fire.

To illustrate the working of the drill, Mr. Keppy, the chief, pulled an alarm from a distant part of the plant, at exactly 11:35 A. M. A camera was focused upon a part of the outside of one of the buildings. Before the elapse of two minutes, the two companies, pulling their hose and ladder trucks, came running around the corner. In less than another minute, a ladder was out and run to the top of the three-story building, hose had been laid to the nearest hydrant, and the nozzleman was at the top of the ladder, ready for a stream of water. It was good work, and would have done credit to professional fire fighters. At the conclusion of each drill, the roll is called, and absentees are fined a small amount.

Fig. 10. The Ladder Company, just as they have left their Work

Apparatus

The hose team and ladder truck maintained by this company are shown in Fig. 1. The apparatus is complete in every respect, including extension ladders, short ladders and poles for steadying, as well as a good supply of hose, nozzles and fittings. The apparatus is used without horses, on the short distances about the factory. The houses in which the hose team and ladder truck are kept, are located on the side of one of the streets that bound the plant. The men that comprise the companies are from all departments of the factory, from sweepers to foremen. In Figs. 10 and 11, the men appear just as they have left their work in the shop to answer to the alarm. Chief Keppy appears on the left end of each group.

One of the important features of the fire fighting apparatus is the pair of Worthington fire pumps, in the engine-room, which can be thrown into action at any minute, night or day. They each have a capacity of pumping one thousand gallons per minute, which is equivalent to four good smooth nozzle streams, each one and one-half inch in diameter.

Fig. 11. The Hose Company, with Chief Keppy on the Left

Credit is due to Mr. Frederick C. Moore, superintendent of the inspection department of the Hartford Fire Insurance Co., for assistance in the preparation of this article. The prevention of fire dangers is closely allied to the prevention of accidents in the industries, and the two subjects should receive equal attention.

MILLING RADIAL TEETH IN CUTTER BLANKS—1*†

By GEORGE W. BURLEY‡

When radial teeth, such as the side teeth of slot-milling cutters and the end teeth of end-mills, have to be milled, it is necessary to set the cutter blank at an angle in order to produce uniform widths of "land" on the teeth. The usual formula which is employed for figuring out this angle of elevation of the index-head is as follows:

$$\cos\theta = \tan\phi \cot a \qquad (1)$$

in which,

θ = angle of elevation of index-head (see Fig. 1).

ϕ = tooth angle of cutter blank, or $\dfrac{360 \text{ degrees}}{\text{number of teeth}}$ (see Fig. 2).

a = grooving cutter angle.

The method of determining the depth of cut at the circumference of the cutter blank is, however, not so well known, and it is for this reason that this article has been written.

In Fig. 1 the conditions of the problem are indicated. The angle θ is the angle of elevation of the index-head, and is obtained by Formula (1); and d is the depth of cut required. It will be noticed that this is the maximum depth of cut, and that it is measured at the circumference of the cutter blank, or in other words, at the highest point of the blank in its inclined position. A (see Fig. 2) is a dimension which is somewhat less than the radius of the blank, its determination being dealt with hereafter.

From the geometry of the figure, $\dfrac{d}{A} = \cos\theta$. Therefore

$$d = A \cos\theta \qquad (2)$$

Fig. 2 is a part plan of a cutter having radial teeth. Here it can be seen that A is equal to $R - B$, where R = the radius of the cutter blank, and B = the distance XY, which is equal to $\dfrac{W}{\sin\phi}$, W being the width of the tooth-land measured in the plane of the side face of the cutter (*i. e.*, normal to its axis), and at right angles to the cutting edge of the tooth. It should be observed here that X is the point where the grooving or spacing cutter would leave the blank if the latter were fed along far enough and had no recesses in its side faces.

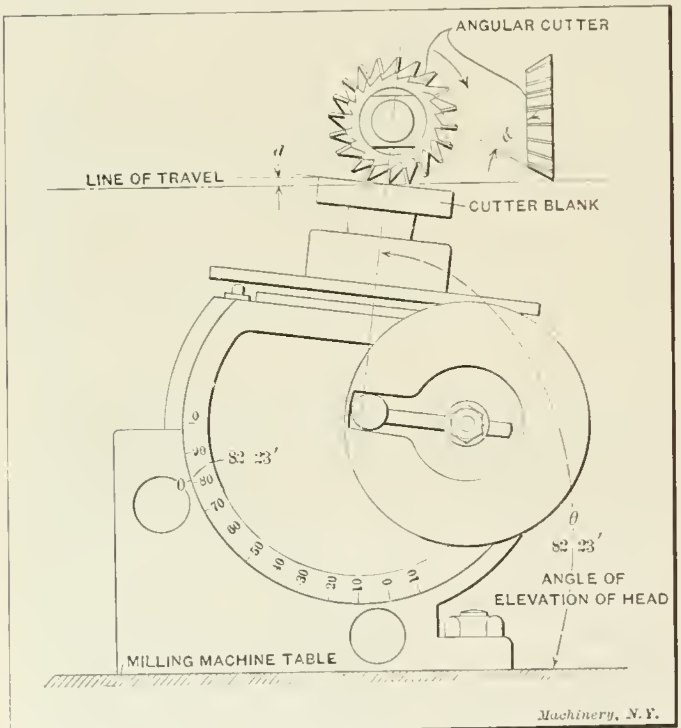

Fig. 1. Diagram for Calculating Angle of Elevation of Index-head

Since $B = \dfrac{W}{\sin\phi}$ $R - B = R - \dfrac{W}{\sin\phi}$, and $d = \left(R - \dfrac{W}{\sin\phi}\right)\cos\theta$

$$\text{Then } d \text{ in terms of } R = R\left(1 - \frac{W}{R\sin\phi}\right)\cos\theta \qquad (3)$$

Of the quantities involved in this expression, all but d and W are known or easily obtainable; however, d is the value which is required, so that if we can obtain a value for W we can readily solve the equation for d. In regard to the obtainment of W, we can either select a value for it or for $\dfrac{W}{R}$. This latter quantity is one which is fairly constant, varying from 0.017 to 0.033 inch, giving an average value of 0.025 inch. This average value is representative of the latest practice. Introducing the value of W in Formula (3), we get:

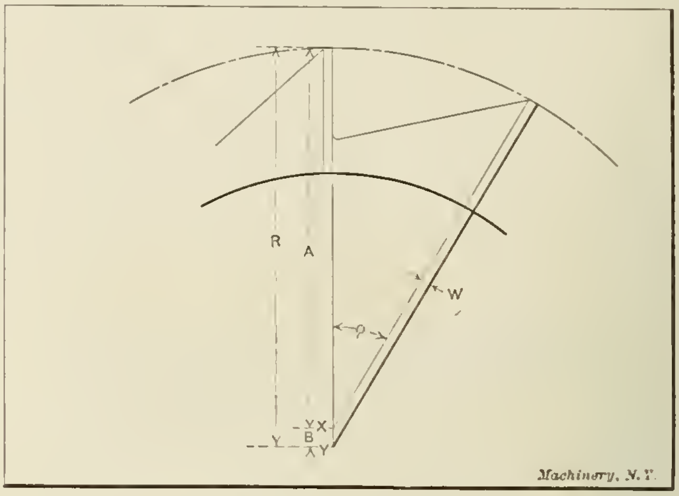

Fig. 2. Part Plan of a Side Milling Cutter, Illustrating Method of Determining Width of Land, etc.

$$d = R\left(1 - \frac{0.025}{\sin\phi}\right)\cos\theta \qquad (4)$$

which is the expression wanted under the stated conditions.

[Modified formulas for common practice will be given in the second and concluding installment. The Data Sheet, giving width of land and depth of cut, will also be continued to comprise cutters from 30 to 52 teeth, inclusive.—EDITOR.]

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IMPROVED CONSULAR SERVICE

As the consular officers are seldom in a position to represent the industries of their country, so far as it relates to questions of a purely technical nature, because they do not possess the necessary professional knowledge, it has been proposed in Germany to assign technical experts to various important German consulates. The activity of these experts will be largely confined to following the progress of the industrial developments of foreign countries, and to report on the advance in the engineering field. Considering the meager return to the engineering and industrial interests of a country from the reports of the consular service, it seems that this is a move well worth imitating by any nation desiring to serve its industries with useful information. Whether, however, the technical expert stationed in a foreign city will be able to report on engineering matters in such a manner that his reports will be of direct value to the industries of the country is somewhat doubtful. The field he will have to cover will be very broad, and of necessity he can have but a limited knowledge of the many subjects upon which he will be called to report.

* * *

Cromwell Dixon, the aviator who flew across the Rocky Mountains, September 30, fell at the Inter-State fair grounds at Spokane, Wash., October 2, and received injuries that caused his death. According to published statistics, Dixon's death makes the ninety-eighth fatality connected with aeroplanes since Lieut. Selfridge's death in 1908.

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* With Data Sheet Supplement.

† For additional information on this and kindred subjects see: "Setting Angles for Milling Angular Cutters and Taper Reamers"; November, 1908, engineering edition, and other articles there referred to.

‡ Address: University of Sheffield, Sheffield, England.

THE METAL-WORKING INDUSTRIES OF DUSSELDORF

THEIR EXTENT AND VARIETY—SHOP CONDITIONS AND SURROUNDINGS WHICH ATTRACT AND RETAIN SKILLED LABOR

By C. A. TUPPER*

In no part of Germany will the American traveler who wishes to investigate the differences between methods of metal-working at home and abroad find so many valuable suggestions as in Düsseldorf and vicinity; nor will he conceive, anywhere, a greater admiration for what is best and most progressive in German practice. For a European trip of relatively short duration, such as most American business men feel obliged to take, if they are to go at all, Düsseldorf is the best possible objective point.

The city itself has a number of important industrial districts. In Oberbilk, which is the nearest to the Hauptbahnhof, or main railway station, one finds the Aktien-Gesellschaft Oberbilker Stahlwerk, formerly C. Poensgen; Giesbers & Cie, fabricators of pressed steel; the Düsseldorf Rohr und Eisenwalzwerk Akt. Ges.; Rohrwalzwerk Piedboeuf and Walzwerk Oberbilk, tube and rolling mills; the Akt. Ges. Düsseldorfer Eisenbahnbedarf, manufacturers of railway supplies; the machine shops of Fischer & Cie.; the plant of Hein-Lehmann & Cie. Akt. Ges., builders of railway and bridge material, signal systems, etc.; the works of the A. Hahn Akt. Ges., and others. The adjacent district of Lierenfeld contains the factory of the Gebrüder Inden; the machine-tool building plant of Habersang & Zinsen, or Düsseldorfer Werkzeugfabrik; the Düsseldorfer Rohren und Eisenwalzwerk, rolling mills; the iron and steel fabricating shops of the Oeking Akt. Ges., whose product includes gear wheels of very large size; and a number of boiler works and metal-working plants extending through what was formerly the village of Klein Eller.

Between Flingern and Grafenberg, above Lierenfeld, are the great foundries, forging and machine works of Haniel & Lueg; and on the way one passes the iron works of Senf & Heye; the sheet-metal works of Springerum & Cie.; and, some distance to the left, the Düsseldorfer Rohren-Industrie, or tube mills and pipe factory, as well as various furnaces and kilns. At Ratingen are the Eschweiler-Ratingen Maschinenbau Akt. Ges., outfitters of pipe and drawn steel products plants; and the home of the celebrated Dürr water-tube boilers, the Düsseldorfer-Ratingen Rohrenkessel Fabrik, formerly Dürr & Cie. Others, the locations of which the writer does not recall clearly, from having visited them in a closed automobile on a rainy day, are Hartung, Kuhn & Cie., who do a world-wide business in governors for engines, turbines, compressors and pumps; and Wellman, Seaver & Head, Ltd., manufacturers of charging machines, strippers, etc., for open hearth furnaces. The latter is a branch of the Wellman-Seaver-Morgan Co. of Cleveland, O.

Haniel & Lueg, from whose plant the illustrations accompanying this article are taken, are builders of heavy machinery, including large gas and steam engines, blowing engines, steam-hydraulic forging presses and other equipment for complete hydraulic plants, mining machinery and pumps, material for steel ships, heavy forgings for cranks, shafts, propellers, etc., boilers and plate work, large castings, etc. The equipment of the shops is thoroughly modern in character, and all tools, except the hammers and forging presses, are electrically operated and controlled. From the foregoing it will be seen that the work is mostly of a special character and calls for the utmost skill; hence, the standard of wages corresponds with the high grade of the labor. The firm has never experienced any serious labor difficulties and succeeds in keeping good men a long time in its employ. The grounds of the establishment occupy over 30 acres, nearly half of which is covered by shop buildings. From a small beginning in 1872, the firm has come to employ upwards of 2000 men.

In the steel works are three furnaces, of 30, 40 and 60 tons capacity, of the Siemens-Martin type, for the production of ingots of both mild open-hearth and nickel steel, suitable for forgings weighing up to 70 tons. Steel castings as heavy as 60 tons are also turned out. In making the ingots and castings, a special process is used which tends to leave them free from internal defects, and the good results thus obtained

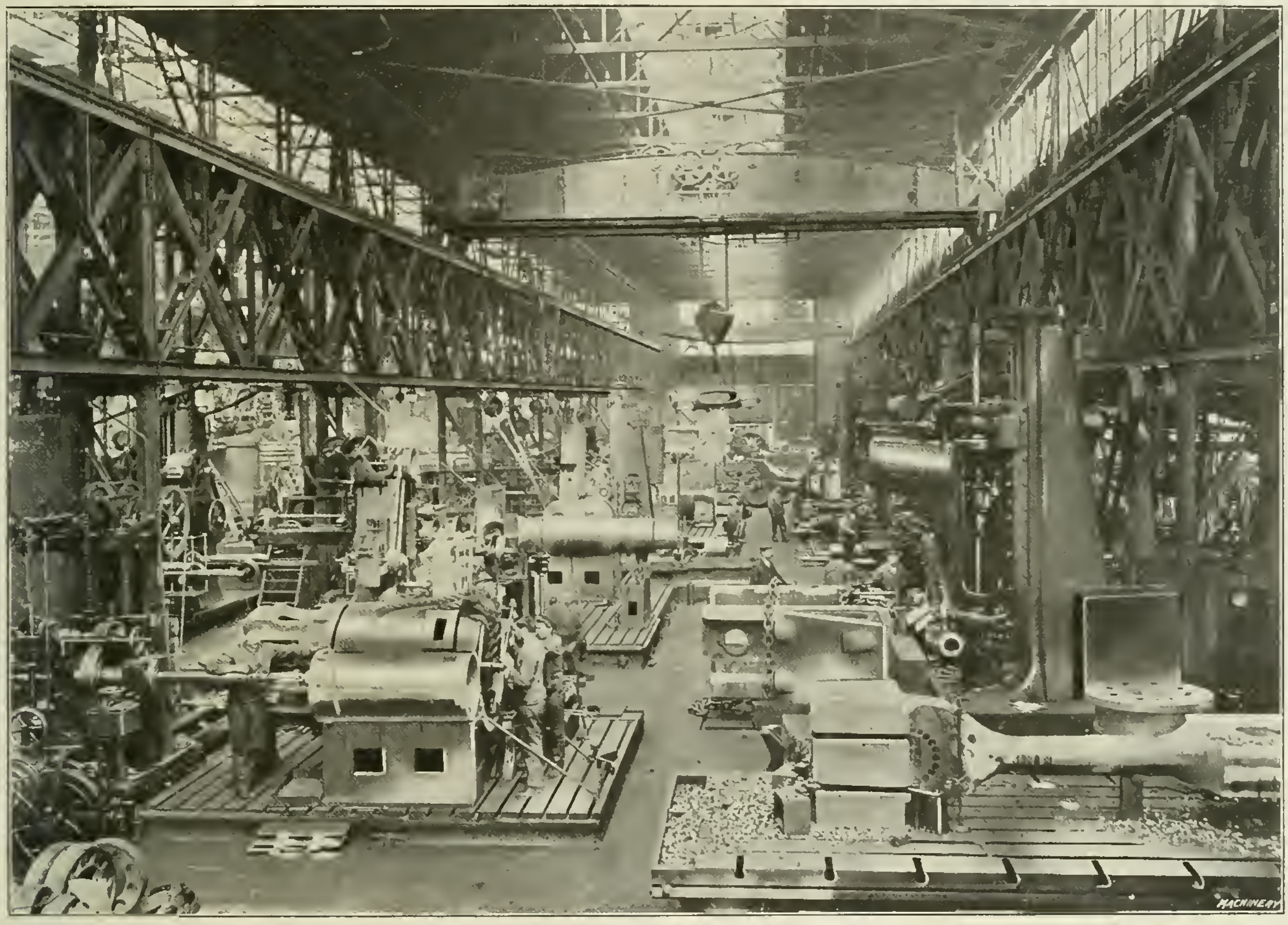

Fig. 1. Machine Shop No. 1 of the Firm of Haniel & Lueg, Dusseldorf

are further improved upon by careful reheating and annealing, for which seventeen auxiliary furnaces have been provided. In this department there are eight steam hammers, from the smaller sizes to the largest, with suitable cranes to facilitate the handling of the work. The iron foundry has three cupola furnaces and is capable of producing the largest castings required for gas engine frames or other heavy parts.

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* Address: 389 Thirty-first Ave., Milwaukee, Wis.

The most interesting section of the works, outside of the machine shops, is the steam-hydraulic forging department, a view of which is shown in Fig. 2. This illustration shows a 2500-ton forging press of the firm's own design, duplicates of which have been built for other forging plants, notably in England. There are also presses in operation of 500 and 1800 tons working pressure, constructed on similar lines. These three presses are used in forming steel shafts, rods, cranks, and parts such as stern posts, rudder frames, etc., required in ship building.

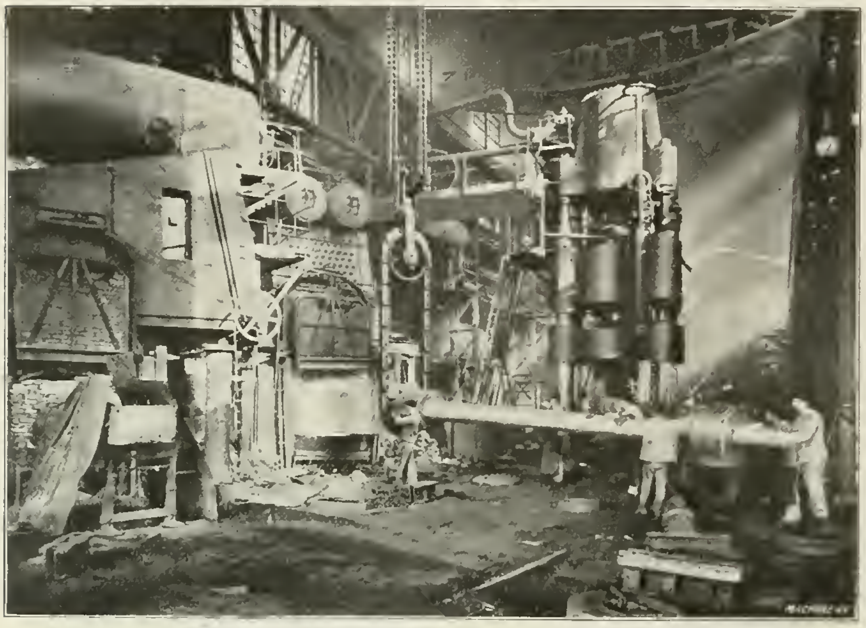


Fig. 2. Forging Shop of Haniel & Lueg, showing Steam-hydraulic Forging Presses

Fig. 1 shows the main bay of machine shop No. 1, with stationary and portable tools working on independent floor-plates, which appear to be used with as good results as the continuous floor-plates that are coming into vogue in this country. Great pains are taken to so arrange the tools that heavy work may be routed through the shop in such a manner as to insure the minimum of handling. Except for an irregular space between the floor-plates, there is no aisle, and practically no material is transported at ground level, two large cranes being kept in almost constant service for this purpose. The other machine shops are similarly arranged. Fig. 3 shows a view of a section of the erecting shop, where mine pumps are being assembled. The ample head-room will be noted by comparing it with the height of the man to the right of the center.

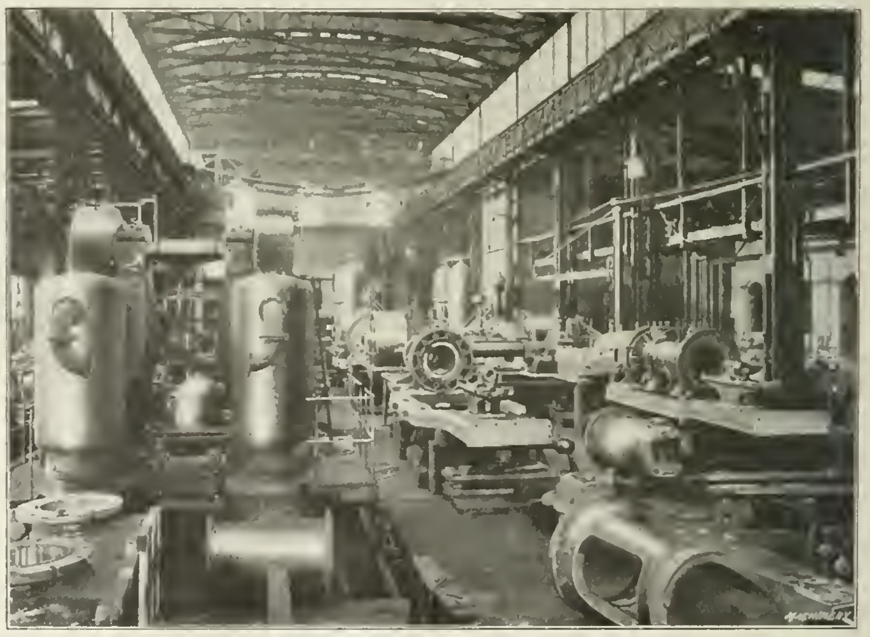


Fig. 3. A Section of the Erecting Shop for Mine Pumps

Careful provision is made for the welfare and comfort of the men. The firm of Haniel & Lueg believes that, in addition to being a good thing in itself, it increases the efficiency of labor. At the works each man has his own locker, and a change of clothes is customarily made upon entering and leaving. There are also baths and lavatories, with soap and towels provided, and steam heaters for drying garments during wet weather. When it is cold or stormy, the men take their noon meal in a mess room, with which a canteen is connected. Food and liquid refreshment may be purchased here at low prices. The writer believes that coffee is furnished free by the firm, but is not positive on that point. In the summertime meals are eaten out of doors in an extensive, well-kept garden, and the men frequently have, at noon, the company of their wives or other members of their families.

The average day's wage in the works amounts to about $1.20, but on piece-work the skilled men make very much more. For molders and machinists it varies, say, between $1.80 and $2.90, including a system of bonuses. Spoiled work is penalized by deductions from the bonus. In the forging department, where the men work in gangs, the first man earns about $2.50 for the day, and the others are paid at a lower rate, with a premium placed upon good work. There is also a system of gratuities for employes who have been in the service ten years or more. A savings bank is maintained by the firm, which allows a good rate of interest, and advantage of it is very generally taken by the men. Wages do not expand and shrink with conditions of trade, but are kept at a uniform, although gradually rising, level. The variety of the work done by the firm and the fact that its shops have had plenty of work, even in dull seasons, has enabled it to maintain this policy when less fortunate concerns might not have found it possible to do so; but there is, no doubt, a direct relation to be traced between keeping a large force of trained men satisfied, and having the work for them to do.

There is a circulating library at the shops, having nearly 5000 volumes. An ambulance service and hospital have been provided for accidents or cases of serious illness, and the firm even maintains a maternity hospital for the wives of the men. Especial attention is devoted to apprentices, who receive only a small daily wage, but who are allowed to attend continuation schools for a certain number of hours each week.

The hours of labor are from 6:30 A. M. to 12:00 M., and from 1:30 P. M. to 6:30 P. M. This would be considered a long day in our country, but the men enjoy a noon rest of an hour and a half, and they are also given a quarter hour, both in the morning and afternoon, for further refreshment. Furthermore, their personal cleanliness, bodily comfort and general working conditions, with good light, ventilation, etc., are so carefully looked after, that men accustomed to military discipline thrive under this routine; and the state of their minds is reflected in the neat, orderly character of the shops and the work.

Another notable Düsseldorf plant, and one of the most interesting in Europe, is that of the Ernst Schiess Werkzeugmaschinenfabrik Akt. Ges., located almost in the center of the city. This concern was founded in 1866 by Dr. Ernst Schiess, now chairman of the Board. Since 1869, a period of 42 years, nearly 12,000 tools have been built. The significance of this may be better appreciated when it is realized that the company makes a specialty of very heavy machines used in the manufacture of armor, ordnance, steam turbines, engines, and of plates for furnace construction, ship building and the like. The company operates in conjunction with a plant at Riga, Russia, formerly known as Felser & Co. Although the Düsseldorf works are so situated that the surrounding real-estate is very valuable, they have been steadily enlarged and occupy now a site of 13½ acres. About 1200 men are employed. Part of the erecting shop for heavy machine tools is shown in Fig. 4.

A plant of nearly equal interest to the Haniel & Lueg and Schiess establishments is that of the De Fries & Co. Akt. Ges., which is especially well known in the United States from the fact that this company has the agency for many tools of American manufacture, which it sells in connection with its own. There are also more American machines in use in these works than in the other shops described. The plant is located at Heerdt, a suburb of Düsseldorf, situated a short distance across the Rhine beyond Ober-Cassel.

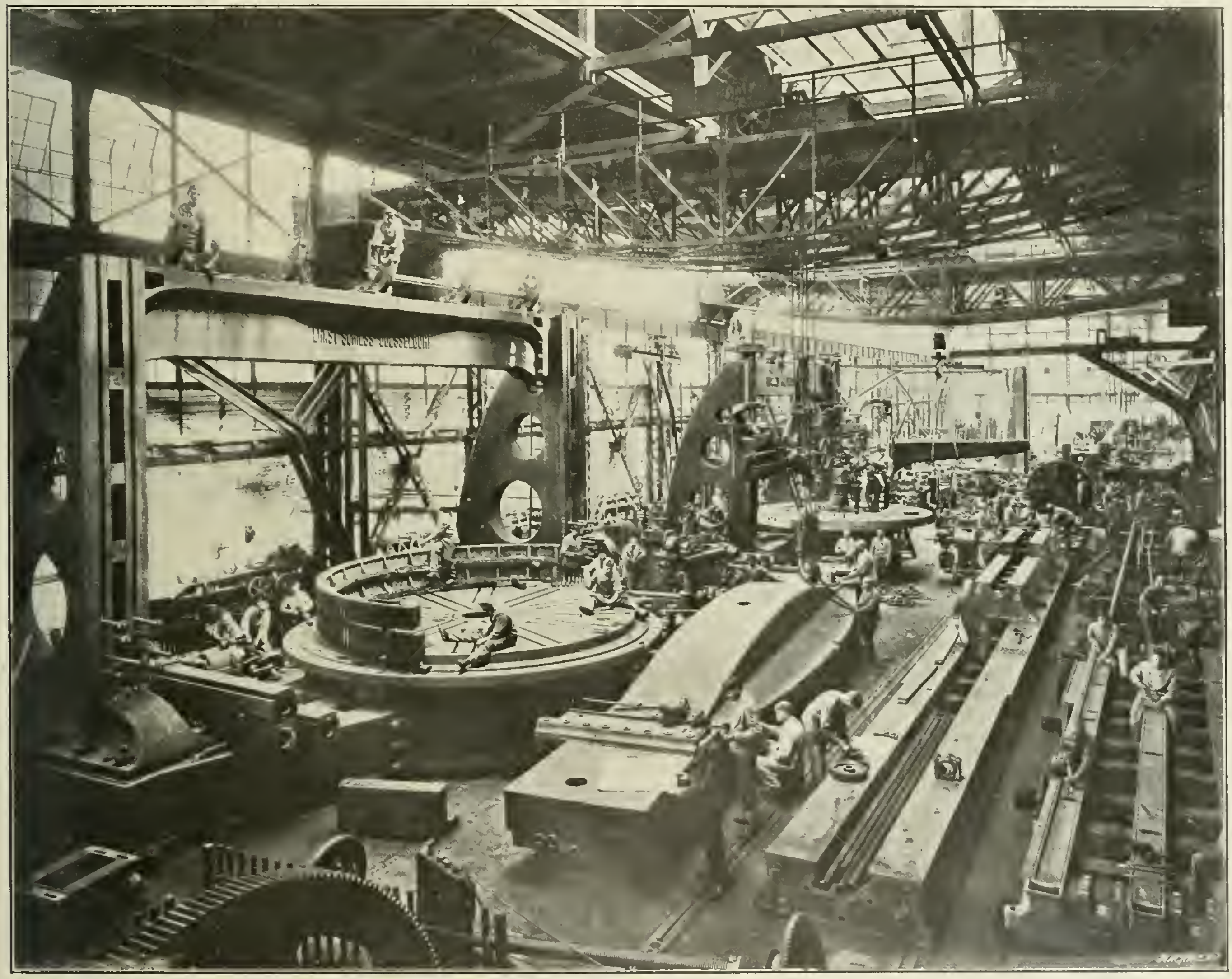


Fig. 4. Part of the Erecting Shop in the Ernst Schiess Werkzeugmaschinenfabrik

In the city are also located the Mannesman-Rohrenwerke, whose specialty is seamless drawn and welded tubing, the Press und Walzwerk Akt. Ges., Düsseldorf-Reisholz, manufacturers of rolled, drawn and pressed steel products; De Limon Fluhme & Co., makers of hydraulic presses and accumulators, machinery for tube mills, gears, castings, etc.; the boiler and sheet metal plant known as the Kesselschmiede und Blechwalzwerk von Piedboeuf; Schlosser & Feibasch, makers of cranes and hoists; the Maschinenfabrik Wikschtröm & Bayer, makers of machines for the wire industries; the Rheinische Metalwaren und Maschinenfabrik, manufacturer of seamless drawn steel tubing; the Walzmaschinen-Fabrik Aug. Schmitz, manufacturer of rolling mill machinery, and other plants of less importance.

Moreover, Düsseldorf is the center of a great industrial district, all points of which may be reached by short journeys on the steam and electric railways that radiate in every direction. It is not far to the great Krupp works at Essen; the Deutsche Maschinenfabrik Akt. Ges., the Duisberger Maschinenfabrik J. Jaeger, and the Gebrüder Scholten, at Duisburg; the Rud. Meyer Akt. Ges. and Thyssen & Co., at Mülheim-am-Ruhr; the Maschinenbau Akt. Ges. Balcke, at Bochum; the Wilhelm Breitenbach Maschinenfabrik at Unna; Basse & Selve at Altona; Otto Froriep, at Rheydt; the Maschinenfabrik Sürth, Gas Motoren Fabrik Deutz, Kolnische Maschinenbau Akt. Ges., the J. Pohlig Akt. Ges., and Maschinenbau Anstalt Humboldt in Cologne and vicinity; the great steel works and machinery building plant at Oberhausen, called the Gutehoffnungshütte, a name that is said to be derived from the iron works at Sterkrade where the founder of the Krupp works learned his trade; and other establishments along the route. In addition there are Dortmund, Gelsenkirchen, Hagen, Hamm, Horde, Remscheid, München-Gladbach, Solingen, Eberfeld-Barmen, Neuss, Mülheim-am-Rhein and perhaps Aachen, the farthest to the West, all of which will repay visits if a traveler has the time.

Düsseldorf now has a population not much under that of Cincinnati. It is a fine modern city, the seat of the provincial council, with wide, well-paved streets, a good harbor, beautiful parks, and public utilities of every description. As a pleasant, comfortable place in which to live, it has attracted the best classes of labor, not only from other parts of Germany but also from neighboring countries. The value of this condition as an asset both of the present and future is fully appreciated by the manufacturers mentioned, who are cooperating in every possible way to perpetuate it. Conditions such as those in Pittsburg, and which other American machinery centers are rapidly approaching, will, if the present policy is maintained, never be known in Düsseldorf, the busy, hospitable city on the Rhine.

NOISY GEARING*

ITS CAUSES AND A METHOD OF CORRECT DESIGN FOR ITS ELIMINATION

By E. A. VESSEY† and J. A. SEAGER‡

A great deal has been written on the subject of noisy gearing. Many suggestions have been made for its elimination and some improvements have undoubtedly been made. In the present article a method will be explained which tends to produce silent-running gearing. This method has been practically applied by one of the writers for several years.

Causes of Noisy Gearing

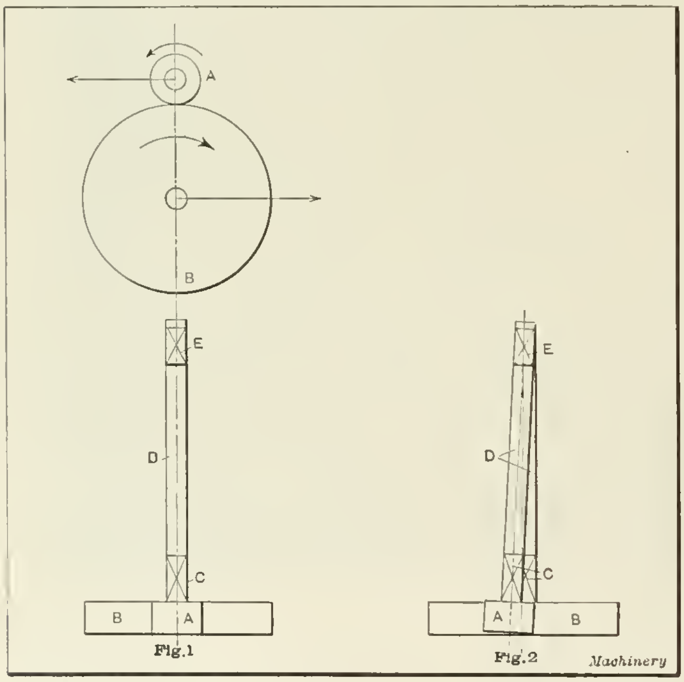
All noise in gearing is caused by the vibration of the material in the gear. The source of this vibration is usually a series of blows resulting from one or more of the following causes:

1.—The individual teeth are unequally loaded; that is, the load is borne by more teeth at some periods than at others. In this case it is perhaps incorrect to describe the effect on the teeth as a blow, since it takes the form of an increased compression of the material, which, however, produces vibration.

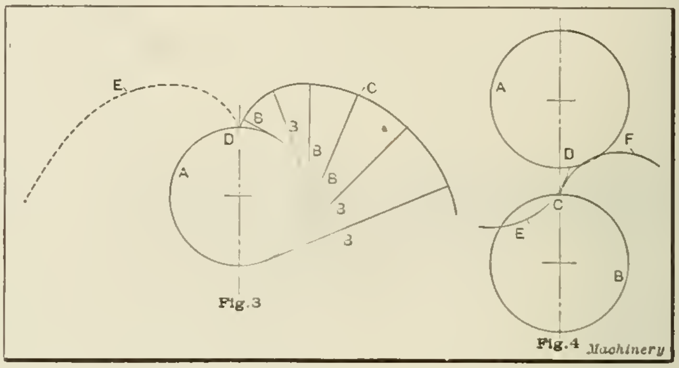
2.—The blow may be an actual concussion caused by one tooth being disengaged before the next tooth takes up the load. Under present conditions this is a cause seldom met with, but was often found in the past when pinions with too few teeth were used.

3.—Owing to inaccuracies in cutting, the pitch of the teeth may vary around the gear circumference, so that while theoretically two or more teeth should be in contact, only one supports the load. When the latter comes out of contact, the load is transmitted to the next tooth by a sharp blow. This has been a most prolific cause of noisy gearing.

4.—The faulty alignment of the shafts on which the gears are mounted produces a jamming action, causing an objectionable grinding noise. Even if the alignment is perfect when the gears are erected, the shafts are practically certain to become displaced sooner or later owing to uneven wear in the bearings. Figs. 1 and 2 show, diagrammatically, a case of this kind. In Fig. 1 the power is transmitted from pinion *A* to gear *B*. Assume that the action between the teeth is perfect and that, therefore, the pressure between the teeth is at all times in exactly the same direction relative to the pitch circles. This pressure tends to force *B* in the direction of the lower horizontal arrow and *A* in the opposite direction. Actual motion is prevented by bearings *C* placed as close to the gears as possible, but, in time, the pressure on the bearings *C* will cause wear; if the bearing surface is inadequate, which is commonly the case, perceptible wear soon takes place. The result is that the shafts *D* tend to turn bodily about their bearings at *E* where the wear is not likely to be so pronounced. The gears then take a position as indicated in Fig. 2 and the teeth will bear on both sides. This is undoubtedly the reason why gears originally silent in action, gradually become noisy. This defect is difficult to cure entirely, but a great deal may be done by increasing the available bearing surface close to the gears, or by placing another pair of bearings outside of the gears. Of course, the forces acting on the bearings are not horizontal, but slightly inclined, owing to the inclined action on the teeth. For simplicity of illustration, however, the case has been presented as indicated.



Figs. 1 and 2. Diagrammatical View showing Effect of Disalignment



Figs. 3 and 4. The Involute Curve and its Application to Gear Teeth

5.—Noises are also due to special forms of teeth. For example, with cycloidal teeth, the smallest separation of the shafts destroys the uniformity of transmission and noise results. Since, however, the involute tooth is now practically universally adopted, the present article will deal with the latter form of tooth only. The statement that a partial separation of the centers of involute gears does not affect the true working of the teeth is not wholly true; cases may occur when noise will result from this cause. A separation of the centers has the effect of reducing the length of time of contact, and hence it is reasonable to assume a case when two gears have such a number of teeth that one tooth is released from the load at the instant when the next tooth in succession comes into mesh. In this case the conditions mentioned under (2) are met with.

6.—Interference between the teeth themselves is a common cause of noisy gearing. To rightly understand this cause it is necessary to enter briefly into the theory of the shape of the involute tooth. The involute is commonly defined as a curve described by the end of a string as it is unwound from a cylinder, the string being kept taut, so that in every position it may be described as a tangent to the cylinder. In Fig. 3, *A* represents the cylinder and *B* the string in various positions as it is unwound from the periphery of *A*; *C* is the involute described by the end of the string. The circle *A* is known as the "base circle" of the involute, and *D* is called the "source of the curve." It follows from the definition that the involute is not a closed curve; in other words, it terminates in infinity. It is also evident that it is a curve of two branches because the string may obviously be unwound from the "base circle" in either a clockwise or a counter-clockwise direction, the second branch being indicated in Fig. 3 by the dotted curve *E*. As the involute lies entirely without the circumference of its base circle, the working part of the curve terminates at *D*. It is, therefore, evident that we must so proportion the mating involutes that when the two curves are rolling together, the point of contact between the source of one curve with the other curve shall be the outer termination of the latter.

This will be made clearer by referring to Fig. 4. Here *A* and *B* are two base circles with their respective involutes *E* and *F*; *D* is the source of *E*, and *C* of *F*. The two involutes are in contact, and it will be seen at once that the involute *E* must be cut off at the point which has been in contact with *C*, and similarly that *F* must terminate at the point which will come ultimately into contact with *D*. If the involutes are extended beyond these points, the mathematical action still continues but actual contact is impossible, since it entails an overlapping of the curves, causing one tooth to dig into the other. The points C and D, are known as "interference points," and interference or the digging of one tooth into its mate is a direct result of extending the addendum beyond the circle drawn through the interference point.

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* For information along similar lines previously published in MACHINERY see: "Interchangeable Involute Gear Tooth Systems," January, 1909.

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Evidence that interference actually occurs in practice will usually be found on examining a pair of gears which have been in action for some time and where one of them is a pinion of less than 20 teeth. On examining the pinion teeth, a groove will be found in the face of the teeth, slightly below the imaginary pitch line of the tooth, and the points of the gear teeth will be found to be rounded over and bright. In some cases this groove becomes a keen line, as if it had been drawn with a scriber. Except in the case of equal gears, the groove is usually found only on the teeth of the gear with the lesser number of teeth. The presence of this mark is invariably accompanied by noise, and is a sure sign of their being too few teeth in the pinion. It is proposed to deal more fully with this point later, since it deserves a great deal more attention than it generally receives. The blow which causes vibration and noise in this case takes place between the points of the gear teeth and the flanks of the pinion teeth. On first contact, it is a blow pure and simple, afterward becoming an abrasion, so that from this cause two distinct kinds of noises arise, namely, the ring due to the blow and the grind due to the abrasion. Noisy gears must of necessity be inefficient transmitters of power. Therefore, altogether apart from the question of comfort, noise must be reduced as far as possible if high efficiency is to be attained.

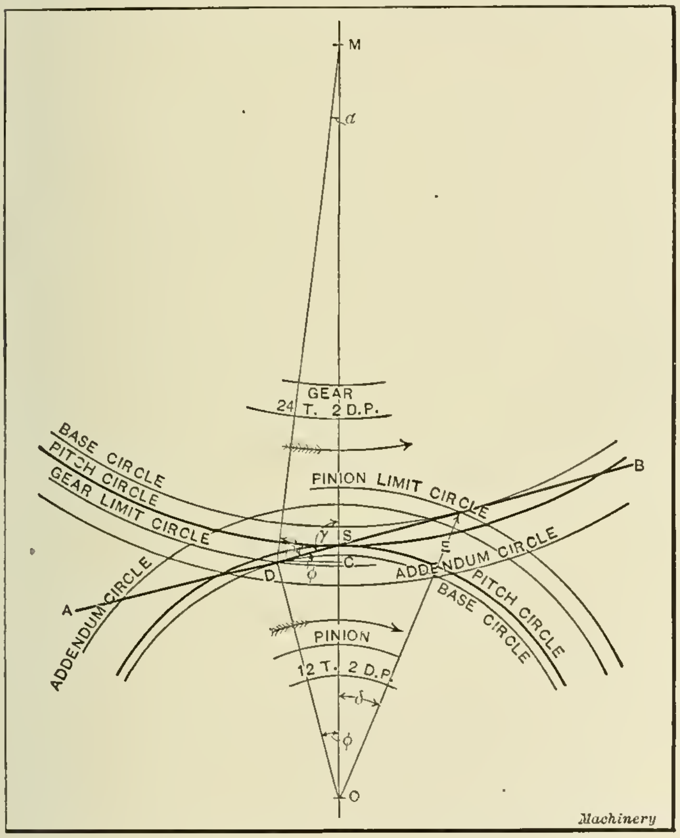

Fig. 5. Diagrammatical Lay-out for the Derivation of Formulas

The foregoing paragraphs give the six chief causes of noise in gearing. In the cutting of gearing by the various processes now in use, the limit of refinement in workmanship has practically been reached. It is therefore evident that in order to eliminate the noise of gearing, it is necessary to make a change either in the design of the teeth or in the gears themselves. One method which has been adopted for the reduction of noise is the use of pinions made of rawhide, paper, fiber and other similar materials. Gears made from these materials, however, do not remove the cause of the trouble, but merely allay it, and the very causes which produce the noise in regular gearing in most cases end by destroying the pinion when made from less wear-resisting materials. In the writers' opinion, the materials mentioned, by their very nature, do not always promise good wearing resistance—with the exception probably of fiber. Besides, other troubles are introduced: rawhide is easily injured by oil, and the same applies to paper pinions; consequently lubrication is difficult, it becoming necessary to use solid lubricants, which are somewhat difficult to apply. Fiber is peculiarly susceptible to moisture, which causes it to swell and often to jam. These materials for gearing cannot, therefore, be considered a permanent aid for securing efficiency of transmission.

Noise due to Interference—Analysis of the Conditions

It has already been shown that for any two gears in mesh, owing to the nature of the involute curve, interference points exist, and that if circles are drawn through these points, the points of the teeth must not be prolonged beyond these circles. This being so, we are led to believe that, given a ratio, there should be one pair of diameters which will give the best results, and one pair only. It is proposed to prove that such is actually the case, and to proceed to establish formulas which will enable us to fix the correct number of teeth in the larger gear of a pair for any ratio. The present article has been written particularly with the object of bringing this important matter before the practical man.

In Fig. 5 is shown, diagrammatically, a pair of gears, and the number of teeth has been purposely chosen very low in order to render the argument more obvious. The tooth profiles are assumed to be involutes and hence the line of contact is a straight line AB. The base circle (that is the circle from which each involute is generated) is marked for each gear. Now, the limit line for each gear is found by striking from the gear center an arc passing through the point of tangency of the line of contact AB and the base circle of the other gear (*i. e.* the source of the working involute). These points are D and E, respectively, and the limit circles are shown passing through them. It will at once be seen that as far as the pinion is concerned, no interference is to be anticipated, since the addendum circle lies well within the limit circle, but a considerable shortening of the addendum of the wheel teeth is necessary if interference is to be avoided. The addendum is usually taken as a function of the pitch, the value most commonly used being:

$$\text{Addendum} = \frac{1}{\text{diametral pitch}}$$

It will, therefore, be seen that if standard teeth are to be used, it is necessary to redesign the gears, adjusting the number of teeth and pitch so that the addendum circle and limit circle shall at least coincide. The best conditions are secured when these two circles coincide because the maximum arc of contact without interference is then obtained. Further, it is obvious that since the height of the teeth in the larger gear is dependent on the point of tangency of the line of contact and the base circle of the pinion, any variation in the ratio of the train by altering the pitch diameter of the pinion, and consequently also its base circle diameter, will entail an alteration in the tooth height for the gear; in other words, there is for every ratio one pair of gears, and one only, which will give the best all around efficiency.

The requirements are filled when the first point of the contact of the gear (the intersection between the line of contact AB and the addendum circle) is so located that a radius from the center of the pinion, through this point, makes a right angle with the line of contact. In that case, the addendum circle and the limit circle of the gear will coincide.

In Fig. 5 let angle SDO be a right angle, and let the angle SDC of the involute be called ϕ. The line CD is perpendicular to line MO, the line through the gear centers. Then, angle SOD = angle $SDC = \phi$

Let $SD = a$, and $SC = x$. Then, $\dfrac{x}{a} = \sin\phi$ (1)

Let n = number of teeth in pinion,
N = number of teeth in gear, and
P = diametral pitch.

Then, $SO = \dfrac{n}{2P}$, and $\dfrac{SD}{SO} = \dfrac{a}{n \div 2P} = \sin\phi$ Hence,

$$a = \frac{n}{2P}\sin\phi \qquad (2)$$

Substituting in (1) and transposing:

$$x = \frac{n}{2P} \sin^2 \phi \qquad (3)$$

In triangle CDO we have $\frac{CD}{CO} = \tan \phi$. But,

$$CO = SO - SC = \frac{n}{2P} - \frac{n}{2P} \sin^2 \phi = \frac{n}{2P} \cos^2 \phi$$

Hence,

$$\tan \phi = \frac{CD}{\frac{n}{2P} \cos^2 \phi} \qquad (4)$$

Let angle $CMD = a$; Then, $\tan a = \frac{CD}{CM} = \frac{CD}{SM + SC}$

But $SM = \frac{N}{2P}$. Hence,

$$\tan a = \frac{CD}{\frac{N}{2P} + \frac{n}{2P} \sin^2 \phi} \qquad (5)$$

Dividing (4) by (5):

$$\frac{\tan \phi}{\tan a} = \frac{N + n \sin^2 \phi}{n \cos^2 \phi} = \frac{N}{n \cos^2 \phi} + \tan^2 \phi. \quad \text{Hence,}$$

$$\cot a = \frac{N}{n \sin \phi \cos \phi} + \tan \phi \qquad (6)$$

from which a can be determined.

We have further, $a + \beta + \gamma = 180$ degrees. But $\gamma = 90° + \phi$.

Therefore, $\beta = 90° - \phi - a$ (7)

from which β can now be found. Further,

$$\frac{DM}{\sin \gamma} = \frac{SM}{\sin \beta}$$

But $DM =$ half the outside diameter of the gear $= \frac{N + 2}{2P}$

$$SM = \frac{N}{2P} \text{ and } \sin \gamma = \cos \phi. \quad \text{Hence,}$$

$$\frac{N + 2}{2P \cos \phi} = \frac{N}{2P \sin \beta}$$

$$\sin \beta = \frac{N}{N + 2} \cos \phi \qquad (8)$$

As β is known from Equation (7), N can be obtained by solving (8). The value of N thus found is the smallest number of teeth permissible in the larger gear if interference is to be entirely eliminated.

Charts for Finding Number of Teeth in Large Gear

The foregoing solution appears cumbersome, but in applying it to practice the only equations used are (6), (7), and (8), which are easy to solve. The curves corresponding to the equations for 14½- and 20-degree angles of involute are given in Figs. 6 and 7. One curve in each chart was arrived at by solving Equation (8) and was plotted with values of $\sin \beta$ as abscissas and corresponding values of N as ordinates. From Equation (6) values of $\cot a$ were then found corresponding to given values of $\frac{N}{n}$ (the ratio). Knowing a and ϕ, values of β were then obtained from (7) corresponding to the given values of $\frac{N}{n}$. Corresponding values of $\sin \beta$ were then found from a table of sines, and the second curve was plotted with $\frac{N}{n}$ as ordinates, and the value of $\sin \beta$ as abscissas. The dotted lines on each chart indicate the course to be traced in using the diagram. The most usual problem will be, given a ratio, to find the most suitable number of teeth for the larger gear. In solving this problem, first find on the left-hand side of the chart a figure denoting the given ratio, and trace horizontally to meet curve marked "Curve I." From this point trace vertically to meet "Curve II," and then again horizontally to the right-hand side of the chart, where the correct number of the teeth for the larger gear will be found. Thus in the example chosen it was required to find the correct number of teeth in the larger gear of a pair having a ratio of 5 to 2. This ratio is first expressed in terms of unity, *viz.* 2½ to 1, and 2½ is found on the left-hand side of the chart. The dotted line is then followed horizontally to Curve I, and then vertically to Curve II, and finally horizontally to the right side of the chart. In Fig. 6, for 14½-degree involute, the number of teeth is found to be 65, and in Fig. 7, for 20-degree involute, 38. The pinions then will have 26 and 15.4 teeth, respectively. Since fractional teeth are impossible, these values for the pinions become 26 and 16, and, therefore, the corresponding gear teeth values are 65 and 40.

For the moment, since 14½ degrees has been practically universally adopted as the standard angle of involute, our attention will be confined to Fig. 6. Two things are particularly to be noticed:

1.—As the ratio increases, the number of teeth in the pinion must also increase. Thus with a ratio of 1 to 1 (equal gears) both gears should have 22 teeth; with a ratio of 4 to 1 the pinion must have 118 ÷ 4 = 30 teeth; and with a ratio of 8 to 1 the value must be increased to 250 ÷ 8 = 32 teeth.

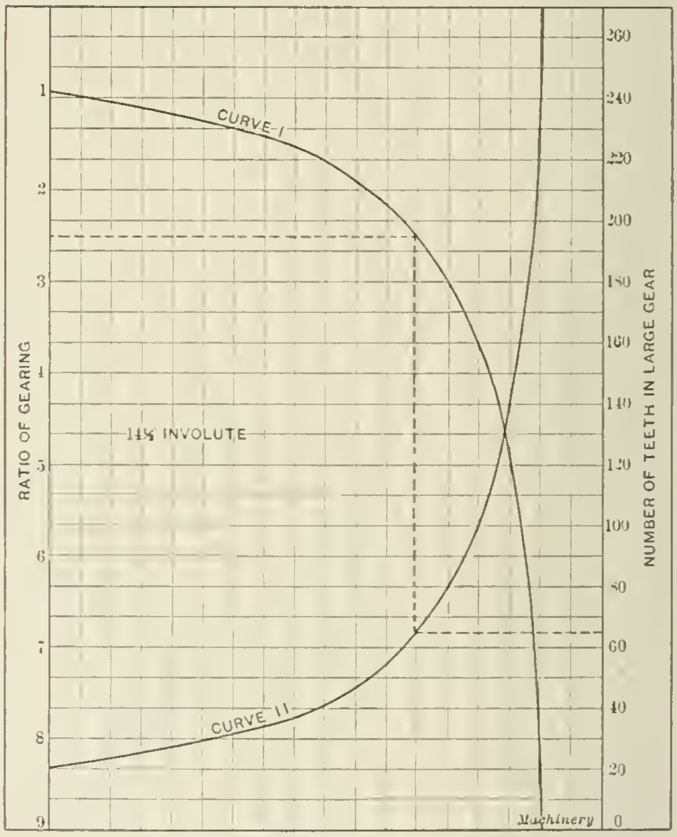

Fig. 6. Chart for Finding Smallest Number of Teeth in Large Geer for Given Ratio with 14½-degree Pressure Angle

2.—The number of teeth in common use for pinions is as a general rule far too small, especially for the high ratios.

Possible Methods for Avoiding Interference

The significance of these two points is very great. A reference to recent specifications for gearing will show that to a certain extent this principle has been grasped, but has not been carried sufficiently far. Probably the greatest field at the present day for gearing is in the transmission of power from electric motors, and it is here that the tendency to increase the number of teeth in the gears is most evident. Large gears with teeth of fine pitch and wide faces are used, but it is doubtful whether the slight advance which has been made in this direction has had any very appreciable effect in reducing the noise from the gearing. There are two reasons why the difficulty cannot be wholly dealt with by adopting finer pitches in order to increase the number of teeth:

1.—From consideration of strength, if fine pitches are used, the gear face must be correspondingly increased. Until quite recently face widths used to be from 2½ to 3 times the circular pitch, but now it is not at all uncommon to find 5 or 6 times the circular pitch used. With such relatively wide faces extreme accuracy in erection is necessary in order to secure an equal bearing all along the tooth face. Equal accuracy in the cutting is also most important. If this accuracy does not obtain. the whole load is thrown on the corner of a tooth, and since the pitch is small, breakage is extremely likely to occur. Wear in the bearings will have the effect described under cause (4) at the beginning of this article.

2.—High ratios are, at any rate with electric motors, a necessity, if first cost of installation is to be kept down. Now, if the correct number of teeth is used in the pinion, the number of teeth in the gear becomes so great that difficulties are experienced in the cutting. Even on the hobbing machine, the time taken by the hob in traversing the circumference of the wheel is considerable, and on this account there is strong reason to believe that local heating of the blank is introduced with consequent errors of pitch. Such errors may undoubtedly be reduced to a minimum, but the cost of production is thereby considerably increased.

These two objections have obviously been raised by the practical man, and he alone has set the limit for the number of teeth which are practically advisable. Indeed, it is only with the aid of great persuasion that he has been induced to go so far as he has. Fine pitches do not "look right," and with the born engineer that is everything. He recognizes of course that silence is important, but if it is only to be obtained by the adoption of finer and still finer pitches, he begins to wonder if the game is worth the candle. Consequently if it can be shown that we may, by following certain simple rules, return once more to the coarser pitches and secure even greater degrees of silence than has so far been obtained by the use of the finer pitches, a great deal has been done to successfully solve this problem.

It is evident from Fig. 7 that one way of reducing the number of teeth required for efficiency, is to increase the angle of the involute. Thus with a 20-degree involute, a 16-tooth pinion may be used with a 5 to 2 ratio, as compared with a 26-tooth pinion with a 14½-degree involute. This looks promising, and in some cases has been adopted, but it is an unfortunate fact that involutes of a given angle of obliquity will work only with others having the same angle; consequently 20-degree involutes will not work with the standard 14½-degree involutes. It, therefore, will be seen that confusion is likely to result from varying the angles, and in any case, the greater advantage of interchangeability is sacrificed. Another great objection to the adoption of increased pressure angles is that owing to the greater inclination of the path of contact, the pressure tending to force the gear teeth out of mesh is greatly increased; in other words, gears with teeth of high obliquity crowd on their centers to a considerably greater degree than those with smaller angles. On the whole it, therefore, appears that this method of arriving at the required result is not advisable.

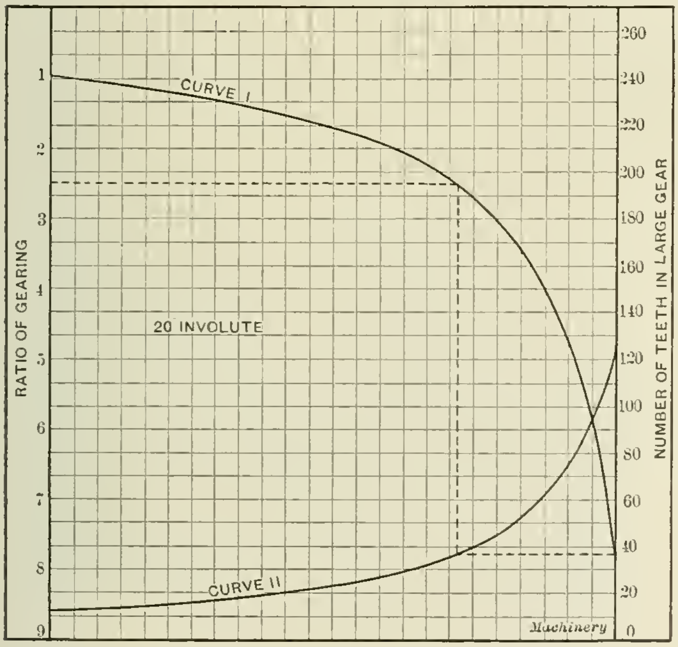

Fig. 7. Chart for 20-degree Pressure Angle

Proposed Method—The Shortened Addendum

The method which the writers suggest, and which has been used by one of them in everyday practice with marked success for several years, may be set out as follows:

Interference, when present, is due to the addendum of the teeth in the larger wheel being prolonged beyond the limit circle; therefore, it seems logical to reduce the addendum by the amount it projects beyond this circle. It is, of course, necessary to see whether by so doing any objectionable features are introduced. A point which appears at once is that by shortening the teeth the duration of contact between two teeth is apparently shortened. As to whether this is a fact or not there seems to be very considerable doubt, but it is not proposed to enter fully into this question at this time since the investigation is somewhat lengthy. Admitting for the sake of argument, however, that the duration of contact is decreased, the important question now to consider is whether the shortened duration of contact is such as to cause one tooth to come out of mesh before the next one is engaged. Referring to Fig. 5 it has been shown that

$$\cot \alpha = \frac{N}{n \sin \phi \cos \phi} + \tan \phi \qquad (6)$$

By the same process it may be shown that if the angle SOE is called δ, then $\cot \delta = \dfrac{n}{N \sin \phi \cos \phi} + \tan \phi$

Now, in Fig. 5, $n \div N = \frac{1}{2}$, and ϕ is 14½ degrees. Hence, $\cot \delta = 2.3206$, and $\delta = 23$ degrees 19 minutes.

Angle $SOD = \phi = 14$ degrees 30 minutes. Hence angle $DOE = 37$ degrees 49 minutes.

This angle may be taken as a measure of the angular duration of contact. Around the circumference of the pinion there are twelve teeth and twelve spaces. It therefore follows that

$$\frac{37.82}{360} = \frac{x}{12}$$

where x equals the number of teeth always in mesh. In the present case x equals 1.26. Hence it will be seen that even in the extreme case chosen, one tooth will not come out of mesh before the next one is engaged.

The question of whether the life of the teeth is shortened should also be considered. In this connection it is necessary to point out that the action between teeth of true involute profile is only a true rolling action when the teeth pass the pitch point S, Fig. 5. At any other points in contact there is more or less slipping between them, the maximum being reached at the points of first and last contact and the minimum at the pitch point. When the teeth first make contact they approach each other obliquely, and even if interference is absent, the slipping is very great and causes wear. If interference is present, the effect is greatly aggravated. It, therefore, would seem that by removing the point of the tooth, the life of the gear is actually prolonged and this deduction is amply borne out in practice. Having disposed of the objections, the following rule may be enunciated:

When it becomes necessary to use a smaller number of teeth than that indicated by the chart, interference may be avoided by reducing the addendum of the teeth in the larger gear to what it would be if the number of teeth found from the chart were used.

For instance, suppose that the number of teeth given by the chart is 180, and that the required diametral pitch is 6. The pitch diameter would be 30 inches and the addendum 1/6 inch. Suppose also that 120 teeth is the largest number permissible. The diameter being as before 30 inches, the diametral pitch would have to be 4, the standard addendum being ¼ inch. With this gear, interference would occur, but if according to the rule, the addendum be reduced to 1/6 inch, no trouble would be met with. The actual reduction in diameter is given by the formula:

$$A = 2\left(\frac{N - T}{P \times N}\right)$$

where A = amount by which the over-all diameter of the gear is reduced,

N = number of teeth, found from chart,

T = number of teeth actually used,

P = diametral pitch actually used.

In the above example we have:

$$A = 2\left(\frac{180 - 120}{4 \times 180}\right) = \frac{1}{6}$$

which agrees with what has previously been said.

When carrying out this method in practice difficulties may be anticipated from cutting the teeth if the gear has been previously reduced in diameter; but it must be borne in mind that the reduction in diameter is a known quantity and, hence, can easily be allowed for when calculating the depth of the cut. If difficulties are experienced, the gears may be left with standard outside diameters until after the teeth are cut, when they may be reduced the required amount in the hobbing machine itself.

When giving this method a trial, it is not advisable that experiments be made on gears that have already been in use, because if wear has taken place the results may be most misleading. The probability is that a great improvement will be noticed in the running; indeed, the writer who has tried it has never yet found a case when the noise has not decreased; but if wear has taken place to any extent, other conditions are met with, and the trial may prove misleading. To get a fair idea of the results obtained by this method, a pair of gears with a ratio of 3 or 4 to 1 should be made, the pinion having 12 or 14 teeth, and with all dimensions standard. Another pair should then be made precisely similar, except that the diameter of the larger gear should be corrected as suggested; the two pairs should then be carefully erected and run side by side and the difference noted.

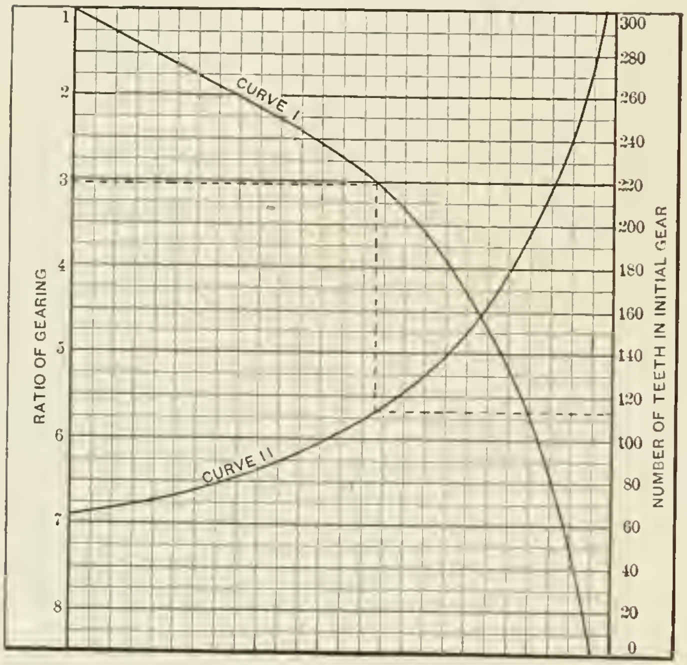

Fig. 8. Chart for Internal Gearing, 14 1-2-degree Pressure Angle

It may be pointed out that since the addendum of the gear tooth has been reduced, the flank space of the pinion may be to a corresponding extent filled in, thus shortening the pinion tooth and thereby reducing the under-cut and greatly increasing the strength of the tooth. This can only be done by using a special hob or cutter with shortened teeth, and unless a large number of duplicate gears are to be cut, the expense is not warranted.

It should be pointed out that if the gear ratio is one to one (equal gears), and the number of teeth to be used is less than the number found from the chart, it will be necessary to shorten the teeth of both gears. This being so, we are led to suppose that possibly with other ratios it may become necessary to reduce the height of the pinion teeth, if a low number of teeth is used. Such is the case in practice, and it may be demonstrated by a construction for the pinion similar to that given in Fig. 5 for the gear. This correction of the pinion may be necessary with ratios from 1 to 1 up to 3 to 2, but since the ratios between these limits are less often used, it has not been thought necessary to give specific formulas.

Application to Rack and Pinion, Worm Gearing, and Internal Gears

The principle may be applied to rack systems in which case it can be shown that to avoid interference:

$$\frac{n-2}{2}\tan^2\phi = 1$$

in which n = the minimum number of teeth in the pinion,

ϕ = the pressure angle in degrees.

Solving this equation for $\phi = 14\frac{1}{2}$ degrees, we obtain $n = 31.86$ or 32 teeth. A smaller number of teeth may be used, provided the rack teeth are shortened in a similar manner to that described for external gears.

If x = the amount to be cut off the rack teeth,

N = the number of teeth to be used in the pinion,

ϕ = the pressure angle, and

P = the diametral pitch,

then it may be shown that

$$x = \frac{2 - N\sin^2\phi}{2P}$$

It will be noticed that if N is made $= 31.86$, and $\phi = 14\frac{1}{2}$ degrees, the numerator of the fraction vanishes, whence $x = 0$, which agrees with what has previously been said.

It is obvious that when dealing with the rack and pinion we have also disposed of the worm and worm-wheel. It follows that if interference is to be avoided, a worm-wheel should never have less than 32 teeth. Incidentally, it may be suggested that this probably explains why worm-wheels with a small number of teeth frequently run hot in spite of the fact that they are only lightly loaded.

One other case remains to be dealt with, *viz.*, the internal gear. It has so frequently been shown that there is a certain minimum allowable difference between the numbers of teeth in the pinion and the mating internal gear that it is only necessary to mention it in passing, and to say that the interference which occurs if this rule is infringed upon is entirely separate from the interference dealt with throughout this article.

The argument already presented for spur gears may be equally well applied to internal gears. As with the spur gear, a similar line of argument results in three formulas which naturally bear a strong resemblance to formulas (6), (7) and (8).

$$\cot\alpha = \frac{E}{\sin\phi\cos\phi} - \tan\phi \qquad (9)$$

$$\beta = 90° + \phi - \alpha \qquad (10)$$

$$\sin\beta = \frac{N}{N-2}\cos\phi \qquad (11)$$

where E = the ratio of the train,

ϕ = the pressure angle,

N = the number of teeth in the internal gear which gives the best all around results for that particular ratio.

The chart shown in Fig. 8 combines these formulas and puts them into a convenient form for use. A smaller number of teeth than the number found from the chart may be used, and interference is avoided as before, if the internal teeth are shortened. It must be noted that shortening the teeth in this case has the effect of increasing the internal diameter of the gear blank, the increase in bore being equal to

$$2\left(\frac{N-T}{PN}\right)$$

in which N = the charted number of teeth in the wheel,

T = the actual number of teeth used,

P = the actual diametral pitch.

In conclusion it may be pointed out that a similar line of reasoning may be applied to bevel gears, which in extreme cases may need correction for interference. It is hardly necessary to state that the actual numbers of teeth in the gears must not be used in applying the formulas, but that for these values must be substituted the developed numbers of teeth obtained in a manner well known to all designers.

* * *

It has never been proved that copper was hardened by the ancients, although one frequently hears statements made to that effect. Most of the copper implements that have been supposed to have been hardened are merely alloys of copper and tin. Other implements of pure copper have been given firmness by hammering or "cold-working," as it is frequently called. Both of these two processes are well-known to-day, and by no means constitute a lost secret of the past.

THE ROSS RIFLE AND ITS MANUFACTURE—2

THE PROCESSES EMPLOYED IN THE MANUFACTURE OF A MILITARY RIFLE OF UNIQUE DESIGN

By DOUGLAS T. HAMILTON*

The production of a high-grade military rifle presents some unusual difficulties in interchangeable manufacture, on account of the stringent requirements which must be met. It is absolutely necessary that it be manufactured from the best materials obtainable, be of first-class workmanship, of simple design, easily and quickly operated, and also be able to withstand reasonable wear, without getting out of order.

The chief difficulty, however, which confronts the designer and manufacturer is that of producing the rifle within the limited cost at which it must be manufactured. However, with an efficient machine- and tool-equipment, it is possible by careful and scientific management to produce a military rifle at a reasonable cost which will meet these requirements. The methods employed by the Ross Rifle Co., of Quebec, Canada, in surmounting these difficulties should be of more than passing interest to readers of MACHINERY. While the following description applies more particularly to the Mark II ** military rifle, it also covers the operations on the sporting rifles, with the exception of a few minor details.

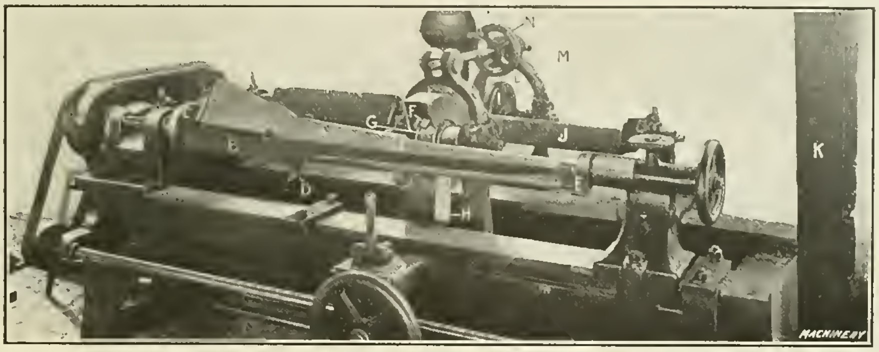

Fig 9. Rough-turning the Front End of the Stock in a Blanchard Lathe

Turning the Wooden Stock

The wooden stock is made from selected black walnut, which is obtained from Italy, France and Roumania. The trees from which the stock is made are felled in the autumn, when the sap is down in the roots; then the wood is roughly cut into the form desired, examined for worms, gall, shakes and other defects, and stored to season for about three years. When received by the Ross Rifle Co., the stock closely approximates the shape required, but is of sufficient thickness to allow turning and roughing out in a general way. Before any work is done on the stocks they are again kiln-dried and seasoned for five or six months, so that any tendency to warp is practically eliminated.

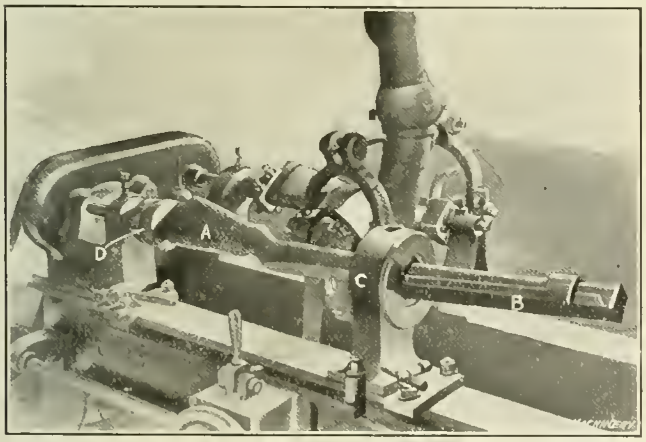

Fig. 10. Rough-turning the Butt End of the Stock

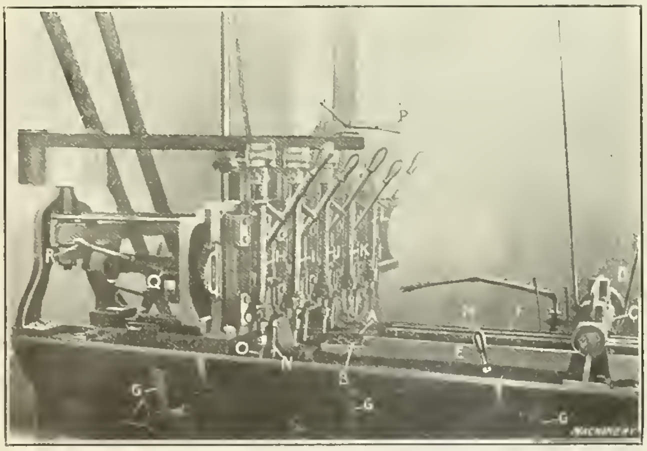

Fig. 11. Inletting for the Barrel, Receiver, Magazine and Spring Clips

The first operation on the stock is to plane both sides, to show up the grain and to expose any defects that cannot be seen when in the rough condition. The stocks are then "grained" or graded, those having the prettiest and most perfect grain being selected for the most expensive rifles. After planing, a saw slot is cut in the butt end to facilitate driving when turning. The stocks are then taken to the lathe shown in Fig. 9 where the front end of the stock is rough-turned. This interesting lathe originated in the Springfield Armory, and was designed by Thomas Blanchard in 1822. Previous to its invention, the gun stocks were cut out and finished entirely by hand. As the lathe was not patented, the English government, in 1855, obtained permission to inspect it and make drawings, which were later taken to the government shops at Enfield, England, where the lathe was then adopted. Of course, this lathe has changed somewhat from its original design, but it works on practically the same principle as the machine designed by Blanchard in 1822.

When ready for turning, the stock *A* is placed on the fixture *B*, and is held with a C-clamp *D*, the slot in the butt end fitting on a projecting member of the head *C*, while a pointed center *E*, operated by the handwheel shown, holds the fore part of the stock in position. The turning is accomplished by scooped cutters *F*, which are similar in shape to a carpenter's gouge; six of these cutters are held by cap-screws to the revolving head *G*. The cutter head is driven by a belt *H*, from a driving shaft underneath the machine, and is guided by the wheel *I*, revolving on a cast-iron dummy *J*. As the two brackets *L* and *M* are connected by a screw which has a right- and left-hand thread, any motion of the bracket *M* is transmitted to the bracket *L* in which the cutter head *G* is held. The iron dummy *J* is made of the required shape, and revolves at the same rate of speed as the bracket carrying the stock, the dummy *J* and the bracket *B* being connected through spur gearing. Power is transmitted to this machine through a belt *K*.

The longitudinal feeding of the cutter head is similar to that of the ordinary lathe. Of course it is evident that the cutter head and the bracket holding the wheel *I* travel along at the same rate of speed. The handwheel *N* is used for governing the "diameter" of the stock; by drawing the brackets together the "diameter" is increased, while by moving them apart it is decreased. The time required to rough-turn the front end of each stock is three minutes and ten seconds.

The stock is now taken to the Blanchard lathe shown in Fig. 10 where the butt end is turned. Here the stock *A* is held in a fixture *B* which is free to rotate in the head *C*, being clamped by a clamp, operated by a wrench which passes down through the hole shown in the revolving head. Before clamping, the stock is located in the correct position against the head *D*. The same type of turning tools is used, and the time required for rough-turning is two minutes, thirty-five seconds.

Inletting for the Barrel, Receiver, Magazine and Trigger Guard

Before finish-turning, the stock is taken to the machine shown in Fig. 11 where it is cut out for the reception of the barrel and receiver. This machine is called an "inletting" machine and works on the same principle as a profiling machine. After the stock *A* is placed in the fixture *B*, which clamps it down firmly, the groove for the barrel is cut. This is accomplished by means of six gouge cutters, three of which are held to the heads *C* and *D*, respectively. These heads are located on an arbor, and are moved in and out by means of guides *E* and *F*, fastened to the bed of the machine and set to the required taper. The heads *C* and *D* are kept apart by a spring, the cutters on one head overlapping those on the other. As the table holding the stock *A* is traversed to the right, the guides *E* and *F* draw the heads *C* and *D* together, which increases the overlapping of the cutters, thus gradually widening the slot.

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* Associate Editor of MACHINERY.

After the groove is cut, the table is moved back by means of the handles *G*, to bring the stock under the cutters held in the five heads *H*, *I*, *J*, *K* and *L*. Each of these heads holds a cutter and pin, the latter operating in a profiling guide *M*, fastened to the bed of the machine. The former pins *N* are made to follow the outline of this guide, thus governing the movement of the cutters *O*. The guide is made of separate blocks of steel of varying thicknesses, so that the top of one guide acts as a stop for the depth of the cut. The various cutter spindles are brought into operation by moving the lever *P*, which throws the belt from the loose pulley onto the pulley on the cutter spindle.

The cutter in the first head is used for roughing the outside seat for the receiver; the second, for finish-shaping the seat; the third cuts the clearance for the finger piece; the fourth drills the holes for the bolt stops, and the fifth makes the clearance cut for the ejector. After these various operations have been accomplished, the bed of the machine is again shifted by moving the handles *G*, which brings the stock *A* under the revolving cutter arbor *Q*. This arbor holds cutters which finish out the radius for the receiver and the sight. The cutter head remains idle until the handle *R* is depressed, when, through a series of links, the belt at the rear is shifted from the loose to the tight pulley, thus revolving the head.

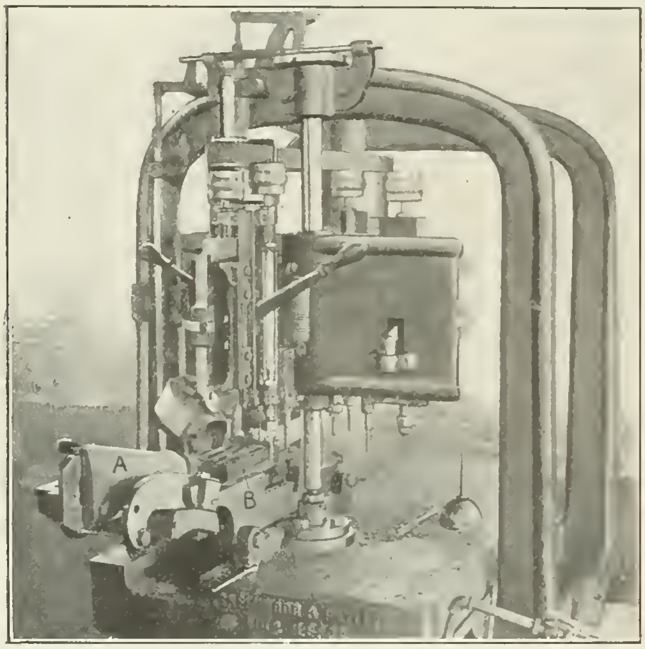

Fig. 12. Inletting for the Trigger Guard

Before inletting for the trigger guard, the top face of the stock is milled as is also that part of the stock which is to be inletted for the trigger guard and magazine. The stock is then taken to the machine shown in Fig. 12, where it is clamped in a fixture as shown. This machine also works on the profiling principle; it consists of a revolving head carrying four sets of scooped cutters and former pins. The depth of the cut, in this case, is governed by stops placed on the former pins which come to rest on top of the profiling guide *B*. Two of the cutters are used for roughing and finishing the seat for the receiver, while the other two are for cutting the impression for the trigger guard.

Turning for the Bands and in between the Bands

The next operation is turning for the front and rear bands which hold the barrel to the stock. This is accomplished in the banding machine shown in Fig. 13. The stock *A* is placed in the revolving head *B*, and a clamp fitting in the space cut out for the magazine holds it firmly. This machine is provided with two swinging cutter heads *C* and *D*, to each of which six flat cutters are attached, the cutter heads being revolved by belts as shown. The stock when "banding" is rotated by means of the large handwheel *E*, which is revolved by hand. The guiding of these cutter heads so that the cutters form the correct shape is accomplished in a novel way. A shaft running the entire length of the machine, carries four cams *G* and *H*, which are of the same shape as that required on the stock. This shaft is connected to the revolving head carrying the stock by spur gearing and is thus rotated with it.

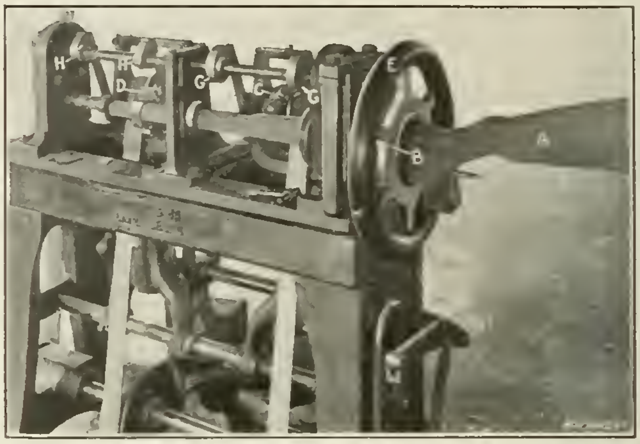

Fig. 13. Reducing the Stock for the Bands

In operation, as the cutter head *C* is brought up in contact with the stock, by operating the foot-lever, the square rods *I* are forced back by the cams *G* until they come in contact with set-screws which act as stops. Now upon turning the handwheel *E*, the head carrying the cutters is guided by these cams, and the cutters turn the stock to the required shape and size. The same operation is repeated for the front band, the other foot-lever being depressed to operate the head in a similar manner.

After turning for the bands, the stock is taken to the machine shown in Fig. 14, which is of similar design to that shown in Fig. 13, where it is placed in the revolving head *B*. A long brass casting *C*, somewhat the shape of a barrel, but which is cast with seats for holding twenty flat cutters clamped to it at intervals and overlapping each other, forms the cutter head. This revolving head *C* is brought into position by depressing the foot-lever *D*, and is guided by cams, as in the previous operation. After turning the fore end of the stock,

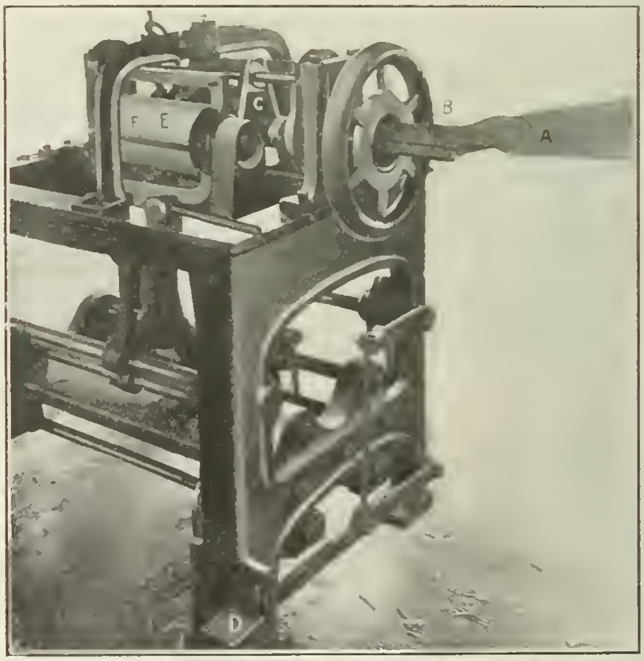

Fig. 14. Finish-turning between the Bands and Sandpapering

the other treadle is operated, thus bringing the sandpapering-wheel *E* into action, which is used for finishing. The sandpaper is held on a cast-iron drum, around which a band of felt, ⅜ inch in thickness, is wound, to prevent the sandpaper from stripping. The sandpaper is retained in position on this drum by means of a steel strip *F*, fastened with four screws as shown.

The stock is now taken to a Blanchard lathe where it is finish-turned its entire length, with the exception of that part which has been finished in the machine shown in Fig. 14. After this, the holes for the lifter screws are drilled, and the butt end is profiled. The ¾- and ½-inch holes in the butt end are then drilled, and the milling for the butt-plate is accomplished. The fore end of the stock is now finished, and the slot cut for the lifter.

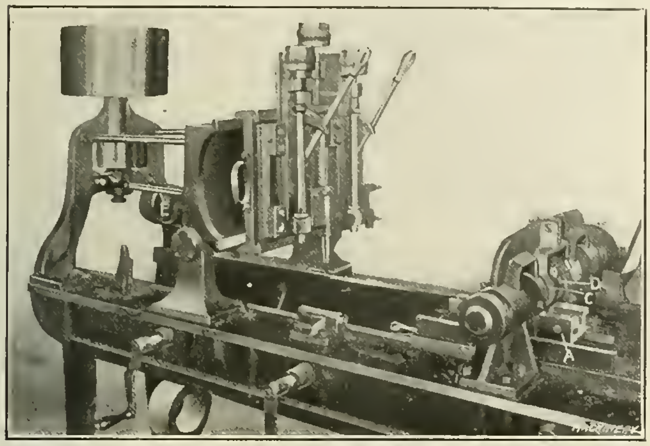

Fig. 15. Inletting the Hand Guards for the Barrel and Spring Clips

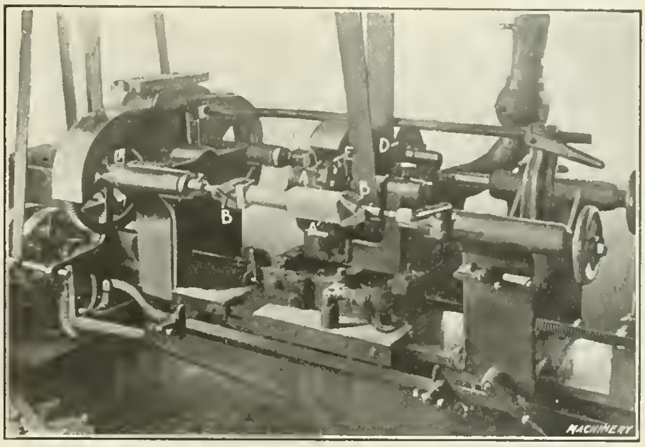

Fig. 16. Turning the Front and Rear Hand Guards

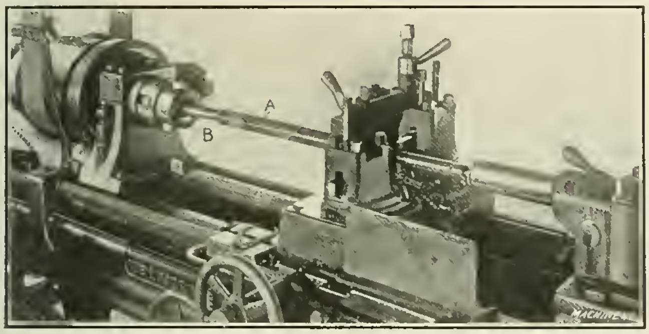

Fig. 17. Rough-turning Barrels in a Lodge & Shipley Lathe

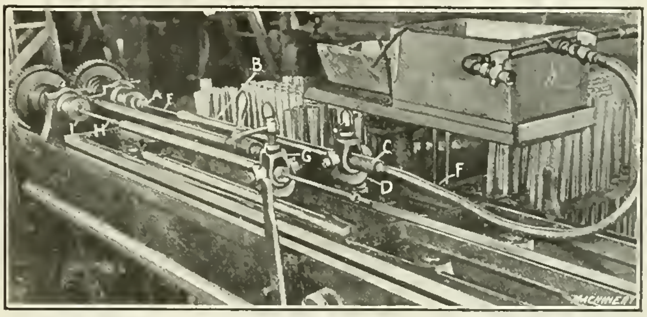

Fig. 18. Rough- and Finish-reaming Barrels in a Two-spindle Machine

Upon the completion of the machine work, the stock is fitted to a gage of the same shape as the receiver, so that it will be flush with the receiver when assembled in it. The other parts of the stock which cannot be sandpapered in the machine are done by hand, and the stock as a whole is carefully inspected and "touched up." The stock for the sporting rifles—model E and the 0.280 Scotch deer-stalking pattern—are checked at the fore end or grip, and at the rear of the trigger guard, or "pistol grip" as it is called. This checking is done by hand; the operator lays off the design with a templet, and then with a small tool which is provided with two V-shaped projections, he cuts out the design. One of these V-shaped projections fits in the groove previously cut and acts as a guide. The object of the checking is to furnish a good grip, and it also adds considerably to the finished appearance of the stock. The stock is now ready for the finishing operation which consists of strapping and polishing, the polishing being accomplished on a cotton wheel, after which it is oiled with linseed oil and inspected.

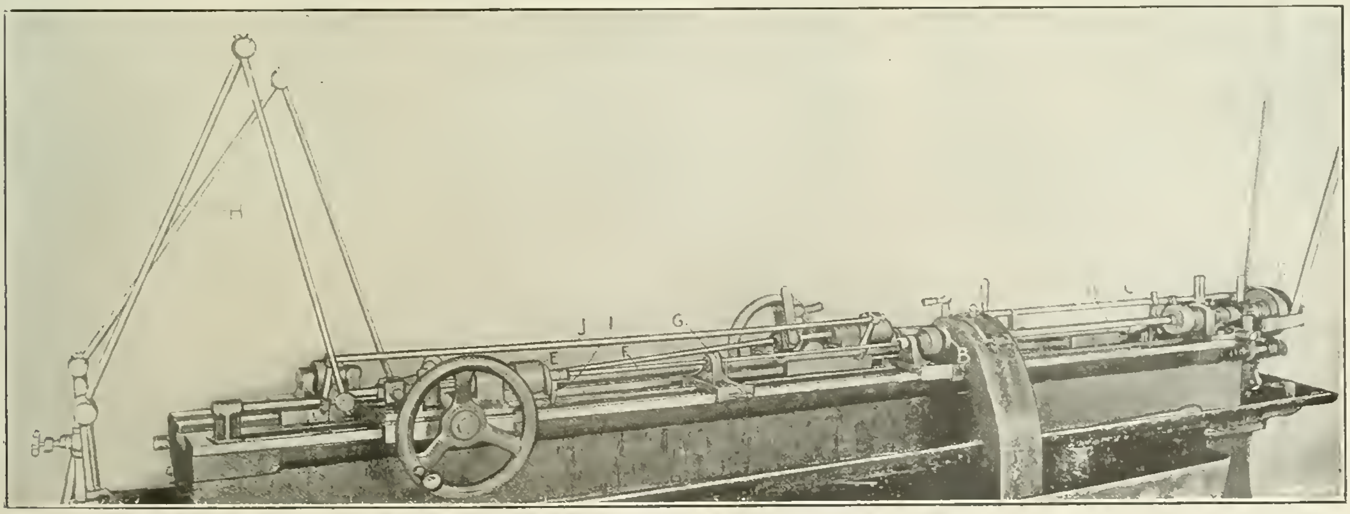

Fig. 19. Drilling Barrels in Pratt & Whitney Barrel Drilling Machine

Inletting and Turning the Front and Rear Hand Guards

Thus far, the description has been that common to the stocks for all types of rifles manufactured by the Ross Rifle Co. The front and rear hand guards are applied only to the military rifle, their use being principally to prevent the soldier from burning his hands when the barrel becomes heated after continual shooting. They also assist in protecting the rear sight and give a neat appearance to the gun as a whole.

The first operation on these bands is cutting them into blocks of the required length and thickness, which is done with an ordinary circular saw. After this they are taken to the inletting machine, Fig. 15, and clamped in a jig *A*, which is fastened to the table. Here the groove for the barrel is cut with scoop cutters held on the cutter heads *C* and *D*. These heads are of the same design and work on the same principle as those shown in Fig. 11. The table is now moved along by means of the various handles placed at the side of the machine and brought under the cutter arbor *E*. This arbor is provided with cutters for cutting the grooves for the spring clips used in holding the bands on the barrel. This cutter arbor works on the same principle as the one shown at *Q* in Fig. 11.

The hand guards are turned in a Blanchard lathe as shown in Fig. 16, two pairs of bands being turned at one time. The two halves *A* are held by "alligator" jaws *B* on centers. The form or dummy *C* at the rear of the machine is made of the required taper, and, through a wheel *D*, guides the cutter head *E* to which the scoop cutters used in turning the bands are attached. One thing is very noticeable about all these woodworking machines, and that is the absence of cuttings. A large suction fan system employed throughout the works sucks in all the wood cuttings and carries them to the engine-room where they are used as fuel. Compressed-air blowers are also used for cleaning the chips off the machines.

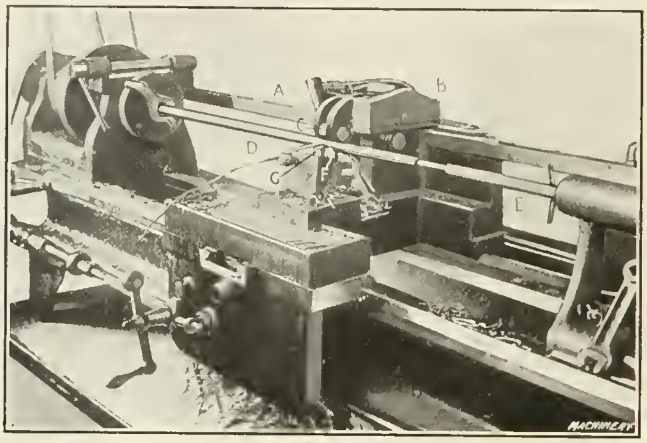

Fig. 20. Finish-turning Taper on the Barrel

Rough-turning Operations on the Barrel

The barrel for the Ross rifle is not drop-forged or rolled, as is the common practice, but is turned down from bar steel of special analysis. The first operation is cutting the long bar into suitable lengths for the barrel, in an ordinary circular cutting-off machine. The barrel is then centered in a centering machine, after which it is necked at the breech end with a wide forming tool, in a Jones & Lamson flat turret lathe.

The barrel is now ready for the rough-turning operation, which is accomplished in the Lodge & Shipley lathe shown in Fig. 17. The breech end of the barrel *A* is held in a chuck *B*, and the fore end is placed on the tailstock center. A bushing of the same diameter as the barrel—1⅜ inch—precedes the turning tools and is used to support the work while turning. The barrel is reduced from 1 3/8 to 15/16 inch diameter with two Novo 2 A high-speed steel turning tools, at a feed of 1/16 inch per revolution. The length turned is 26 inches, and with two lathes in operation one-hundred and twenty-five barrels are turned out in ten hours. After rough-turning, the barrel is turned taper in an ordinary lathe, which is equipped with a dovetailed guide, holding roller supports. The turning tool is operated by a square bar at the rear of the machine, which is set to the taper desired. The small end of the barrel is reduced to ¾ inch diameter in this operation.

Drilling and Reaming the Barrel

After rough-turning the taper, the barrel is taken to the Pratt & Whitney barrel drilling machine shown in Fig. 19, where two barrels are drilled at the same time. The barrel *A* is held in a bushing, located in the head *B* in which it revolves, and is driven by a corrugated bushing *C*. The bushing *C*, in turn, is driven by a friction pulley *D*, which also drives the lead-screw operating the head *E*, carrying the drill tube *F*. Should the drill stick and revolve, a dog *I*, attached to the head *E*, holding the drill, comes in contact with the bar *J* which, in turn, disconnects the feed-nut, thus stopping the feeding of the drill and at the same time shifting the belt from the tight to the loose pulley.

The location of the oil feeding tubes on these machines has been changed, the telescopic tube having been removed from the carriage. Formerly, if the drill stuck and the operator unlocked the feed-nut without shutting off the oil, the carriage would fly back at a terrific rate, on account of excessive pressure in the oil-feed tube. This caused considerable trouble, so the Ross Rifle Co. designed the scissor arrangement of tubes shown at *H*. This disposition of the tubes reduces the pressure on the carriage, so that the feed can be disconnected when the oil pressure is on without causing any serious results. The oil is forced into the barrel under a pressure of 1000 pounds per square inch.

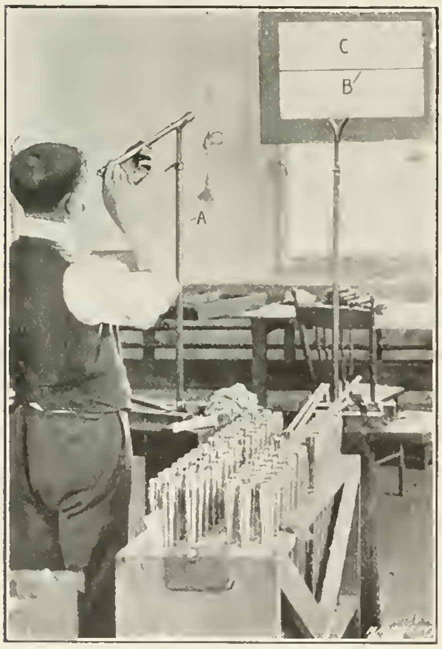

Fig 21. Straightening the Barrels

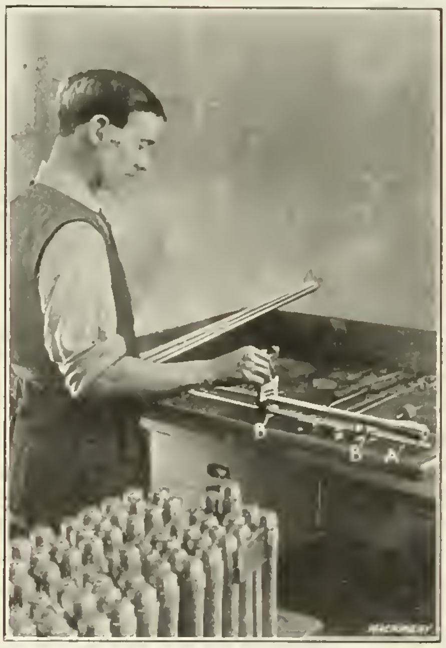

Fig. 22. Gaging the Taper on the Barrel

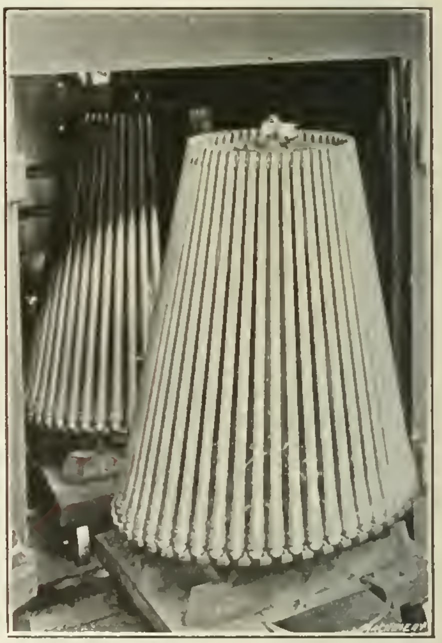

Fig. 23. Producing the "Brown Finish" by Sweating

A C-drill, held in the forward end of tube *F*, is used. (A description of this drill is given in MACHINERY's Reference Book, No. 25 on "Deep Hole Drilling.") This drill is provided with an oil and chip groove, the latter running back clear of the barrel and allowing the chips to work out freely. The barrel is rotated at 2200 R. P. M., while the drill is held stationary and is guided at the forward end by a bushing in the head *B* and also by a bushing held in the movable slide *G*. The drill makes a hole 0.290 inch in diameter, and as the finished size is 0.303 inch, this leaves sufficient material to be removed by the successive reaming operations.

The next operation is to rose-ream the hole to 0.300 inch in diameter. This is done in the two-spindle reaming machine shown in Fig. 18, which is used both for rose- and finish-reaming. The spindle *A* is used for rose-reaming, and the barrel *B* is clamped in the bushing *C*, held in the slide *D*, the latter being operated from beneath the machine at the required feed per revolution. A rose reamer *E*, having four cutting teeth, straightens and gives a finished appearance to the hole in the barrel. Oil is pumped in through the tube *F*, so that the reamer is completely flooded at all times. The reamer in this machine is rotated, and the barrel travels over it.

Finish-turning the Barrel

The barrel has now been rough-turned taper and reamed and is ready for the finish taper turning. This is accomplished in the lathe shown in Fig. 20, which is provided with a special cross-slide, carrying a turning tool and roller supports. The cross-slide is operated by a square bar *A*, attached to brackets at the rear of the machine. This bar guides the head *B* carrying two roller supports *C* which support the barrel *D* while being turned. An ingenious floating center *E* is used on this lathe, so that the outside of the barrel will be perfectly concentric with the hole. A hardened and ground plug is provided with two diameters, one of which fits in the hole in the barrel, and the other of which is of the exact size and tapered to suit the external diameter of the barrel.

Before putting the barrel on the centers, this plug is inserted; then the carriage is brought over, so that the roller supports *C* rest on this hardened and ground plug. While in this position, the barrel is held against the supports by the spring plunger *F*. The floating center is then put in position, holding the barrel on the rear center. The headstock center is straight, ground perfectly true, and fits the reamed hole in the barrel. The turning is accomplished by a turning tool *G*, made from round rod and ground with a top rake of about 20 degrees, and soap and water are used as a cutting lubricant. It is evident from the foregoing description that it is possible in this way to turn the external diameter of the barrel concentric with the hole, which would be more difficult to accomplish if the barrel were placed on the ordinary centers.

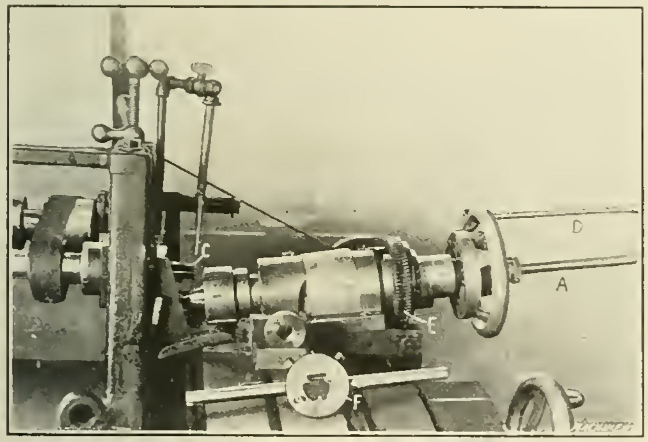

Fig. 24. Cutting the Thread on the Breech End of the Barrel

Straightening the Barrel

We now come to one of the most important operations on the barrel, the correct execution of which governs its accuracy. After taper turning, the barrel passes through what is called a "straightening" operation. This is essentially a hand operation and requires the attention of a specialist. Many attempts have been made to devise a machine for straightening rifle barrels, but as yet all have been failures. The method used in straightening the barrel is as follows:

The straightener holds the barrel in his two hands, and places it in a Y-shaped support *A*, as shown in Fig. 21. He now sights the bore of the barrel on the strip of wood *B*, which is placed across a ground glass *C* mounted in a frame held over the window. The strip of wood casts two shadows down the bore of the barrel, each edge of the strip casting one shadow. Now if the barrel is slowly revolved, these shadows move in and out, that is to say, they do not remain the same distance apart throughout their length. To determine the exact point where the barrel is bent, the operator rotates the barrel with his right hand watching carefully the movements of these two shadows. If the barrel is much bent at some points these shadows will wiggle in and out in a very interesting manner. The operator becomes so proficient at his work, that he knows the exact point at which the barrel is bent, and the intensity of the blow necessary to straighten it. The shadows do not extend the full length of the barrel, but gradually diffuse and become obscure after they pass three-quarters of its length, so that it is necessary to reverse the barrel end for end to complete the straightening operation. However, as these shadows are clearly perceptible for more than one-half the length of the barrel, it can be straightened its entire length by reversing. When the barrel is in a rough condition it is straightened with a steel hammer, but after it has been ground a copper hammer is used.

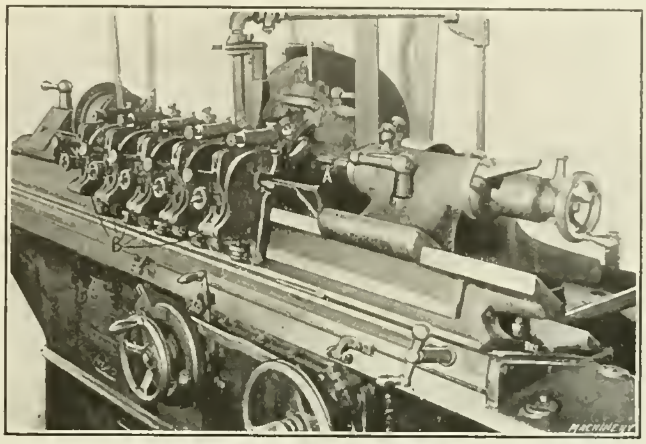

Fig. 25. Finish-grinding Taper on Barrels in a B. & S. Plain Grinding Machine

After the first straightening operation, the barrel is again taken to the lathe shown in Fig. 20 where it is again turned taper; then it is brought back to the straightener, given a few more blows and taken to another lathe where the neck—that part of the barrel close to the muzzle—is finished. The breech end of the barrel is then ground in a Brown & Sharpe plain grinding machine, after which it is reduced in diameter for the thread by means of which it is held to the receiver.

Threading the Breech End of the Barrel

Following the turning operation on the breech end, the barrel is taken to the threading machine shown in Fig. 24 where the thread is milled. The barrel *A* is held in a chuck in the revolving head. This head is inclined at an angle of 10 degrees with the horizontal plane, so that by using a cutter having one side flat and the other edge beveled at an angle of 35 degrees, a buttress form of thread can be cut.

In operation, the table is brought into position so that the center of the cutter *C* is on the center of the barrel; then the head is revolved by means of the handle *D*, to start the thread. The feed clutch is now engaged, and the machine works automatically, being driven from a shaft at the rear through a worm and worm-wheel. The head to which the worm-wheel *E* is keyed, is provided with a thread of the same pitch as that required on the barrel. After the thread is cut, the barrel is removed and the die, held in the stock *F*, is passed over it to remove the burrs, after which the thread is gaged.

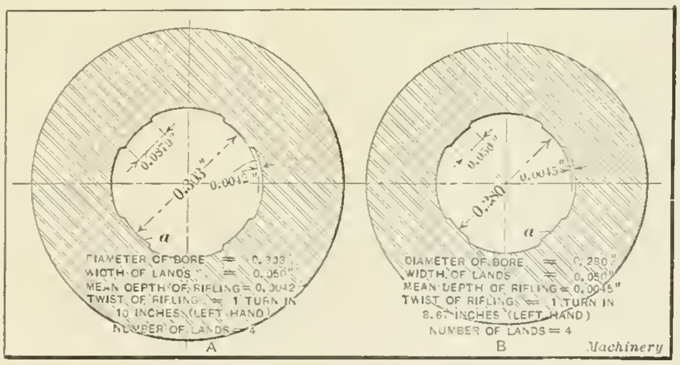
0.0870"
0.303"
0.0042"
a
DIAMETER OF BORE = 0.303"
WIDTH OF LANDS = 0.050"
MEAN DEPTH OF RIFLING = 0.0042"
TWIST OF RIFLING = 1 TURN IN 10 INCHES (LEFT HAND)
NUMBER OF LANDS = 4
A
0.050"
0.280"
0.0045"
a
DIAMETER OF BORE = 0.280"
WIDTH OF LANDS = 0.050"
MEAN DEPTH OF RIFLING = 0.0045"
TWIST OF RIFLING = 1 TURN IN 8.67 INCHES (LEFT HAND)
NUMBER OF LANDS = 4
B
Machinery

Fig. 26. Form of Rifling cut in the 0.303 and 0.280 Ross Rifles

Grinding the Taper on the Barrel and Finish-reaming

After threading, the barrel is taken to the Brown & Sharpe plain grinding machine shown in Fig. 25 where the taper on the barrel is finish-ground. The barrel *A* is supported by five

B. & S. universal steadyrests *B* which are spring-actuated and resist the thrust of the wheel. These steadyrests are provided with bronze shoes which fit the finished diameters of the work and are prevented from further pressure on the work (after it is ground to the required diameters) by check-nuts. The barrel is located from the bore, hardened and ground plugs being fitted in the breech and fore ends. The centers, however, in this case do not "float," but remain stationary as is common in this type of grinding machine. Before the barrel is again straightened, the taper is gaged in a special gage provided for the purpose, as shown in Fig. 22. The taper on the barrel is gaged at three different points—for the front and rear sight base and in the center. This gage consists essentially of a rod *A* on which six blocks *B* are held. The spaces between these blocks are "limit" allowances, a snap gage having a slot equal to the required diameter working in between them.

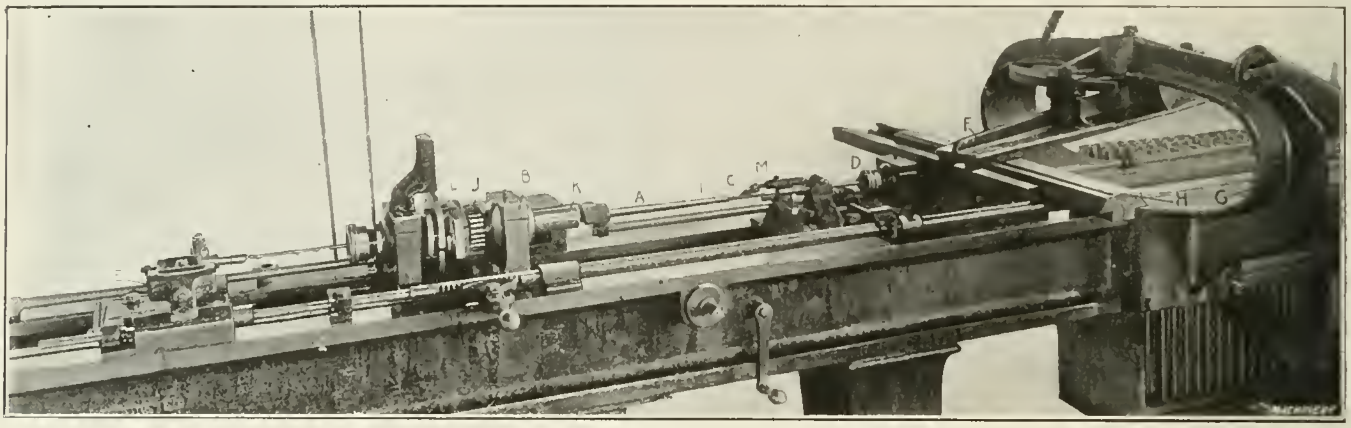

Fig. 27. Cutting the Rifling Grooves in a Pratt & Whitney Rifling Machine

The barrel now passes through another straightening operation—a copper hammer being used. It is then taken to the reaming machine shown in Fig. 18 where it is held in the head *G*. A rod *H*, to which is attached a square reamer, is held in the chuck *I*. Oil is placed on the reamer, and a rosewood shim is held in one of the grooves by a washer. This shim backs up the reamer and keeps the cutting edge at all times in contact with the work. Many types of reamers have been used for this finish-reaming operation, but the old square reamer used holds first place as giving the best results. It requires, however, the attention of an experienced operator. This reamer finishes the bore to 0.303 inch diameter. A plug gage 0.302 inch diameter by 6 inches long must drop through of its own weight after reaming, which, of course, necessitates a very accurate finish.

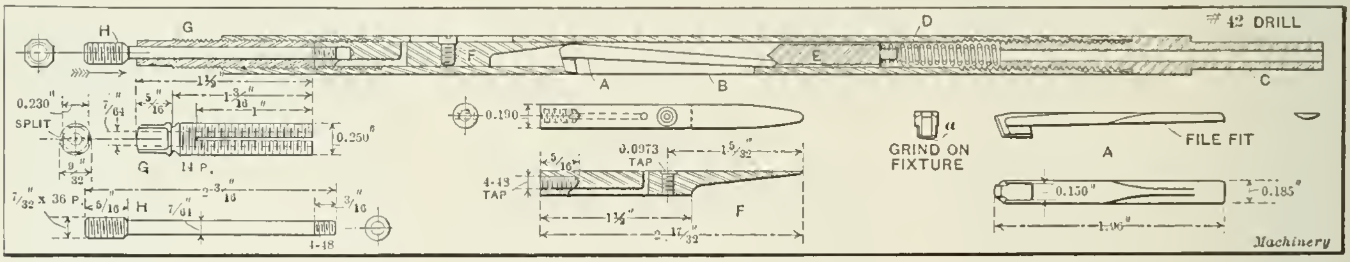

Fig. 28. The Rifling Head, Cutter, etc.

Cutting the Rifling Grooves

Aside from making the hole in the barrel perfectly straight, possibly no operation on a rifle requires such careful attention as does the production of the helical grooves termed "rifling." The accuracy as well as the efficiency of the rifle depends to a large extent upon the proper execution of this operation. Rifling may be defined as "a series of helical grooves cut in the bore of the barrel which cause the projectile while passing from the breech to the muzzle to rotate." The rotation thus imparted to the bullet continues during flight giving gyroscopic stability and overcoming the tendency of the bullet to erratic flight, caused by the irregularity of its form or density. The shape of the grooves cut in the Ross rifle is shown in Fig. 26, where *A* is a cross-section of the 0.303 barrel and *B* the 0.280 barrel. The four projections or lands *a* form corresponding grooves in the periphery of the bullet, and in this way rotate it and keep it point-on.

Rifling was first applied to weapons for sporting purposes and did not come into prominence for military guns much before the middle of the nineteenth century. However, it is stated that it played an important part in the American War of Independence, in which the weapon used for sporting purposes only became of necessity a military arm. Napoleon tried this type of rifle out, but abandoned it again in favor of the smooth bore in 1793. The first military rifle on record provided with rifling grooves was the Baker rifle. The barrel was 2 feet, 6 inches in length, had seven grooves with a spiral of one turn in 10 feet, and was bored 0.615 inch in diameter. The type of bullet used in these first rifles was spherical in shape, and the velocity, as well as the accuracy, was not very great. A later rifle invented by Mr. Forsyth had a bore 0.704 inch in diameter and was provided with two grooves of semicircular shape with a twist of one turn in 30 inches—the length of the barrel. The ball or missile had a belt cast completely around it which fitted in the rifling grooves.

The machine used for producing the rifling grooves, shown in Fig. 27, is made by the Pratt & Whitney Co. The barrel *A* is held in a chuck in the indexing head *B*, by means of a nut which fits on the threaded end of the breech, and the front end of the barrel is held by a split bushing in the spindle *K*. The rifling tool or "head," as it is called, is grasped in a chuck *D* which is located in a spindle provided with a spur gear. The helical groove is produced by a cutter of the correct shape, as shown at *A* in Fig. 28; the cutting face is shown at *a*.

Before proceeding with the description of this machine, it may be well to describe the construction of the rifling head proper, Fig. 28. It consists mainly of a tool-steel tube *B* tapped in both ends. In one end is fitted an arbor or plug *C* on which a long tube is located, the latter being held in the chuck *D*, Fig. 27. Bearing against this arbor is a spiral spring *D*, operating a cone-pointed plunger *E* which bears against the rifling tool *A*, keeping it in contact with the adjustable wedge *F*. The other end of the tube is tapped out to receive the feeding-screw *G* which butts against the adjustable wedge *F*. The rear end of wedge *F* is tapped out to fit stop-screw *H* which is so set that the cutter can only be fed out the required amount. Stop-screw *H*, shown in its "relieved" position in the illustration, hits against a stop in the feeding-head *E*, Fig. 27, on the forward stroke, which forces it in the direction indicated, and as it is attached to the wedge *F* it forces the latter forward, thus sending out the cutter *A*. The cutting is only done on the back stroke, giving a draw-cut, so the cutter has to be relieved, or, in other words, forced back out of action when returning; this is accomplished by finger *M* (see Fig. 27).

The Ross rifle is provided with four rifling grooves, as shown in Fig. 26, so that for every fourth revolution of the barrel, the feeding-screw *G* must be operated. This is accomplished by the feeding head *E*, Fig. 27, which is provided with a square hole in the end of the spindle fitting the squared end on the screw *G*. The turning of the screw *G* (in a right-hand direction) increases the distance between the stop-screw *H* and the feeding-screw, so that when the former hits the feeding-head *E*, the cutter *A* is sent out further, thus taking another cut. A chip averaging from 0.0005 to 0.001 inch thick is taken at each stroke, and is automatically removed from the muzzle of the barrel by a finger.

Returning to the rifling machine shown in Fig. 27, the pitch or twist of the rifling is accomplished by an arm *F* fastened to the O-shaped bracket *G* on which it is free to swivel when the nuts are loosened. This arm *F* is provided with a boss which is cut to fit a segment marked off for the different twists per revolution. A square groove is cut in the lower end of the arm in which a roller operates, the roller being attached to a slide *H*, which is provided with a rack on its under side; this rack meshes with a spur gear held on the spindle carrying the rifling head *C*.

The indexing of the barrel for the cutting of the four rifling grooves is accomplished by a rod *I*, attached to a flat plate in which is cut a cam groove. A roller runs in this groove, and is held on a rack meshing with gear *J*. Gear *J* is keyed to the spindle *K*, and as the former rotates it carries a ratchet pawl which meshes with a ratchet plate keyed to the spindle. A locking disk *L*, provided with four notches, is attached to this ratchet plate, and a spring plunger securely locks the disk when it has been indexed. The spring plunger is lifted by a cam on the ratchet plate coming in contact with a pin driven into the spring plunger, which lifts it up and allows the locking disk *L* to be rotated.

The feeding of the screw *G*, Fig. 28, is accomplished in the following manner. A one-lobed cam keyed to the spindle *K*, Fig. 27, comes in contact with a lever beneath it every fourth revolution. This lever, in turn, is in contact with a cam attached to a rod, the latter operating a ratchet which revolves the feeding disk, and turns the feed-screw *G*, when it is located in the square hole in the end of the spindle. The cut starts at the breech end of the barrel, and as the cutter reaches the muzzle a finger *M* hits the former, forcing it out of action and at the same time acting on wedge *F*, which carries with it the stop-screw *H*. This brings stop-screw *H* back into position ready for the next cut.

The breech end of the barrel is now chambered to receive the cartridges, and the muzzle end is chamfered inside and out to prevent it from burring. After this, the gage line is marked on it, so that it will breech up properly with the receiver. The cut for the extractor, and the entrance cut for the cartridge, are then made in a plain milling machine.

Producing the "Brown" Finish

The next operation is what is called the "browning" operation, this operation getting its name from the oxidized coating formed on the barrel during the sweating process. The barrels are placed in a rack—fifty at a time—and are dipped in soda and boiled; they are then rinsed in boiling water which must be absolutely clean. After this, they are coated with a solution of sulphuric acid and nitrate of alcohol. The rack holding fifty barrels is then placed in the sweating cupboards, shown in Fig. 23, which are provided with steam pipes. Here they are left for 3 or 4 hours, and when they come out they are covered with rust. They are then boiled, which increases the rust coating. The rust is removed with a cotton carding brush, leaving a dark surface on the barrel. This series of operations is repeated four or five times according to the depth of color required. Four times is usually sufficient, but the state of the atmosphere controls to a large extent the formation of the rust; on some days it requires five or more operations to get the same results. After the barrel is browned, it is inspected, which completes the manufacturing operations on the barrel. A final test for accuracy, however, is given when the sights are set by the government inspector. This will be described in the December number.

PHYSICAL HEALTH AND DRAFTING*

By L. R W. A.

The draftsman's vocation demands good sight, apt conception, interpreting intelligence, and a steady hand, coupled with a degree of health which will permit of indoor confinement without serious consequence. Health is largely Nature's gift, but although it may be excellent, it is easily ruined through a lack of appreciation of the simple laws that govern it. Dealing with the self-inflicted ill consequences which may ensue from following the drafting occupation, we find that the most important questions deal with the right posture and the proper care of the eyes. In both cases, the question is simply one of the application of the elementary principle of common sense to one's work.

Proper Posture

How frequently do we see the draftsman commence his day's work by tying a small apron about his waist to protect the clothing from being rubbed, or, if this precaution is not taken, how often do we notice the vest and trousers shining from contact with the drafting board? Why is this necessary? Does the draftsman's pursuit call for a use of the abdominal portion of the body to correctly fulfill the duties? One is inclined to believe differently, and attribute it to a somewhat lazy disposition which finds this way "the easiest." It is, however, also a senseless short cut to bodily harm, absolutely unnecessary. The drafting board was never designed for this purpose, else an "edge-cushion" would have long since been adopted. The same reason "being the easiest," is likewise responsible for the stooped carriage, so readily acquired and so much more difficult to rectify.

That the effects due to improper posture may be serious, is obvious. They need never be experienced, however, if the draftsman takes care to keep his body in a proper position when working. The board should suit the draftsman's height and should incline slightly toward him, being a few inches higher at the back than in the front. The draftsman should stand clear of it, and bend over the work in such a manner that the back is not formed into a hoop shape. Rest firmly on both feet, and not on one at a time. This posture when once acquired will be found as easy to occupy as the other injurious one. There is no question of the benefits to be derived from it.

When the drawing is larger than normal size, covering the entire board, the rules given may not apply directly. If the drafting board is accessible from all sides, however, there is no difficulty; and if it is not, instead of leaning against the front, assume a sitting position on the board or rest the knees on the stool. When once the idea of keeping the body clear of the board is kept in mind, it will not only become the natural and easiest way, but will have a noticeable effect on the person and apparel.

The stool should be of a height to suit that of the draftsman. It ought to be of the adjustable type. It should under no circumstances be too high. The rigid wooden stool often used is usually made for high bookkeeping desks, and, as a rule, is too high for the drafting board. If the stool is too high, the draftsman must sit at his work in a contracted position. A bookkeeping stool can be made to suit the purpose by sawing off the legs to the correct height. The draftsman should make it a point to sit erect, both on account of his health and for appearance—a curved back on a young man is not particularly to his credit. It should not be implied from the foregoing that a rigid posture, either in standing or sitting is intended, but one may be easily comfortable without leaning against other objects in either position. If it is necessary to lean against the board, let the elbows rest on it.

It is hardly within the province of this article to elaborate on the subject of exercise; nevertheless the draftsman should take proper exercise. Breathing exercises, walking, and exercises that tend to prevent him from becoming stoop shouldered are especially recommended.

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* For additional articles dealing with this and kindred subjects, see MACHINERY, May, 1911, "Physical Injury from Drafting"; April, 1911, "Ventilation of Drafting Rooms"; February, 1911, "Notes on Drafting-room Lighting"; and January, 1911, "Physical Injury from Drafting."

Light in the Drafting-room

There are few branches of industry which require more excessive demands on the eye than drafting work. It is required that the draftsman do his work accurately, neatly, and often to a scale where the details become of minute dimensions. Hence the requirement for good vision is obvious, and the strain on the eyesight is considerable. In the following we shall deal with the two subjects: the care of the eyes, and the light in the drafting-room.

The first principle as regards the care of the eyes is to adopt the correct distance between the eye and the work, governed by normal sight. It is a common occurrence to witness that out of a score of draftsmen at least one-half work with their eyes very close to the drawing. To work with only a few inches between the board and the eye exposes the latter to an abuse that no eye can for any length of time be subjected to without permanent injury. In some cases this injurious condition may be due to insufficient light, but in the majority of instances it is due to a habit cultivated from the beginning of the draftsman's career. Remaining uncorrected, it invariably calls for the use of powerful eye-glasses in the end. If so close a position of the eye to the work is caused by natural near-sightedness, the draftsman should wear proper glasses. If, however, when wearing glasses properly adjusted to the eye, it still becomes necessary to work with the eyes so close to the board, then it would be advisable for the man to leave an occupation so exacting to his eyes, and find some work in another branch of the business. An example of the effects of the habit mentioned may not be amiss. In the engineering department of a large plant a set of standards was worked up. They were executed on tracing cloth, blueprinted, and bound in sets. The lettering work was distributed among the youngest men; the figures varied on the different sheets from 3/32 to 3/16 inch in height. One of the men who had been working at the board for about eighteen months, spent an equal period on this work. When starting on this work the distance between his eye and the board was about 9 inches; a short period later about 4 or 5 inches, and after a year's time the nose and board were almost in contact. This is because "he could make better figures that way." He then adopted glasses, but in a few months left to engage in another line of business. That the nature of the work subjected the eyes to excessive strain is certain, but if the man had adapted himself to it and used good judgment in the work, there would have been no need for this disastrous result. The writer has himself been through the same ordeal without ill effects. To give exact figures for the correct distance between the eye and the board which will fit all draftsmen, or even a majority, would be next to impossible, but as a general rule, with normal sight, from 9 to 12 inches is close enough for any work which the average draftsman is required to do.

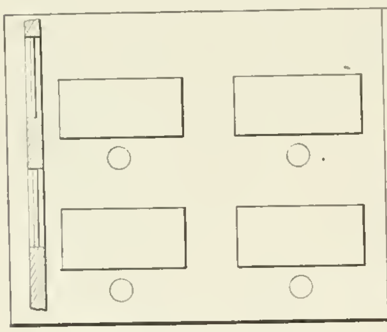

Fig 1. Approved Arrangement of Drafting Boards

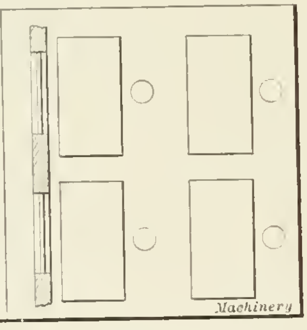

Fig. 2. Unsatisfactory Arrangement of Drafting Boards

Tracing from drawings and blueprints is a severe test on the eyes, and special care should be used, especially when doing this work for any length of time. Tracing from blueprints is especially liable to cause undue strain, and the draftsman should rest his eyes frequently. Such slight delay will be more than counteracted by his ability to work efficiently when resuming his task.

It is very important that sufficient natural light be provided in the drafting-room. The position of the board with relation to the windows should be as shown in Fig. 1. The board should not be in direct line with the window, but somewhat back of it. This position makes the light fall upon the board at a proper angle, and at the same time it does not allow the table nearest the window to entirely monopolize the supply. With the arrangement shown in Fig. 2 the table nearest to the window gets most of the light, and a great fault with this method is also that there is a glare which will affect the draftsman's eyes when he sits constantly facing the windows. The arrangement in Fig. 2, therefore, is not to be recommended.

It seems the custom when a man enters upon his duties in a drafting-room—provided he does not happen to be thoroughly competent or "high-priced"—to accord him the most isolated position available. This is particularly true if he is learning the business. The place he is given is usually unfit for any kind of drafting or clerical work, and requires the need of artificial light throughout the day. It is a frequent occurrence to see such a man use another's board, if the latter is absent for a day or two, in order to obtain better light. This proves conclusively that at his own table the light is insufficient. The earning capacity of a boy or young man should not figure in a question of satisfactory working conditions in accordance with his duties. Whether the compensation be $10.00 or $30.00 a week, each man is entitled to equal consideration in regard to light. The younger man's sight is as important to him as is that of the higher salaried man.

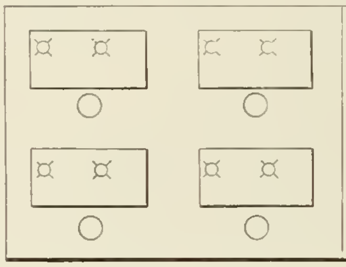

Fig. 3. Arrangement of 16-candle-power Suspended Lights

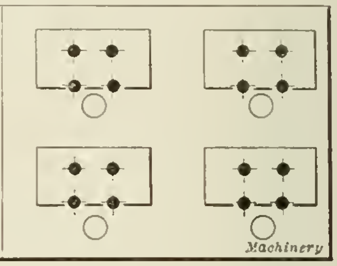

Fig. 4 Arrangement of "Inverted" Tungsten Lamps

The draftsman must endeavor to obtain as uniform a light as possible, and of ample volume. He should never work with the sun or with an unusual glare upon the board, even if he can "see better that way." Shadows are usually hard upon the vision, and incidentally hinder rapid progress, as they make a reversing of the tools and a constant shifting of position necessary. It should be a practice for the draftsman to rest his eyes at intervals. This does not infer "loafing" or staring out of the windows into the bright sunlight; a condition of absolute rest for a minute or two is what is required.

The most common system of artificial illumination is a drop light and reflector with 16- or 32-candle-power lamps. The writer's experience is that a 16-candle-power lamp hardly renders sufficient light for the size of the ordinary drafting board. A 32-candle-power lamp, again, offers a more concentrated and glaring light, causing reflection back from the tracing, which is not favorable to the vision. Two 16-candle-power lamps, therefore, have been found to give the greatest satisfaction, if arranged by two drop cords as indicated in Fig. 3. One of the lamps is placed at the extreme left, and the other a little to the right of the center. By using lamps so arranged, one of them can be turned out in cases when the shadows thrown by it are objectionable. The addition of a piece of transparent tracing paper stretched over the base of the reflector and pasted to its edges, thus hiding the lamp proper, will afford a soft diffused light. [A frosted globe would seem more advantageous.—Editor.] For tungsten lamps, properly arranged, a 40-watt lamp should be suitable.

In Fig. 5 is shown an example of an adjustable lamp fixture which eliminates the necessity of using two lights, and is very satisfactory. It consists of an arm and reflector mounted upon a rod at the back of the drawing board, and supported a few inches above the board by means of small brackets. A T-shaped carriage with universal joint for the lamp arm at *A* permits the rod to be held in any position. Floor sockets are used at the back of the board with a sufficient length of cord to permit the lamp to be moved along the rod. The strictly portable desk lamp with stand is not advantageous for the drafting board on account of the space it requires, the difficulty of moving it about and of using it in connection with an inclined drafting board.

When individual lamps are used, as previously referred to, the proper height of the lamp above the work is ordinarily a condition which the draftsman himself controls. The lamp should not be held too high causing a glare; neither should it be placed too low, as it then will produce an undue amount of reflection which is harmful to the eyes. Too brilliant an illumination is just as dangerous as insufficient light. Artificial light resorted to when daylight is available is very bad for the eyes.

Ceiling lighting in the drafting-room has not given general satisfaction, owing to the casting of shadows and the glare of the light; it has but few advocates, and there are fewer installations of this kind. Recent tests of this method of illumination conducted by Mr. C. E. Clewell[*] indicate favorable results with lamps arranged as shown in Fig. 4. Here sixteen 40-watt tungsten lamps in groups of four to each board are placed in a room 16 by 20 feet with a ceiling height of 11 feet 6 inches. The lamps are inverted so as to point upwards, and opaque reflectors are used for throwing the light towards the ceiling.

[One excellently lighted drafting-room, about 25 by 60 feet, which we have had the opportunity to see when lighted with artificial light, was provided with three Nernst lamps of high candle-power. The ceiling was painted pure white, and under each of the lamps a large reflector was provided throwing all the light towards the ceiling. A soft white well diffused light was then reflected from the ceiling onto the drawing boards. This method of lighting produced the best artificially lighted drafting-room that we have seen.—Editor.]

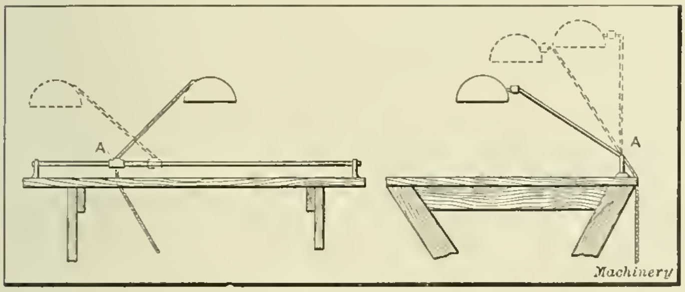

Fig. 5. Light held in Adjustable Bracket

Headache is a common ailment among those who work with their brain and eyes. This is Nature's warning and should not be slighted if the ailment becomes frequent. Other signs of defective sight are as follows: 1. A mist appearing before an object viewed at close range. 2. A need for a light placed between the eyes and the object. 3. A necessity of holding small objects at a far range in order to see them distinctly, and partly closing the eyelid while viewing. 4. The apparent running together or blurring of lines or letters. 5. A state of continual fatigue of the eyes, or necessity for closing and rubbing the eyes frequently. 6. The appearance of spots floating before the eyes.

These are a few common ailments which especially apply to the draftsman and his work. If any of these defects become apparent, special care should be taken and proper glasses should be resorted to, if necessary.

Ventilation in the Drafting-room

Air is a chief sustainer of life and health. Pure air is indispensable to a healthy existence. The purest air, under natural conditions, contains in 10,000 parts about 4 parts carbon dioxide (CO_2), while an atmosphere vitiated through poor ventilation may be contaminated to the extent of 70 to 80 parts of this gas. It is estimated that under usual working conditions in offices, approximately 2000 cubic feet of air per hour is necessary for each person.

Considering this subject with strict reference to the draftsman and the drafting-room, we will eliminate, in general, any phase of technical discussion relating to ventilation. The idea is simply to impress the value of fresh air with regard to one's physical and mental working power, to decry against the absolute disregard of the requirements prevalent in countless instances, and to offer such suggestions as will prove effective with little or no expenditure.

Space wholly unsuited to the purpose is often made to serve for a drafting-room; the smaller the establishment, implying the employment of but one or two draftsmen, the less attention is given to the actual requirements that efficient work demands. Any old place, not in use, seems good enough, whether it ever sees the real light of day or is accorded any supply of fresh air. Again, among larger concerns this same indifference may be noted. The drafting department is regarded as a necessary evil, and afforded quarters hardly fit for even the crudest clerical work. In many cases this may be attributed to the fact that the man in charge has never served his time at the board, and consequently fails to appreciate the draftsman's labor.

In a small machine shop the writer has seen a lone draftsman work over a board placed in a foreman's partitioned office, and far removed from air and light; an electric fan was used to circulate the vitiated allowance of the former, while artificial means served for the latter. The foreman frequented the place no more than necessary, but the draftsman was expected to devote a ten-hour day to design and detail in this room. In a million-dollar incorporated light and power company with a practical operating man for superintendent, the drafting-room, employing three men, was placed in a corner of the transformer room, adjoining the switchboard compartment. The room was enclosed by board partitions, containing barely sufficient space for the three boards. The heat in the winter was excessive, and in the summer it averaged between 95 and 115 degrees. Two small windows, opening into a rear yard, were the sole means of ventilation, letting in air which instantly covered a tracing with a thick layer of dust. If for this reason only, the window had to necessarily be kept closed. The instances cited are not exceptional, and where one draftsman has not met these experiences, many have. It proves that the health of the men in this calling is many times neglected.

Many otherwise well equipped drafting-rooms in large plants and office buildings, lack proper ventilation facilities. The discomfort of a stuffy, ill-ventilated room is apparent. Not only does it affect personal health, but a contaminated atmosphere invariably tends to produce a mental condition which decreases the worker's efficiency. The breathing of impure air brings a sense of drowsiness and a lack of ambition, and in no other branch of endeavor does it show more clearly than in that of drafting. The value of pure, fresh air cannot be over-estimated, and no effort or expense should be spared to supply it during the working day. It must not be regarded in any aspect other than that of an absolute necessity, the expense for which is indirectly returnable to the employer in the form of more and better work.

In a room well ventilated by natural draft, that is windows, doors and transoms, a thorough system of airing, rigorously followed, will, perhaps, be all that is required. The office boy should report in the morning a full half-hour before the men, and during this period he should open every window and door. A similar airing should take place at the noon-hour. This, coupled with sensible admission of fresh air through the day, will provide a reasonably pure atmosphere. This is applicable to any season of the year. Fresh air warmed, in winter, is entirely dissimilar to heated foul, stale air. The use of a system as suggested will eliminate the haphazard fashion of opening the windows when one happens to think of it, an entire morning passing with possibly a score of men in the room, and a lone window or two providing the entire air supply. Where smoking among the men is permitted, there is even a greater need for a constant air circulation, and a small exhaust fan, properly installed, will be found to render adequate service. Windows fitted with a fine mesh screen are especially advantageous in warm weather, when the greatest volume of fresh air is required. The windows are opened both from top and bottom. The screens will not only assist in excluding dirt and insects, to a fair degree, but will protect drawings and papers used for reference and not fastened to the board from the danger of being blown out-of-doors by a sudden gust of wind. Provision should be made, by means of simple and inexpensive ventilators, to permit fresh air to enter the room during inclement weather. Much harm is done by allowing days to go by with no change of atmosphere. Where a mechanical system of ventilation is installed there may be no necessity for the suggestions offered, but such installations, particularly for a drafting-room, are in the minority.

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[*] See Machinery, engineering edition, February, 1911: "Notes on Drafting-room Lighting."

All work of a confining nature is injurious to one's health, and none more so than drafting. A careless mode of viewing the simple demands of health in early life may easily lead to serious consequences in later years. The secret of longevity is founded upon the adaptation of oneself to the conditions of employment and sensible living. The draftsman is called upon to work with hands and brain and is entitled to a full allotment, while on duty, of fresh air, good light, and congenial surroundings; it is only through such conditions that he is enabled to creditably fill his duties; and of him, personally, is demanded the observance of the established rules of life and health.

* * *

REMARKS BY THE ONLOOKER

Prejudice is said to be due to lack of education and this, perhaps, is true, yet how many of MACHINERY'S readers, supposedly fairly well educated, would, without prejudice, consider the purchase of a lathe made in New Orleans? I am sure I would hardly feel inclined to listen to a salesman talk about it. Many of MACHINERY'S readers can well remember when most of the fine mechanical appliances were made in the East; a rough count of the ads in the October issue shows one and one-half times as many mechanical ads of firms in the West as in the East. This is a natural condition, and it seems to me that the trend will continue, until after awhile, perhaps, one may be willing to buy a lathe made in New Orleans.

The rate charges for job works compiled by MACHINERY are interesting, yet at the figures given I cannot see in them, with a nine-hour day, even a moderate profit. Take an average rate of 65 cents per hour; the wages will be 30 cents leaving 35 cents for overhead expense and profit. Now I do not believe that with the shorter day this constant factor—overhead expense—is ever less, in a machine shop, than 110 per cent, and it is probably nearer 125 per cent of the labor cost, but at 110 per cent the possible profit is but 20 cents per day. Of course lower-cost labor is worked in, and file charges, emery cloth, etc., are all added, but still the return is not adequate even if it is considered true that you won't get poor taking profits however small. The question of overhead charges is one which almost always creates trouble and often the differences in rates are the result of it not having been made up on the same basis.

That jobbing shops are hard to run successfully is admitted, and I am also ready to admit that there has been a great advance in machine tool design, which is made perfectly plain by a glance through MACHINERY. Yet I am not ready to admit that a job is done much more rapidly today than it was twenty years ago. In manufacturing, it is true, the advance is almost beyond belief, but not many weeks ago I had to get a job reproduced which I had done twenty-two years ago, and the cost was a little more than what I then paid.

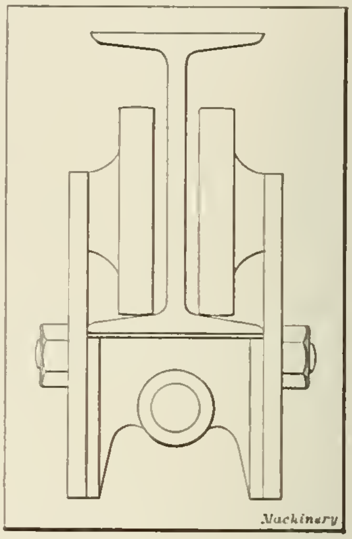
I do not think that the skill of the mechanic is any less. Looking at the produce of the extruded metal system, the cost of such forms as are shown on page 127, engineering edition, is but a fractional part of what it would be if machined, and some of the forms could not be commercially machined at all. There, then, is clearly shown a reduction in manufacturing cost and a wonderful advance in quality.

As an instance of advertising values, a client of mine has been paying, for years, $2.80 for a certain forging. I drew his attention to an advertisement and now he is paying 80 cents for the same thing—quite a nice saving to make by just using one's eyes.

The pencil sharpener illustrated brings to my mind the time when I was very proud to be able to buy a pewter-covered shaped affair that broke about 95 per cent of the points of the pencils I tried to sharpen. I wonder if they are still made? What a contrast with what is now obtainable!

The I-beam trolley illustrated is interesting. I suggest the modification shown, as giving a little more hoist room (that is always an advantage), and I get as stiff a trolley as does P. H.

I wonder if any other MACHINERY readers had as hard a time as I did in understanding Mr. F. B. Hay's file? Somehow the word "wall" seemed out of place and should have read "ceiling," but that would not have worked out with the elevation; after I understood the idea I liked it. I wish Mr. Hays would give the details of how the boards were put in. If I used the system, I would put a padlock on it, as somewhere in a shop a set of working and assembled drawings should be locked in, nailed down and soldered fast, so that under no circumstances could they be taken away necessitating a general hunt for them by the foreman and all hands. The time lost in some shops hunting for blueprints is great.



Suggested Improvement for I-beam Trolley

The method explained of aligning drills when using a jig will accomplish the end, but I do not like the practice of lifting the bushing out of the hole after starting the drill; that is, if the jig is to be used much and first-class results are desired; I have found that the hole wears, not by removing the bushing but by the action of the chips. Just here, I want to have a word to say about the word usually spelled "bush." If you turn to a dictionary you will see that "bush" means a "thicket" or "shrub." I have often been asked how the name came to be applied as it is in mechanics. The matter is made clear at once if the original spelling of the word is looked up; it will be seen that this is "bouche" which is the French word for mouth. A hole lined with steel is, then, "mouthed"—to translate it exactly. Here I think is an example of how unwise it is to change the original spelling of a word when it is taken from a live foreign language.

Of course the cow has always been a factor in mechanics, her hide giving us our belting and years ago our lubricating tallow, but I did not know that she had been helping the Standard Oil by giving her horns for oil-well packing, and if they are useful in such work they should be in many other places as well. I have many times made bearings out of rawhide and used water as a lubricant advantageously, and I have seen vertical shaft steps used in water turbines, made of rolled-up rawhide, which would outlast any other material tried.

The editorial remarks as to "It Can't be Done" bring to my mind something concerning the first breech loading guns. They were tested by the United States government just after the Civil War by officers who reported that they stood prescribed test, were reliable, and much more rapid in fire than the muzzle loader, but the Board could not recommend them for the troop, as to have a package with the powder, ball and cap all in one was too dangerous to be considered!

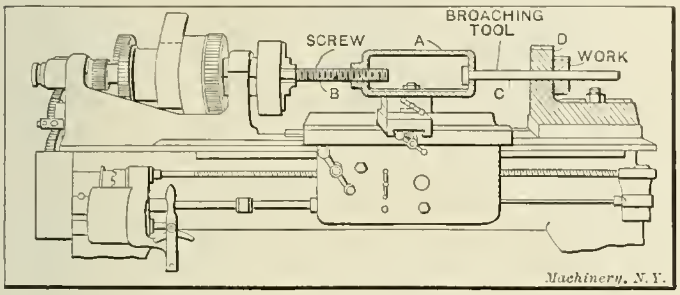
The idea that man cannot fly has been rooted in our minds. We use the expression "You can't do it any more than you can fly," and it is one that is looked upon as a classic. Yet, I believe that fifty years from today the sight of a horse will awaken more interest than a flying machine does now. The impossibility of riding a single wheel was mathematically settled by a French Society, yet a man was produced who rode one about the very stage from which the assertion was uttered. It is well to take the old darkey's suggestion that "it ain't wise prophesying unless you know." W. D. F.

LETTERS ON PRACTICAL SUBJECTS

We pay only for articles published exclusively in MACHINERY.

BROACHING ATTACHMENT FOR THE LATHE

A broaching attachment which can be applied to the lathe at small cost is shown in the accompanying illustration. This consists mainly of a forging *A* fastened to the cross-slide, and tapped out on one end to receive the screw *B* held in the lathe chuck. The other end is bored out to receive the broaching tool *C*, which is provided with a head, as shown, to prevent it from pulling out of the forging. The work is placed against the rear face of a rigid angle-plate *D* which is clamped to the lathe bed, the tailstock casting having been removed. The angle-plate *D* and forging *A* are slotted through on one side, so that the broaching tool can be located in the work, and the broaching tool and work placed on the fixture.



Device for Broaching Work in the Lathe

In operation, when the work is located on the angle-plate, the nut in the apron is disconnected from the feed-screw, so that when the lathe chuck is revolved, the screw held in it will draw the carriage in the direction of the head, thus drawing the broaching tool through the work. The screw *B* should be provided with a head on the end held in the chuck so that it cannot be pulled out, and should be about 1 inch in diameter with a ⅛-inch square thread cut on it. For general work a screw 12 inches long will be sufficient. This device provides for a draw cut, which has been found the best for broaching work.

D. FOSTER HALL

Springfield, Mass.

FORGING AND PLANISHING COPPER BLADES

A simple and effective means of rapidly cutting off, heading and planishing the copper blades shown in Fig. 1 is described in the following: The material upon which these operations are performed is ⅛-inch hard-rolled copper bars, 1 1/16 inch wide; the shape of these bars is best illustrated by the plain portion of Fig. 1, which shows the original stock. In order to satisfactorily upset the end to more than twice the thickness of the stock, and at the same time to produce work that is free from "cold shuts," with any degree of accuracy, careful heating of the upset part of the bar was required in order to avoid scaling. For this purpose the heating was done in a special gas burning furnace that confined the heat to a limited area, leaving all but the very end cool. In addition to making these special provisions for heating, a good deal of experimenting was performed to determine the best punch and die for the purpose. These experiments involved a series of trials with steel, various kinds being used with more or less success. The steel finally adopted was of a low carbon nickel variety which showed the best degree of resistance to fatigue, not being easily cracked or broken. The dies were used soft, no heat treatment whatever being given; in this way they stood up better and lasted longer. Following a run from eight to ten thousand pieces, the dies began to crack, but this was overcome in the same way as that adopted for drop forging dies, that is, by staking them, thereby closing up the cracks. The process, however, could not be repeated, owing to the accuracy of the work and the neat appearance demanded.

The machine used to perform the operations was a 1½-inch Acme forging machine, which cuts off the work with the toggle action cross-slide movement, at the same time carrying it forward and gripping it in the die preparatory to forging the head, the rear end abutting against the faceplate, thereby preventing the blade from slipping. In the illustrations, Fig. 1 shows the finished work after the forged end has been milled to size, Fig. 2, the die, and Fig. 3, the punch. The die consists of two blocks—a stationary and a movable one. The movable one is guided in its cross motion by the four guide pins shown, two of which are attached to the top of the movable block, and two to the bottom of the stationary block. The hot end of the bar being introduced into the stock-hole of the faceplate is shoved forward to the stock stop, the movable die in the meanwhile being in its extreme left position. The stock-hole in the faceplate is located about ¼ inch to the left of the die center-line. The movable die now moving over, shears the stock to the required length and holds it securely in the formed groove between the movable and stationary blocks. The shear has elongated bolt holes which compensate for grinding the cutting face.

The punch shown in Fig. 3 now comes forward, entering the die and forcing the metal to the required shape. Upon the completion of this operation the movable block moves back and drops the finished piece into a chute below. As the furnace heats the ends as fast as they can be handled, continuous operation is possible. The construction of the punch itself might be noted particularly. The slot across its face, which is shown in Fig. 3, guides the end and prevents it from springing to one side. This tends to form more perfect heads, particularly in the corners of the impression. With

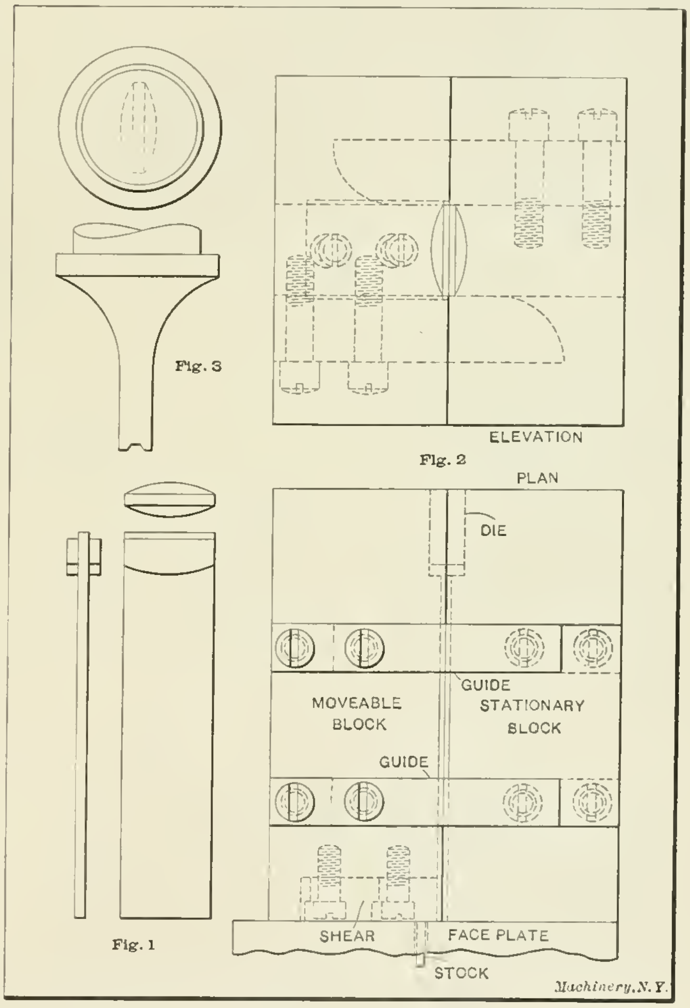


Fig. 1. Finished View of Blades made from Copper Stripe. Fig. 2. Forging Dies employed on the Job. Fig. 3. Punch for Upsetting Ends of Blades

a flat-faced punch, the tendency was to fold the metal, owing to the deflection of the hot end, just as the upsetting began.

The copper blades are next dipped, in order to cleanse and remove the discoloration incident to the heating of the copper. On the completion of this, the work is next passed through the operation of planishing under a 600-pound drop hammer. This is done in dies almost identical with those used in the finishing operations of drop forged dies, the result being that the work is straightened, stiffened and sized as to thickness, at the same time receiving a brilliant finish. These dies are made of carbon steel and are as hard as possible on the face, the working part being very smoothly finished in order to transfer a high polish. It is remarkable what a bright surface is given to these copper bars when struck a blow of sufficient force to decrease the thickness of the metal from 0.002 to 0.003 inch, provided, of course, that the dies doing the work are highly polished. Although the blades are finally buffed, this planishing action under the drop hammer materially decreases the cost of production.

Pittsfield, Mass. C. H. Rowe

STOCKING OUT A STEEL GEAR ON THE PLANER

We were at one time repairing our largest planer, and among the repairs necessary was the replacing of the large rack gear. This gear was made from a steel casting weighing about 500 pounds when turned, and had forty teeth 1½ inch pitch. From the appearance of the casting it was evident that there were a few hard spots, and to avoid the risk of spoiling an expensive gear-cutter we decided to rough out the gear on the planer. The way in which this roughing out was accomplished was as follows: The gear blank *A* was mounted on an arbor *B* which rested in two V-blocks *C*, and was clamped to them as shown in the accompanying illustration. On the outer end of the arbor was keyed an ordinary change gear *D* having 120 teeth, and the pawl *E* was arranged in a bracket to engage with the teeth in this gear.

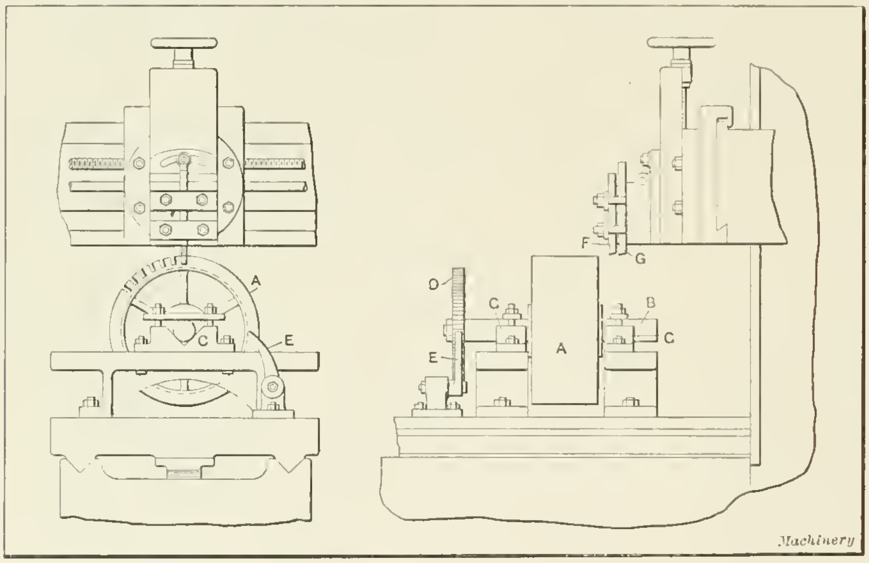


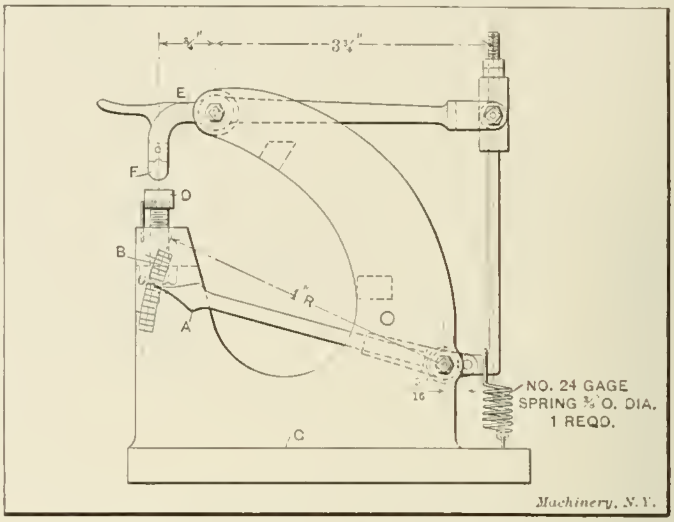
Illustration showing the Method used in Stocking out a Steel Gear on the Planer

When everything was set up, the machine was started and the automatic down-feed engaged. A dead stop was attached to the toolpost to give the exact depth—1.03 inch—but before this depth was reached the automatic feed was disengaged and the final feeding done by hand. The manner in which the roughing out was accomplished is of special interest as the method adopted was both efficient and rapid. Two tools *F* and *G* were clamped in the toolpost, and separated by a ¼-inch strip. The cutting part of the front tool was made 5/16 inch wide, while the rear tool was made 1/2 inch wide. The front tool was placed a few thousandths lower than the second tool. With this arrangement heavy cuts could be taken, as the chips from each tool were always narrower than the groove being cut, thus preventing the tool from binding or digging in. This method of holding the tools would be especially useful for splining in the planer, particularly in steel work. The time required to rough out one tooth using a feed of 0.015 inch was ten minutes including unclamping, clamping and indexing—it being necessary to unclamp and index, of course, for each tooth.

G. Ear

MICA MEASURING GAGE

The accompanying illustration shows a micrometer gage for measuring the thickness of mica segments, which are used for insulation between the bars of motor commutators. However, its use is not necessarily limited to this class of work, as it could be applied to measuring sheet steel, etc.



A Simple Gage for Measuring Mica, Sheet Steel, etc.

Formerly this gage was so made that for a difference in thickness of 0.001 inch in the mica segment, a movement of only 1/64 inch was given to the pointer *A* on the scale *B*. As this movement was not easily detected, and as girls were employed in measuring these mica segments, it was found that this gage was not sufficiently "sensitive." The gage was reconstructed using the same casting *C*, with different multiplying levers, so proportioned that a difference in thickness of 0.001 inch gave a movement to the pointer *A* of approximately 1/16 inch.

In operation, the mica is placed on the anvil *D*, which is furnished with forty threads per inch and is graduated with twenty-five divisions so that it can be readily adjusted to suit the thickness of the pieces being measured. The anvil is adjusted to standard thickness gages, so that when the lever *E* is depressed and the measuring point *F* touches the mica, there will be no movement of the pointer *A*, that is, the pointer will be at zero when the mica is of the exact thickness required.

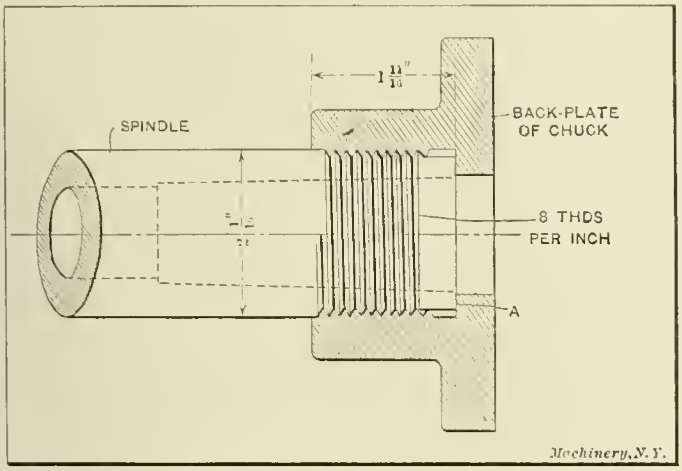
The gage was assembled before the graduations on scale *B* were laid off, they being so spaced that each division moved over by pointer *A* represents a movement of 0.001 inch of the measuring point *F*. At zero on the scale the divisions are 1/16 inch apart, but on account of the short length of pointer *A* the distance between the divisions will vary. To set the caliper when graduating the scale, "feelers" or gage strips were used, so that it was merely necessary to insert the proper strip between the anvil and measuring point *F*, and mark the corresponding graduation opposite the pointer *A*.

Akron, Ohio. J. S. Wilson

A CRANKY LATHE SPINDLE

The accompanying illustration shows the construction of the nose end of a lathe spindle with the back plate of a lathe chuck attached. As will be seen, this construction differs from the ordinary design in that the usual thrust collar or shoulder for the chuck is absent, the thrust being taken at the end of the spindle by the surface *A*. In use, the chuck acts in a peculiar manner; when least expected it will unscrew slightly and wobble on the spindle. The chuck cannot be at fault, as it is one of the best makes on the market, so it would seem as if the spindle must be the offending member. In the illustration the chuck proper has been removed from the back-plate for simplicity.

One explanation of this tendency of the chuck to wobble is that the thrust is taken too near the axis of the spindle, and a cut taken at the outer end of a job in the chuck causes a rocking or see-saw motion of the chuck about its thrust-bearing, jarring the chuck loose. Probably some of the readers could suggest a more plausible reason.



Nose End of Lathe Spindle with Back-plate of Lathe Chuck Attached

Doubtless the difficulty might be remedied by forming a taper on the end of the lathe spindle which would fit in a corresponding taper in the back-plate similar to the lathe center taper. This expedient, however, would not answer nearly as well as a substantial thrust collar. In this particular, some of the best modern lathes are deficient, for instead of a collar of ample diameter, they merely have a low shoulder to take the thrust. This is a cheap construction, but it would seem to be poor policy to economize too much in so vital a part of the lathe as the spindle.

Atlanta, Ga. W. S. Leonard

MACHINING GAS ENGINE PISTONS

In the following letter a description is given of the methods employed by the Potter & Johnston Machine Co., in the machining of gas-engine pistons on its automatic turret machines.

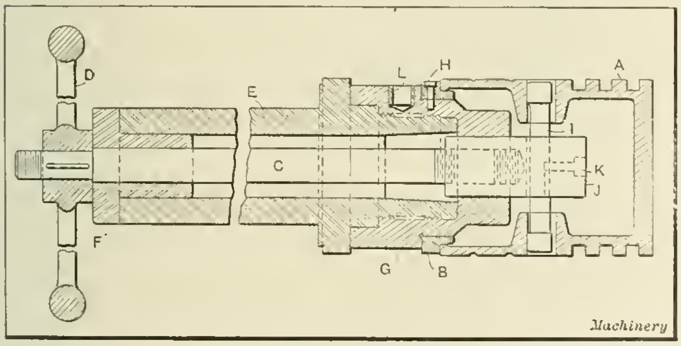


Fig. 1. Device used for Holding Pistons in Potter & Johnston Automatic Turret Machines while Grooving, Facing and Turning

The illustrations Figs. 1, 2 and 3 show a holding device, and also the fixtures used in turning the external diameter of the piston, and cutting the grooves for the rings. Before the piston is placed on the fixture shown in Fig. 1, it is bored out internally and the wrist-pin hole is drilled slightly smaller in diameter than the finished size.

The chucking arrangement shown in Fig. 1 is called a "hold-back" or "pull-back" device, the piston being held on it against the ring *B* by means of the pull-back rod *C* and the handwheel *D*. Rod *C* extends clear through the machine spindle *E* and is steadied on the rear end of the spindle by means of a bushing *F*. The fixture *G* is made to screw onto the nose of the machine spindle, while the ring *B* is held to it by means of the screws *H*. The piston *A* has its open end bored to fit snugly on the ring *B* and pull-back pin *I* passes through a link *J*, held centrally by means of the stop-pin *K*. The pull-back rod *C* is screwed into the link *J* and the handwheel *D* is keyed to the rod *C*, as shown. It is therefore clear that as the handwheel *D* is turned in a right-hand direction, it draws the piston tightly onto the bushing *B* by means of the pin *I* coming against the rear face of the wrist-pin hole. A hardened bushing *L* is driven into the fixture *G*, in which a pin fits to remove the fixture from the machine spindle.

In Fig. 2 is shown the cross-slide arrangement which is used for facing and grooving the piston while it is held on the fixture shown in Fig. 1. The grooves for the piston rings are cut by means of blades *B* and *C*; *B* designates roughing blades and *C*, the finishing blades. The blades *B* are carried in the auxiliary cross-slide block *D*, which is fastened to the standard cross-slide block by means of two collar-head screws *E* and tee-nuts, not shown. The blade *F* which rough-faces the end of the piston is held in a holder *G*, carried in the block *D*. This holder *G* and blades *B* are held in place by set-screws which are located in the cap *H*, the latter being fastened to the block *D* by means of fillister-head screws. As will be seen in the end view, the blades *B* are set at an angle of about 5 degrees, while the holder *G* is set straight.

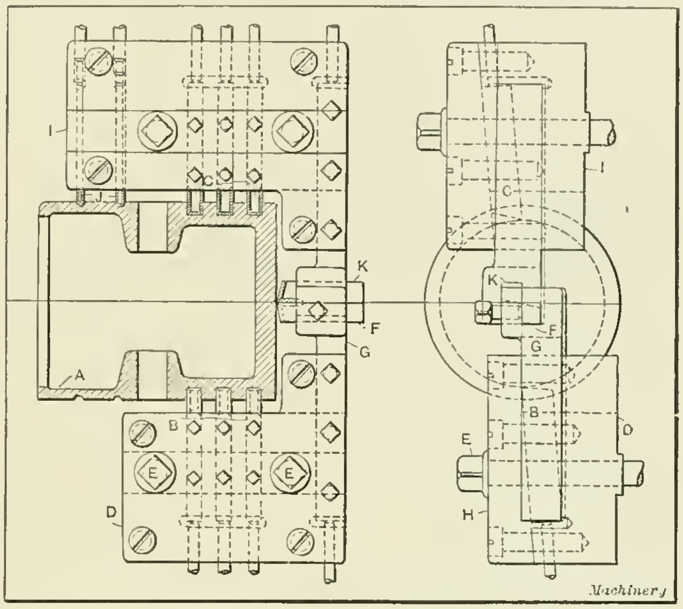


Fig. 2. Special Cross-slide Fixtures for Rough- and Finish-grooving and Facing Pistons

The rear block *I* is similar to block *D* with the exception that it carries two blades *J* for cutting oil grooves in the piston. Blades *C* are for finishing the grooves for the piston rings, and blade *K* is for finish-facing. All the blades in the holders *D* and *I* are furnished with backing-up screws, to provide for adjustment, which are set at the same angle as the blades in the holder.

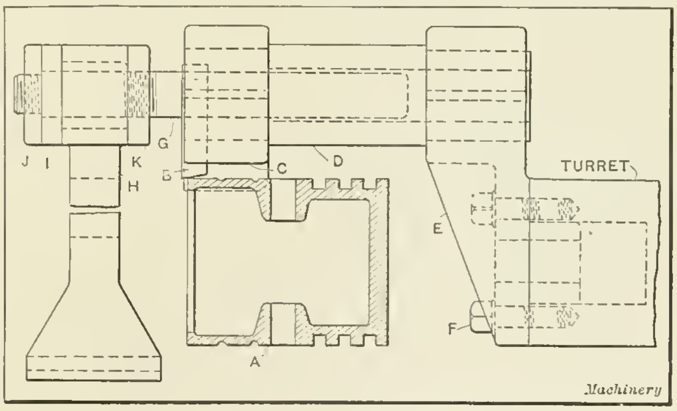


Fig. 3. Fixture used for Rough-turning the Piston

In turning the external diameter, the piston is held on the fixture shown in Fig. 1, where is is rough-turned by means of the cutter *B* located in the head *C*, Fig. 3. Head *C* is held tightly upon sleeve *D* which, in turn, is fastened to holder *E*, located on and clamped to the turret face by means of four collar-head screws *F*. The holder *E* has a shank on it which fits into the hole in the turret. Sleeve *D* is bored out to fit a pilot pin *G*, which is held firmly in the bracket *H* by meaus of the eccentric bushing *I*, and the nuts *J* and *K*. The pilot bracket *H* is held firmly to the machine bed by means of straps.

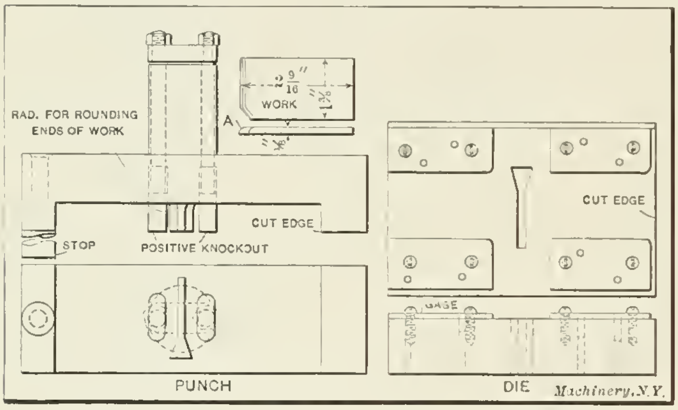
For finish turning, a tool is used which is called a "relieving stem," deriving its name from the working arrangement in which it is held. This stem, after taking the finishing cut relieves itself, and in returning across the face of the piston, does not mark its surface as a stationary tool would do. The piston is now finished, as far as the lathe work is concerned, the turning, facing, and grooving all being done without moving it from the machine, which effects a great saving of time in the manufacture of gas-engine pistons.

Westerly, R. I. HAROLD E. MURPHY

CUTTING-OFF AND COLD-SWAGING DIE

The accompanying illustration shows a punch and die for cutting off, parting in the center by the removal of a small section, and rounding the inner edges of hard copper flats such as the one shown at *A* in the engraving. These blades are made in large quantities in the various sizes and are used in pairs for knife-blade electrical switch clips.

Previous to the making of this tool, the blanks were first cut off in a press and the ends afterwards rounded by milling each piece with a formed cutter, in two operations. While a number of dies are used, some of them slightly different in design, the type here illustrated and described gives a good idea of the method now employed in the making of a pair of blades in the power-press by one operation and consequently at a higher rate of production.



Cutting-off and Cold-swaging Die, and Copper Blade produced

The die of tool steel has a centrally located opening for the purpose of parting the two blanks and cutting the angular ends; gages as indicated are secured to the top surface as guides for the stock. The stop pin, driven in the punch, has its lower end made of sufficient length to project below the face of the die at all times; it is also in contact with the left-hand end, limiting the movement of the copper bar endwise and aligning the work for the punch to pass down over it so that it may be held firmly by the time the end pressure occurs due to the swaging action incident to rounding the corners.

The punch, in order to withstand the great strain to which it is subjected, is a one-piece tool-steel forging, hardened and ground to dimensions and form. The fillet is carefully finished for the twofold purpose of strengthening the center cutting portion and rounding the ends of the work when the punch has entered the die to the requisite depth. Meanwhile the right-hand end cuts this blank from the bar. The ejectors, one for each blade, operate through the shank, being joined together by a strap across the top; their action is positive as they contact with a knockout bar extending horizontally through the press ram just before the latter reaches the full height on the up stroke.

Several dies of this type have been made, some of them cutting off and perfectly rounding blanks up to 3/16 inch thick and 2 inches wide. While the tools are giving satisfaction, standing up well, etc., it should be borne in mind that to utilize them to their highest available capacity, that is to obtain a perfect radius and flatten the blanks, a rigidly constructed press is essential, as the strain when the work is pressed between the two members is severe.

Pittsfield, Mass. C. H. ROWE

ACCURATELY THREADING PIECES IN ENGINE LATHE

The engraving Fig. 1 shows a lathe fixture made from a steel casting, for use in threading the malleable iron casting Fig. 2. These castings are usually machined in two-hundred lots in a turret lathe; but the importance of the thread requires that the threading be afterwards done in an engine lathe in the manner indicated in Fig. 3, two tools cutting both threads simultaneously. These tools are readily set to size, and are clamped to the slide-rest with two ordinary clamps, substituted for the toolpost. The internal thread tool is reversed in position in order to cut on the center with the face upside down. This method of threading was originated by the writer and introduced in the Boyer Mfg. Co.'s shop in St. Louis some ten years ago, where it has been in use ever since. The iron in these castings is very soft, with the result that the threaded sizes are retained by the tools all day, with an occasional oil-stoning on the face of the tools. In the internal threading, a few thousandths inch is left for sizing with a special tap.

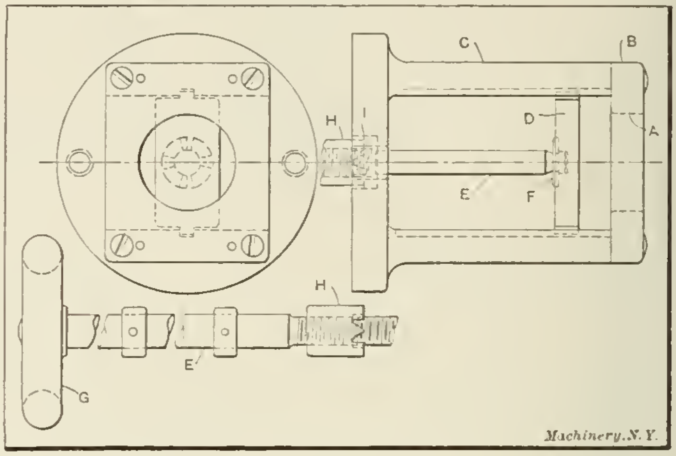


Fig. 1. Jig for Holding Pieces shown in Fig. 2. for Threading

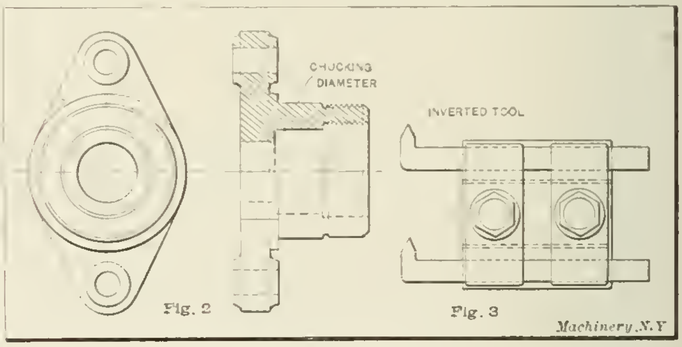


Fig. 2. Piece machined in Turret, to be threaded in Engine Lathe.
Fig. 3. Double Threading Tool used

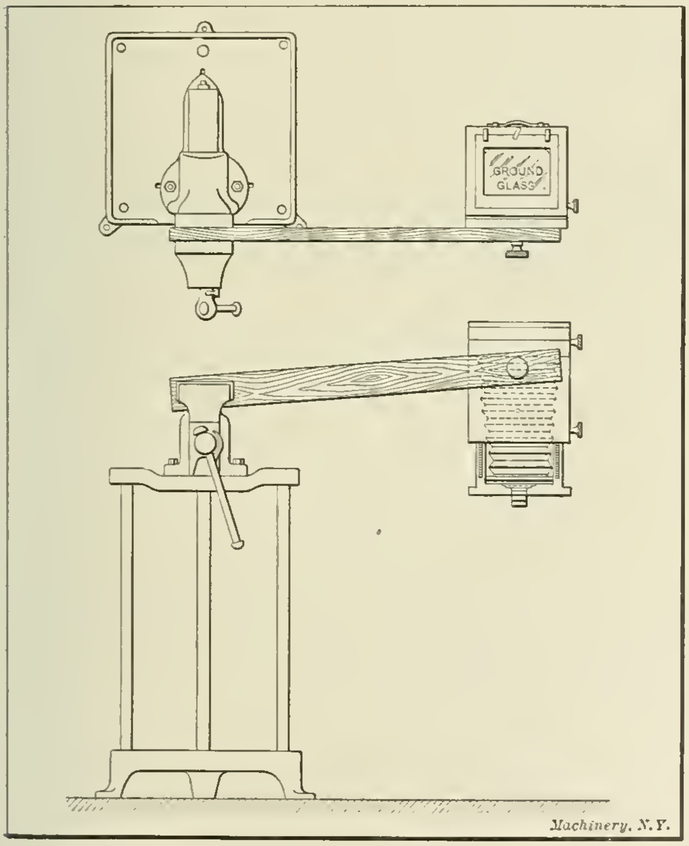
As the flange on the casting Fig. 2, is left in the rough, with the exception of the bosses which are faced, it is necessary to chuck the work by the finished diameter, back of the thread; for this purpose the fixture in Fig. 1 was designed. The hole *A* and back face in the casehardened machinery steel pieces *B* are ground and fastened to *C* by four fillister-head screws and are located by four dowel pins. *D* is also made of casehardened machinery steel, and has a bearing in the fixture on each tongue, this admitting of its sliding freely in the slot in *C*. The rod *E* is free to revolve in *D*, being held to it by a split washer *F* which is riveted in place with four pieces of ⅛-inch gun rod. *E* passes through the 1½-inch hollow spindle of the lathe and is operated by handwheel *G*, the two collars on *E* maintaining it in central alignment in the lathe spindle. The handwheel is removable, being held in place by a key and hexagon nut. *H* is a 60-degree clutch and nut combined, but only the teeth are casehardened. It is ⅞ inch diameter, 16 pitch, and threaded left-handed to correspond to *E; H* when in use, engages the clutch *I*, which is a drive fit in *C*. The clamping pressure on the work is not necessarily very great as the flange on the casting acts as a driver.

In service, *C* is clamped to the small lathe faceplate by two ⅝-inch cap-screws, a sheet of thin paper being inserted between. The hole in *B* is then set true with an indicator, *D* is slid to the back of the fixture, and the casting inserted in place, when *D* is brought forward to bear on the casting and is clamped by rod *E*, the thrust coming on the left-hand combined nut and clutch, which is prevented from turning by this clutch being engaged with clutch *I*. To remove the casting, handwheel *G* is given a turn which releases the pressure on *D*, the latter being free to slide as before.

Detroit, Mich. David Melville

BRACKET FOR HOLDING A CAMERA IN A VERTICAL POSITION

The accompanying illustration shows a simple arrangement for holding a camera in a vertical position, when photographing small articles placed on the floor, such as drills, arbors, etc., which cannot be readily fixed in a position suitable to the usual altitude of the camera. The vise fastened to the portable work-stand shown in the illustration serves as a holder for the bracket. The stand is an ordinary portable work-stand which is used for holding a vise, and can be transferred to the place desired. A piece of wood about 1 by ⅜ inch, and of a convenient length is gripped in the vise, and the camera is attached to this wooden strip by the same screw that is used in holding it to the board of the tripod. By this means the camera is held rigidly and away from any obstruction which would interfere with its field of view, as would be the case if it were held on the tripod. By having the camera held in this way it is possible to swivel it in any vertical plane simply by releasing the jaws of the vise and changing the position of the bracket.

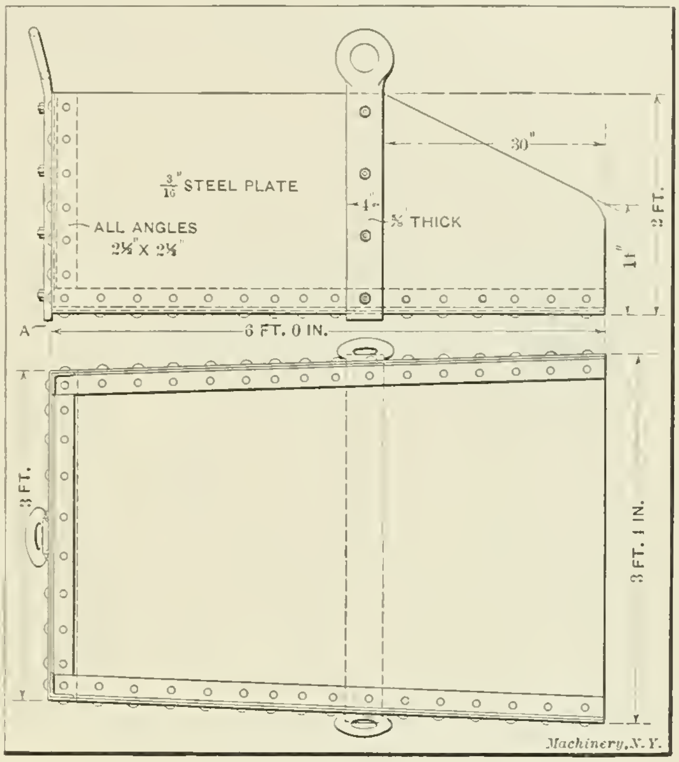


Simple Method of Holding a Camera in a Vertical Position

Shipley, Yorkshire, England. L. B. Oxley

BUCKET FOR TRANSFERRING METAL CHIPS

When handling metal chips in quantities, as, for instance, in transferring them from the shop floor to bins or loading on cars, the bucket shown in the accompanying illustration will be found to pay for itself in a very short time, especially in shops where a crane of any sort is installed. The ordinary chip-box used for transferring chips is usually closed on all four sides, while the bucket shown is open at one end, thus allowing the chips to be easily shoveled or pushed in. The handle at the rear end of the bucket projects past the bottom as shown at *A*, so that the front end is lowered when it rests on the floor, in the same manner as the house-wife's dust-pan. It will be noticed that the front end is wider than the rear, thus allowing easy admission of the chips. The bucket is suspended from the crane-hook by means of a circular ring connecting three chains, which have a hook on each of their ends, fitting in the three handles shown. When being lifted, all three handles are used, and when dumping, the hooks are removed from the side handles and the bucket is lifted by the rear handle and chain, only.



Bucket for Transferring Metal Chips in Quantities

Schenectady, N. Y. J. H. Carver

FINISHING CONCRETE FLOORS

There are concrete floors where the "sanding off" is very objectionable, and others where it might be necessary to mop them occasionally; yet, in their natural state it is impossible to mop them without having them absorb the water as rapidly as it is applied, and in the other the "sanding off" is disagreeable in many ways. Both objections can be overcome by painting with boiled linseed oil. After the cement has been "filled" with oil it takes on a smooth polish by constant use, and the floor can then be mopped and thus kept clear of dust.

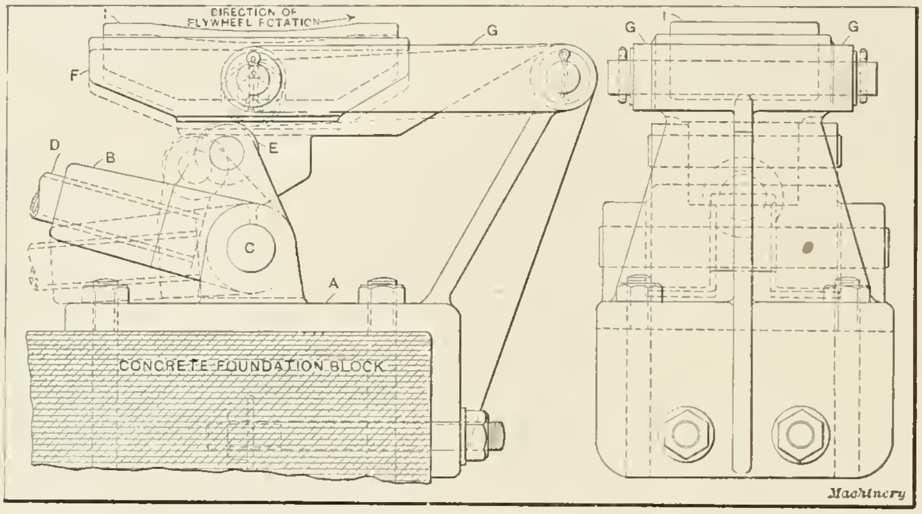
To prepare, first, apply one or possibly two thin coats of the oil with a paint brush, working fast all the time for it cannot be "rubbed" out like paint on wood, and letting these dry a day; then another coat, waiting a couple of days until thoroughly dry, and so on until four or five coats have been applied or until the oil remains and dries on the surface. It is this top coat that gives it a linoleum finish and that causes the surface of the cement to take the polish instead of "sanding off."

The floor in a large storage vault for tracings was finished in that way nine years ago; a year ago it received another top dressing of oil, and today it is smooth and glossy, will not "sand off" and can be mopped whenever it is dusty without absorbing all the water.

Salem, Ohio. H. W. Weisgerber

BRAKING DEVICE FOR POWER-PRESS FLYWHEEL

The large flywheel on punch presses, and in fact on other machinery as well, is often very difficult to stop quickly in case of an emergency, on account of the tremendous energy stored up in the rapidly revolving rim. The device shown in the accompanying illustration was designed to stop the flywheel quickly and easily. The customary method of stopping it, especially if the department head is not around, is by prying under the wheel with a piece of 2- by 4-inch timber, or oftentimes by the far more dangerous method of holding a piece of wood against the rim of the wheel by hand, and the writer has even seen flywheels stopped with the bare hands of the operator.



An Effective Device for Braking Large Flywheels

In the illustration, the braking device is shown assembled and mounted on a concrete foundation underneath the flywheel. Suitable fastening bolts are embedded in the foundation when the concrete is poured, and the bracket *A* is secured to the foundation by nuts. The bracket is of cast iron, properly ribbed, and is provided with two bosses between which the operating lever *B* rocks on the hinge pin *C*. A handle *D* of wrought-iron pipe is driven into this lever, and projects toward the front of the press, so that the operator may readily grasp it. The lever *B* carries a steel roller *E* at its upper end, and when this roller is forced under the brake tray casting *F*, it is capable of exerting a powerful thrust on the casting because of the toggle action of the roller and lever. The brake pan or tray *F* is hinged between two steel links *G*, which are fastened to the right-hand boss of the bracket *A* by a hinge pin, washers and cotter-pins. A maple block *I*, whose upper surface is curved to conform to the flywheel, is pressed into the tray *F* and acts as a brake shoe.

When the operating handle is allowed to fall, the tray comes to rest on the roller *E* on one side and on a boss projecting from the central rib of the bracket *A* on the other side, as shown by the dotted lines in the illustration. Where large punch presses or other machines embodying heavy and rapidly revolving flywheels are in operation, a device of this character will prove very effective and will meet with the approval not only of the men who operate the machines, but also of the factory inspectors who are always ready to endorse any device which will decrease the liability of accidents.

Detroit, Mich. Aron Lawrence

REMOVING A JAMMED FACE MILL

Recently in a large manufacturing concern a rather awkward milling job was put on a vertical spindle machine, an inserted-tooth cutter being used to perform the work. This was secured to the spindle in the usual manner, but as the cut was very heavy, when it was finally desired to remove it, it was found to be very tightly jammed and could not be budged.

The use of a long square bar between two teeth on top of the cutter was suggested, but beyond breaking off a few teeth, this method proved as futile as other attempts. It was finally decided to remove the spindle and turn the cutter away, it being deemed preferable to do this than to spoil the spindle.

The mechanic who was set to perform this task asked permission to try a little scheme which occurred to him. This consisted in taking a piece of waste, dipping the same in hot soda water and placing it around the hub of the cutter; then another piece of waste was placed under the ice water faucet and this pushed into the hollow spindle of the machine. After waiting a few minutes for the cutter to become warm and the spindle to become cool, a smart rap with a lead hammer on the cutter caused it to drop out.

This was a simple operation, merely putting into practice the property which metals have of expanding and contracting with heat and cold respectively. Eskil Rylander

Providence, R. I.

DIAMETER OF SMALL ENDS OF TAPER PINS

The accompanying table gives the diameters of the small ends of taper pins, which vary in length from ¾ to 6 inches. This table will be found very useful for machinists and draftsmen, as from it the size of the drill can be obtained. This will save considerable time as it is not necessary to measure the pin to find the diameter of the drill to use. The sizes given apply to pins which are tapered ¼ inch per foot.

New Bedford, Mass. Geo. D. Hayden

DIAMETERS OF SMALL END OF TAPER PINS

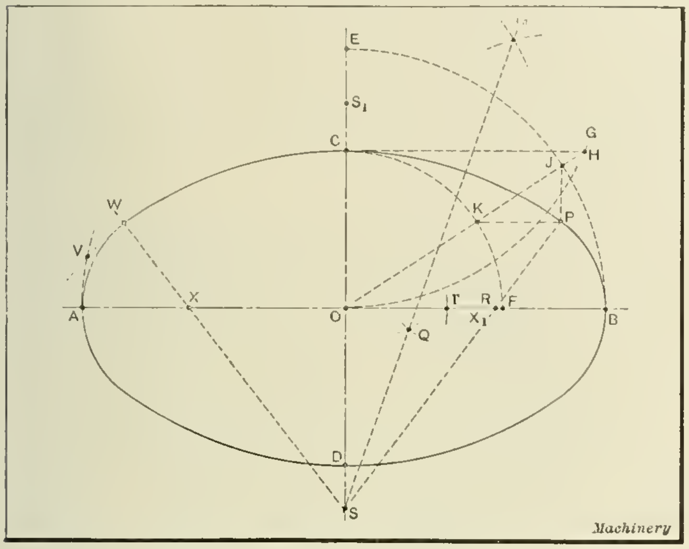
Taper, ¼-inch per foot

Size of Pin	0	1	2	3	4	5	6	7	8	9	10
Diam. Large End	0.156	0.172	0.193	0.219	0.250	0.289	0.341	0.409	0.492	0.591	0.706
Length in Inches	Diameter of Small End in Inches										
¾	0.140	0.156	0.177	0.203	0.235	0.273	0.325	0.393	0.476	0.575	0.690
1	0.135	0.151	0.172	0.198	0.230	0.263	0.320	0.388	0.471	0.570	0.685
1¼	0.130	0.146	0.167	0.192	0.224	0.263	0.315	0.382	0.466	0.565	0.680
1½	0.125	0.141	0.162	0.187	0.219	0.258	0.310	0.377	0.460	0.560	0.675
1¾	0.120	0.136	0.157	0.182	0.214	0.252	0.305	0.372	0.455	0.554	0.669
2	0.114	0.130	0.151	0.177	0.209	0.247	0.299	0.367	0.450	0.549	0.664
2¼	0.109	0.125	0.146	0.172	0.204	0.242	0.294	0.362	0.445	0.544	0.659
2½	0.104	0.120	0.141	0.166	0.198	0.237	0.289	0.356	0.440	0.539	0.654
2¾	0.099	0.115	0.136	0.161	0.193	0.232	0.284	0.351	0.434	0.534	0.649
3	0.094	0.110	0.131	0.156	0.188	0.227	0.279	0.346	0.429	0.528	0.643
3¼	......	......	......	0.151	0.182	0.221	0.273	0.340	0.424	0.523	0.638
3½	......	......	......	0.146	0.177	0.216	0.268	0.335	0.419	0.518	0.633
3¾	......	......	......	0.141	0.172	0.211	0.263	0.330	0.414	0.513	0.628
4	......	......	......	0.136	0.167	0.206	0.258	0.326	0.409	0.508	0.623
4¼	......	......	......	0.131	0.162	0.201	0.253	0.321	0.403	0.502	0.617
4½	......	......	......	0.125	0.156	0.195	0.247	0.315	0.398	0.497	0.612
4¾	......	......	......	......	0.151	0.190	0.242	0.310	0.393	0.492	0.607
5	......	......	......	......	0.146	0.185	0.237	0.305	0.389	0.487	0.602
5¼	......	......	......	......	......	......	......	0.300	0.383	0.482	0.597
5½	......	......	......	......	......	......	......	0.294	0.377	0.476	0.591
5¾	......	......	......	......	......	......	......	0.289	0.372	0.471	0.586
6	......	......	......	......	......	......	......	0.284	0.367	0.466	0.581

THE TWO-ARC ELLIPSE AGAIN

The ellipse construction given by the writer in the engineering edition of MACHINERY, March, 1911, has been criticised because the center of the end arc was not determined by a theoretically exact method. It would take a very accurate draftsman to detect the errors in that method, even for six-inch ellipses. The following *exact* construction may be used, however, for either large or small ellipses, of all proportions. For the sake of completeness the whole process will be given, even though it involves some repetition.

In the accompanying illustration, *AB* and *CD* are the axes of the ellipse. With *OB* and *OC* as radii draw the arcs *BE* and *CF*. With *E* as center and *OE* as radius draw arc *OG*. Draw *CH* parallel to *OB*, intersecting *OG* at *H*. Draw *OH*, cutting arcs *CF* and *BE* at *K* and *J*, respectively. Draw *JP* parallel to *OC*. Draw *KP* parallel to *OB*. With *C* and *P* as centers, and with a radius about equal to *CP*, draw short arcs intersecting at *M* and *Q*. Draw *MQ* intersecting *CD* at *S*. Then *S* is the center of the arc *WCP* which represents one arc of the ellipse. With a center at *T* and a radius *AT* equal to *CS*, draw the arc *AV* cutting arc *WCP* at *V*. With *V* as a center and the chordal distance *AV* as a radius draw a short arc cutting *VCP* at *W*. Draw *WS* cutting *AOB* at *X*. With *X* as a center and *AX* as radius draw the arc *AW* so as to form the end of the ellipse. The two remaining centers S_1 and X_1 may now be easily located and the ellipse completed.



Method for Locating Centers for Drawing an Approximate Ellipse by Circular Arcs

It will be an easy matter for anyone to make a comparison between this and the previous method. Simply draw *PS* cutting *OB* at *R*. Point *R* is the approximate center which, on ellipses less than six inches long, is so close to the true center X_1, that the two can scarcely be distinguished.

Mr. J. J. Clark, in the engineering edition of MACHINERY, July, 1911, wonders why the writer did not give an exact method of finding the centers *X* and X_1 of the end arcs. The writer had for some time been seeking a simple method of finding a point *P* on the true ellipse such as would lie at the junction of two arcs which could be used to construct an approximate ellipse. The method described in the March issue was discovered, and it seemed to be an exact method because a magnifying glass, used in constructing ellipses as large as six inches long, failed to show an appreciable error. To make certain, however, the method was investigated mathematically, and it proved to be only a very close approximation.

In any construction, however exact it may be theoretically, there are so many small unavoidable inaccuracies in its practical use, that it did not seem worth while (in this case) to seek further for a way of more closely locating the junction points of the two arcs, or the centers of the small arcs. The final adjustment of centers would be made anyway, even with a theoretically exact method, so that when inked the arcs would join perfectly.

Mr. Clark offers two methods of locating the centers of the end arcs. The first is a good one, though not so simple and accurate as the one given above, but the second seems too complicated to be of practical value.

South Bethlehem, Pa. H. A. S. HOWARTH

TEMPLETS FOR ANGLES

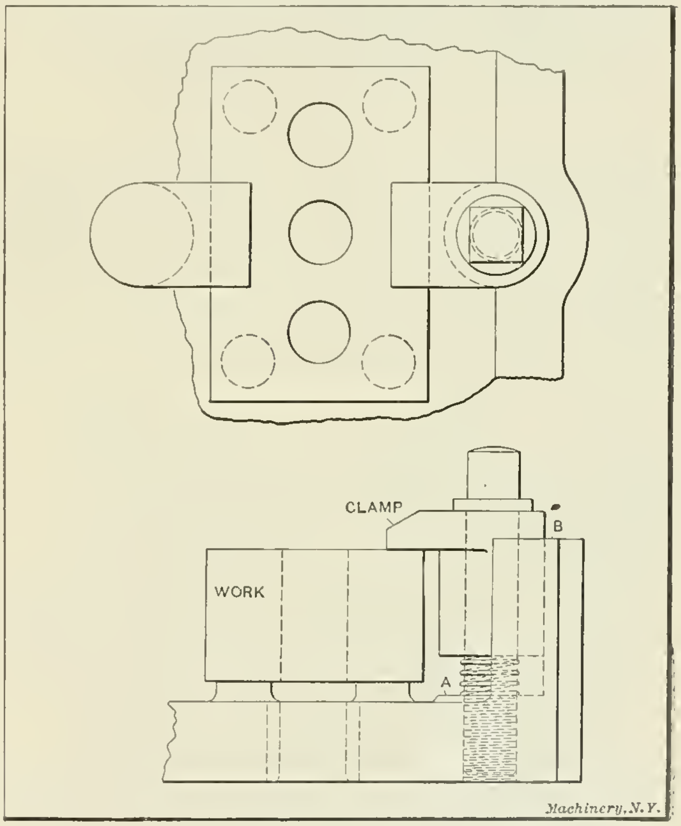
When it is necessary to lay out taper angles, such as those required in cored holes, draft for rough parts, standard Acme thread taper, pipe taper, etc., the writer finds it very convenient and at the same time accurate to secure thin pieces of wood about 6 inches long, scratching them with a scriber to the angle desired, then having the patternmaker plane to the lines. By marking the angle on the templets and then shellacking them over, handy and useful tools are made. A ¼-inch hole in one corner so that they may be hung up, makes them more convenient.

Many draftsmen use this scheme, and those who do not will find it very convenient if they will but give it a trial.

J. C.

A CLAMPING DEVICE

The accompanying illustration shows a simple but effective clamping device for jig or fixture work. The jig is not shown in full, the outline being sufficient to illustrate the application of the clamp. This device can, of course, be used for a number of cases other than that shown. The casting to which the clamp is applied should have a boss *A* cast on it as shown, and the surface of boss *A* should be in the same plane as the surface of boss *B*, so that the seat for the clamp can be counterbored. This is accomplished by drilling and reaming a hole, smaller than the tap drill size, entirely through the boss. This hole guides the teat of the counterbore, which is used for counterboring a seat for the clamp. The seat is one of the most important features of this device, because if the clamp is not properly backed up, its efficiency will be impaired. If the clamp screw alone were used for taking the back thrust, it would become bent and prevent the clamp from seating properly on the work.



An Efficient Clamping Device for Jig and Fixture Work

With this device, no amount of pressure will bend the screw, and this is not true of any other clamp except the flat sliding strap, which also requires a seat or boss to rest upon. Of course many other satisfactory means of clamping could be used in the simple case shown, but this clearly illustrates the application of the device. R. G. B.

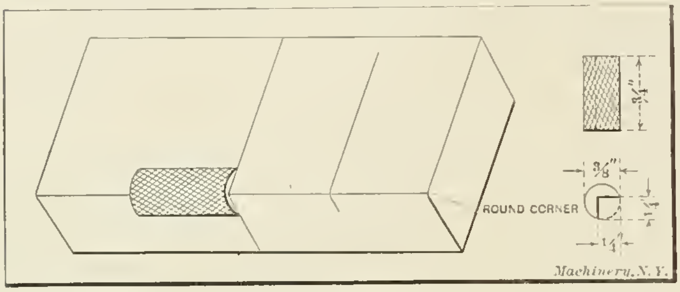
SHOP KINKS

PRACTICAL IDEAS FOR THE SHOP AND DRAFTING-ROOM

Contributions of kinks, devices and methods of doing work are solicited for this department. Write on one side of the paper only and draw sketches on separate sheets.

A SMALL SQUARE FOR TOOLMAKERS' USE

The accompanying illustration shows a small square which is called by shop men a "square square." This tool is made from 3/8-inch drill rod, and is milled out, as shown, and then hardened. A piece of 5/16-inch drill rod is next gripped in the chuck of the grinder, ground to run true, and the square clamped to it. When one end is ground square, the tool is reversed and the other end finished in the same manner.



This tool is used by toolmakers in laying out dies, jigs, etc., and is found especially useful when it is necessary to continue a line around a block having a round corner, as is shown in the illustration. The line is started with this tool, and then continued with an ordinary square.

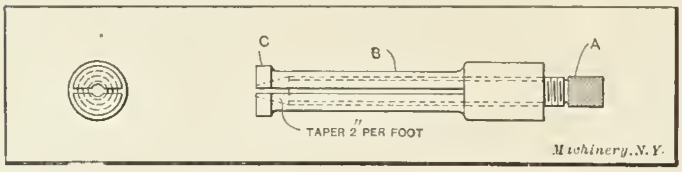
Detroit, Mich. C. L. Vanerstrom

A SCREW CUTTING KINK

When cutting a screw, instead of putting a stop on the lathe bed, a scale can be used to advantage. Having taken the first cut, stop the lathe and lay the scale on the bed with any convenient inch line, in line with the rear end of the saddle. Then lift the clutch, disengaging the nut from the lead-screw, and move the saddle back to the nearest inch mark from the end of the work. Drop the clutch and proceed as before. If the thread should be 11½ pitch, the distance to which the saddle is moved back should be an even number of inches. S. H. C.

AN ADJUSTABLE PLUG GAGE

The accompanying illustration shows an adjustable plug gage which can be used for gaging the sizes of holes, and is especially useful for obtaining the size when lapping ring gages. This gage may also be used for setting the grinder to cut parallel, when doing internal work. The gage is made of tool steel, hardened, and is slotted, as shown. A cone-pointed screw *A* is provided for expanding it.



The method of using this gage is as follows: The gage is inserted in the work, and the screw *A* manipulated until the gage fits the hole. Then the gage is removed and the size determined by an ordinary outside micrometer. If the hole is a long one, the size is determined at the front and then at the rear, and the difference in diameter noted. The only thing to keep in mind in making a gage of this kind, is to have the neck *B* long, the gage end *C* short, and to close the prongs of the gage before hardening. C. T.

* * *

A great dam is being built in the Mississippi River, between Illinois and Iowa, at Dallas City, Ill., which will cost $27,000,000 and develop about 200,000 horsepower. It is expected that the cheap power thus made available will develop a great manufacturing city.

HOW AND WHY

DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST

Give details in full and name and address. The name and address will not be published with the answer.

LEAD OF SPIRAL OF TWIST DRILLS

C. G. B.—In Machinery, June, 1911, you gave data for fluting and relieving twist drills, but did not include the spiral or lead. What is the standard spiral for each size of twist drill up to 3 inches diameter?

A.—There is no accepted standard for the lead of spirals of twist drills, but a common rule is to make the lead seven times the diameter of the drill. Thus a ½-inch drill should have a lead of spiral of 3½ inches; a 1-inch drill, 7 inches; a 2-inch drill, 14 inches; and so on.

MACHINERY FOR MAKING STEEL WOOL

W. L. C.—A substitute for sand-paper that has come into common use is steel wool or shavings. Will you kindly inform me if you know of a concern that manufactures machinery for producing steel wool?

A.—We know of no maker of machinery for producing steel wool and would be glad to have the names of any makers. One process of making steel wool is essentially a lathe operation. Sheet-metal disks are mounted on a mandrel and fine shavings are turned off in the lathe. We are informed that another source of supply is the fine shavings produced by deep hole drills in drilling rifle barrels.

MOTTLED COLORING ON MACHINE STEEL

H. M.—How is a mottled effect obtained on articles of machine steel?

A.—The method given below is used by a prominent toolmaking concern. This method was described in the February, 1909, number of Machinery in an article entitled "The Manufacture of Taps," and is as follows: The object to be treated is first highly polished and then very carefully cleansed of all oil in a hot soda solution. It is then slowly heated to a temperature of from 150 to 200 degrees F., by placing it on the hot firebrick covering the top of an oil-burning furnace. When heated to the degree mentioned, the steel is put into a pot of heated cyanide of potassium and brought to a dark red heat. It is then dipped into clear water and vigorously moved about in this. Unless the work is moved about when cooling off in the water, the mottled effect desired will not be obtained.

WHY A BODY IN MOTION RESISTS DEFLECTION

L. M.—Why does a body in motion resist deflection from a straight-line path?

A.—A body in motion tends to move in a straight line because deflection from a straight-line path accelerates its velocity. Acceleration of velocity demands an increase of the kinetic energy, which can come only from an outside source. To illustrate, suppose that a pound weight is moving at the rate of 100 feet per second. Its kinetic energy, calculated by the formula:

$$E = \frac{Wv^2}{2g}, = \frac{1 \times 10.000}{64.4} = 155.3 \text{ foot-pounds.}$$

Now if the direction of motion is deflected, say, 45 degrees, by a force acting at a right angle, the velocity will be increased in the ratio of the hypotenuse of a right-angle triangle having equal sides, to a side, or as 1.4142 to 1. The original velocity of 100 feet per second having been accelerated to 141.42 feet per second the kinetic energy is doubled, the expression then being:

$$E = \frac{1 \times 20{,}000}{64.4} = 310.6 \text{ foot-pounds.}$$

Hence the external energy required to deflect the weight from its path at an angle of 45 degrees is 155.3 foot-pounds, the difference between its kinetic energy before deflection and the total energy after its acceleration.

NEW MACHINERY AND TOOLS

THE COMPLETE MONTHLY RECORD OF NEW DESIGNS AND IMPROVEMENTS
IN AMERICAN METAL-WORKING MACHINERY AND TOOLS

VAN NORMAN GRINDING MACHINES

The Waltham Watch Tool Co., Springfield, Mass., is manufacturing a design of internal grinding machine which contains a number of interesting features, especially in connection with the spindle construction and the table operating mechanism. The spindle of this grinder is designed to operate indefinitely at speeds high enough to give the small wheels, used for internal work, a peripheral velocity equal to the speed employed for external grinding. The driving power is also sufficient to maintain these speeds while operating at the maximum cutting capacity of the wheels. The automatic stroke or traverse of the table is obtained through a new cam-operated mechanism, by means of which any variation can be obtained, from full stroke down to the point where the table remains stationary, and these changes can be made while the machine is in motion. The adjusting mechanism is so arranged that very minute changes in the stroke can be made.

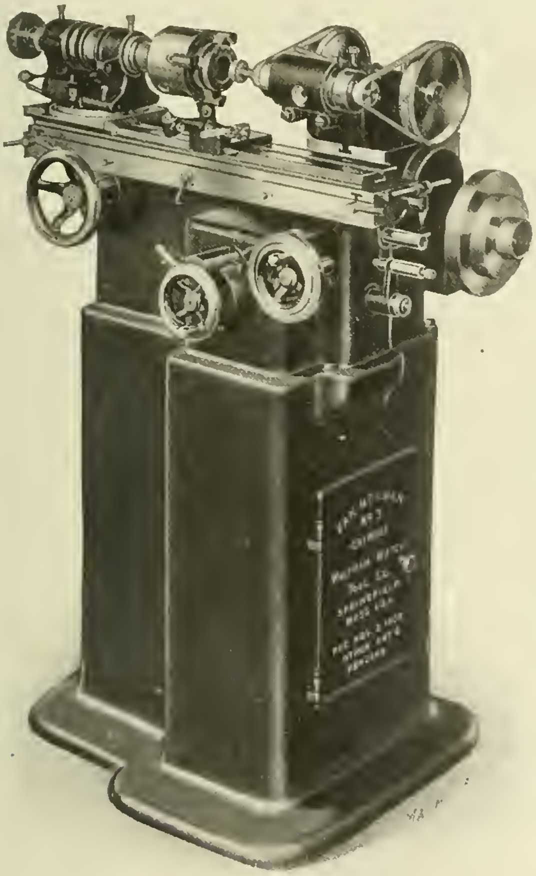


Fig. 1. No. 3 Van Norman Internal Grinder

The table reciprocating mechanism is shown by the sectional and plan views Fig. 5. The table derives its motion from a heart-shaped cam *C* mounted on a vertical shaft, which is driven, through a feed-changing mechanism, by the cone pulley shown to the right in Fig. 1. This cam *C* engages a roll attached to the lower side of an oscillating arm *A*, having on its upper side another roll *B*, which can be adjusted to or from the pivotal point *P* of the arm. This upper roll operates between the parallel faces of two members *D* which form a yoke, and the latter is attached to a rod *E* located beneath the table. On the under side of the table and extending throughout its entire length there is a dove-tailed slide-way in which is fitted a long sliding piece *F* attached to and moving with the reciprocating rod *E*. A lever binder *G*, located at about the center of the table, as shown in Fig. 1, serves to clamp the table to the slide piece *F*.

From the foregoing, it will be seen that when the cam rotates, a reciprocating movement is imparted to the table through the vibrating arm *A*, yoke *D* and the dove-tailed slide, provided, of course, part *F* is clamped to the table. The length of this movement or stroke is, of course, governed by the position of roll *B*, which can be moved along its slide by a screw connecting, through a universal joint and spur gears, with handwheel *H*, the spur gears being interposed to give a rapid adjustment. When roll *B* is moved inward until it coincides with pivot *P* of the oscillating arm, no movement will be imparted to the sliding rod *E* or table. When binder *G* is released, the table is free to be operated by the handwheel shown to the left of the machine in Fig. 1. An adjustable stop, carrying an adjustable screw which passes lengthwise through the stop, is also fitted in the dove-tailed slide-way containing part *F*. This stop is at the left end of the table and it is used to bring the work in the proper endwise relation to the emery wheel when the table is set for grinding a certain part. The stop is shifted along the slide-way until the end of the adjusting screw is in contact with slide *F*. It is then securely clamped to the table by a binder at the front. This adjustable slide forms a positive stop for slide *F* so that the latter, after being shifted for testing the work, can be

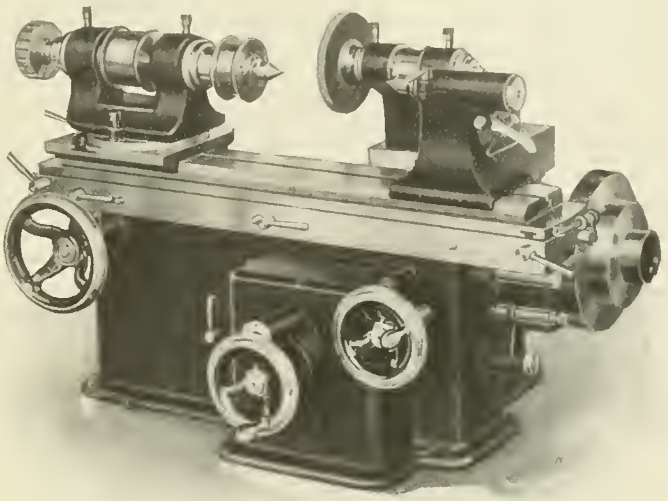


Fig. 2. No. 3 Van Norman External Grinder

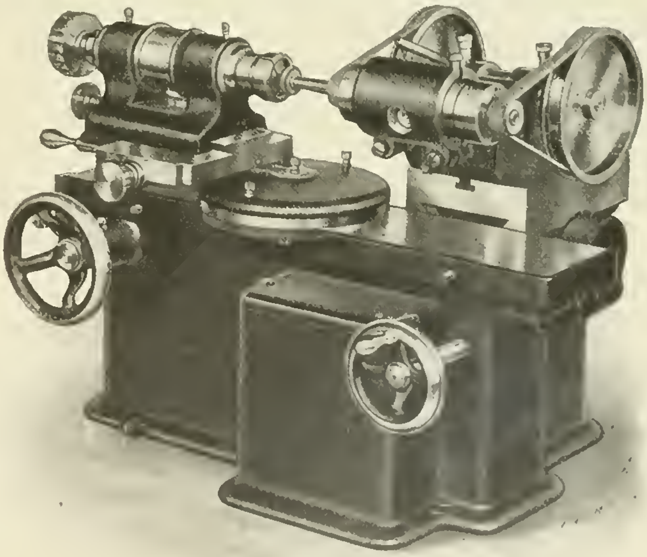


Fig. 3. Radial Ball Race Grinder

brought back to the original setting. This is, of course, particularly desirable when grinding close to the bottom of a hole.

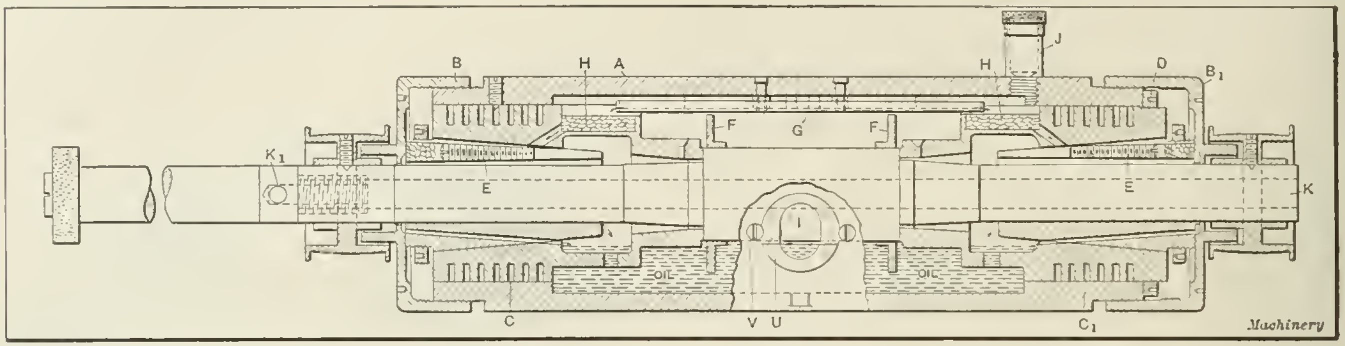


Fig. 4. Sectional View of High-speed Spindle

As previously mentioned, the table is provided with a feed-changing mechanism, as it is necessary with a cam-operated machine to have sufficient changes to maintain a practically uniform rate of travel, regardless of the length of the stroke. The No. 3 grinder illustrated has fifteen changes of feed, and the No. 4 size, twenty-one changes. A throw-out lever located at the front of the machine serves to instantly engage or disengage the feed from the cam mechanism. At the right end of the machine there is an indexing lever (see Fig. 1) that is used for locating the cam in the positions which it occupies at either end of the stroke. One complete turn of this lever gives a half revolution of the cam, and the index pin with which it is provided, should always be withdrawn before starting the feed. The cross-feed handwheel, which is shown at the right, has graduations indicating a movement of 0.0001 inch, and, if desired, this machine can be equipped with an automatic cross-feed.

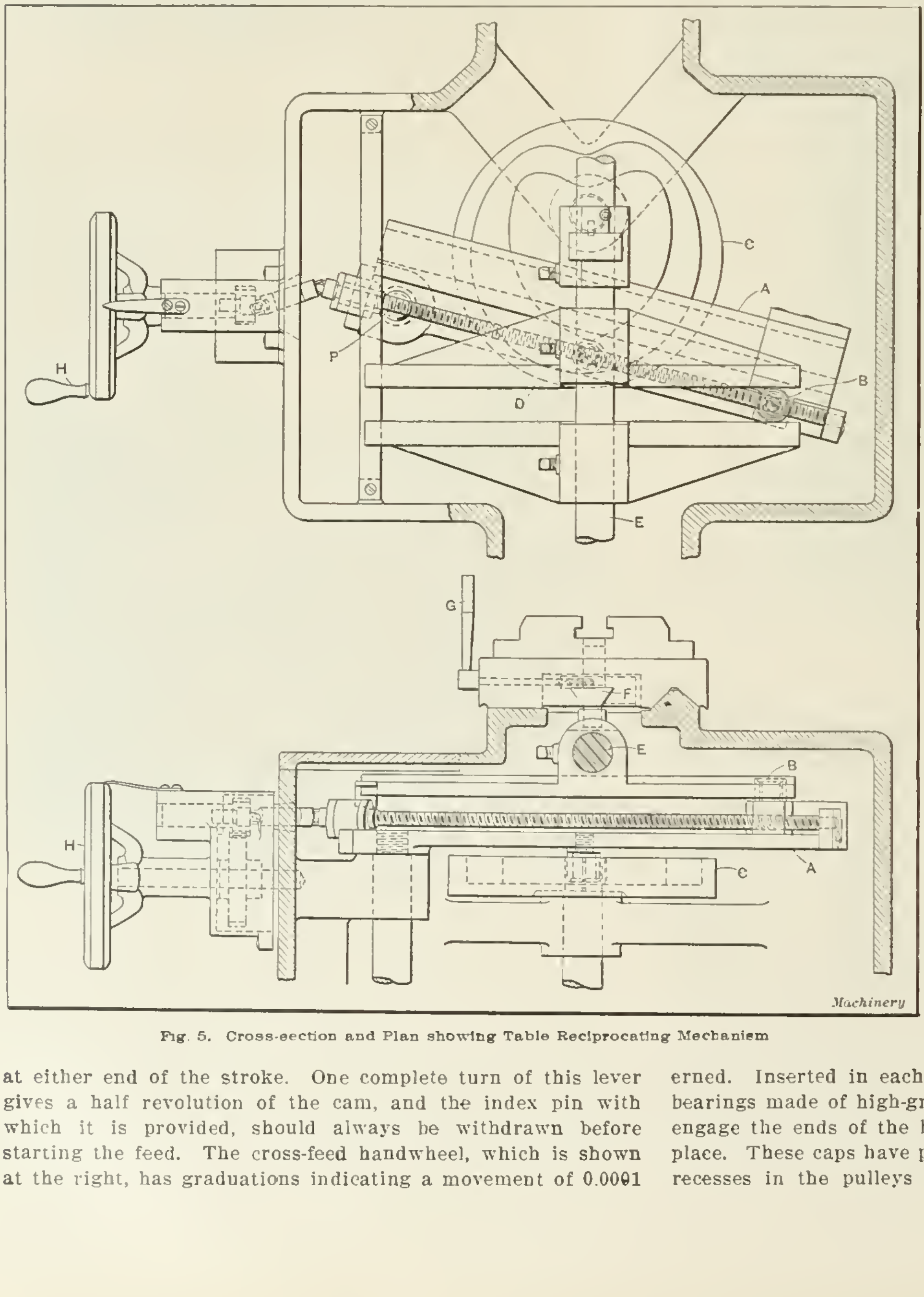


Fig. 5. Cross-section and Plan showing Table Reciprocating Mechanism

The machine is adjusted for internal grinding by first disengaging the drive from the cam mechanism, by means of the throw-out lever previously mentioned. The table is then released from slide bar *F* and the adjustable stop is loosened. The cam is then revolved by the indexing lever and the table is adjusted to the required stroke. The cam with its reciprocating parts is next set to the extreme right-hand position, after which the table is moved to bring the emery wheel approximately in its bottom position in the hole to be ground. The table is then clamped to slide *F* and the adjustable stop is moved against the slide. After the machine is set in this way, the stroke can be tested by turning the indexing lever. In case it is desired to change the depth adjustment of the wheel slightly, this can be done in two ways: First, by turning the handwheel to vary the stroke, and second, by moving the adjusting screw in the stop beneath the table. In case the latter method is resorted to, slide *F* must be shifted to again bring it in contact with the stop.

The quill and grinding spindle is clamped in a quill holder which can quickly be swung out of the way if desired. Means are provided also for bringing it back to the original position where it is rigidly secured. The grinding spindle is driven by two endless belts, ¾ inch wide, which operate on pulleys mounted close to each bearing as indicated in Fig. 1. The quill driving spindle at the rear is mounted on a "take-up" block for varying the tension of the belts, and the whole quill-driving mechanism is adjustably clamped to the top of the cross-feed slide.

The construction of the spindle and its bearings is shown in the sectional view Fig. 4. The outer casing *A* has inserted in its front end a fixed bearing holder *C*, which is secured by a set-screw, and in the opposite end of the casing there is an adjustable bearing holder C_1, having a threaded adjusting collar *D*. The inner ends of these bearing holders come in contact with shoulders formed by the enlarged central part of the spindle, and in this way the endwise adjustment is governed. Inserted in each bearing holder there are split taper bearings made of high-grade bronze. Threaded caps *B* and B_1 engage the ends of the bearings, thus holding them firmly in place. These caps have projecting annular flanges which enter recesses in the pulleys to prevent any emery dust or other foreign matter from getting into the bearings. Endwise adjustment of the spindle is made by first removing the right-hand pulley and cap B_1. The nut D is then turned, thus shifting the position of bearing holder C_1. When making this adjustment, allowance should be made for a slight endwise pressure when the cap is replaced. To adjust a bearing radially, the pulley and cap are first removed at the end where play is to be taken up. The tapering screw E is then backed out slightly for closing the bearing, after the packing at its end is removed. When this change in the position of the screw is made, the pressure of the retaining cap, when replaced, will close the bearing on the spindle. In case the bearing is too tight, it is drawn back from the holder by means of a threaded draw-out collar, after which the taper screw is tightened slightly to force the bearing open. These collars are intended only for withdrawing the bearings and they should be screwed away from contact with the bearing holders before replacing the outer caps. The spindle should be adjusted so that it can be revolved freely with the fingers. A slight endwise movement is not objectionable except when grinding against shoulders.

On the central part of the spindle are two flanges F which enter an oil reservoir in the outer casing. The oil is lifted by these flanges, as they revolve, and is caught by a trough G, having a longitudinal partition through its center. The oil flows from this trough through the packing H, which not only filters it, but regulates the supply for the bearings. It then enters conduits which lead to the bearings and finally back to the reservoir, as indicated by the arrows. Annular recesses in the caps B and B_1, which connect with the return conduits, catch any oil which may work beyond the ends of the spindle bearings. Oil holes are also provided for keeping the shoulder bearings flooded. The reservoir is provided with a sight glass, which indicates the oil level. This reservoir is filled through cup J and it can be emptied by removing a screw at the bottom. This system automatically furnishes a constant flood of oil to the spindle bearings.

The spindle of the No. 3 grinder will maintain a speed varying from 40,000 to 50,000 revolutions per minute without excessive heating, and the No. 4 size can be operated at 30,000 revolutions per minute. Ordinarily, however, the spindles only make about 15,000 revolutions per minute, which gives a peripheral speed equal to that used in external grinding. In addition to this efficient system of lubrication, the spindle is air-cooled. A hole K is drilled through the spindle, as indicated by the dotted lines, and there is a cross-hole K_1 at the inner end. As the spindle rotates, the air is discharged from this cross-hole by centrifugal force, thus causing a continuous flow of air through the spindle, which helps to keep the temperature normal.

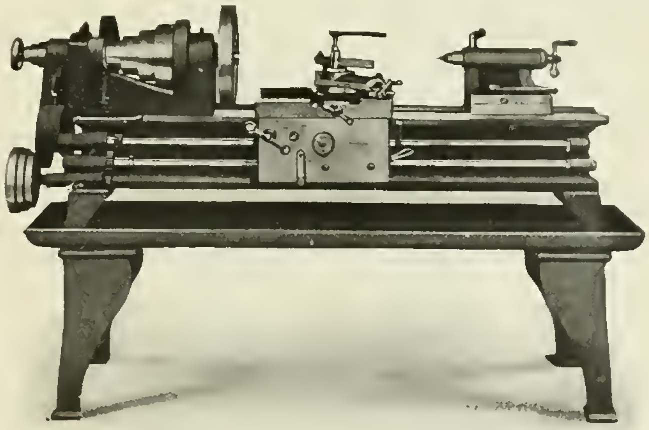
The headstock of this grinder has a graduated swivel base which can be adjusted along the table. A taper pin positively locates the head parallel to the table for cylindrical grinding. A central cam binder at the rear clamps the head and base to the table, and an auxiliary cam binder at the left end serves to clamp the head to the base and hold it firmly in position when the rear binder is released for adjusting the head. A simple clutch mechanism on the headstock enables the spindle to be started and stopped instantly, without interfering with the overhead countershaft. Combined with this clutch mechanism, there is a locking device for the spindle, which is particularly useful when tightening collets. The same lever that is used for engaging and disengaging the clutch serves to lock the spindle.

In order to adapt the machines for external grinding, the table is made with a swivel top which is secured to the lower member by cam binders located at each end. These grinders are built in the sizes, designated as the Nos. 3 and 4. The No. 3 size, which is the smaller, has a table 29 inches long, a stroke varying from 0 to 4 inches, a swing of 9 inches, and the weight is 900 pounds. The general construction and arrangement of the No. 4 grinder is very similar to the No. 3 size. The length of the table is 34 inches, the stroke ranges from 0 to 6 inches, the swing is 9¼ inches, and the weight, 1300 pounds.

One of these grinders arranged with a headstock, tailstock and grinding spindle for external work, is shown in Fig. 2. The general dimensions, stroke and arrangement of the driving and feed mechanisms are the same as for the No. 3 internal grinder illustrated in Fig. 1. This external machine is especially adapted for the rapid grinding of small shafts, studs, and similar work which is revolved on centers. Fig. 3 shows a No. 3 ball race grinder used in the production of radially ground ball races, etc. This machine is fitted with the same type of high-speed spindle used on the regular internal type. The work-holding head is mounted on slides which form a part of the hand-operated swivel member attached to the table. This swivel member has a broad supporting base and a long taper bearing which extends downward through the table. A pivoted holder for the diamond trimmer is supplied for forming the emery wheel to the proper radius, and provision is made for locating the work in the exact position for grinding. These machines are furnished with or without a base.

MIAMI VALLEY 14-INCH LATHE

The Miami Valley Machine Tool Co., Dayton, O., is now manufacturing the design of 14-inch lathe shown in the accompanying engraving. This lathe is designed for manual training schools and automobile garages, as well as for general manufacturing plants. The actual swing over the bed is 14¼ inches. The spindle, which runs in large phosphor-bronze bearings, can be equipped with a draw-in attachment and collets. The lathe can also be provided with a taper attachment, thus adapting it for tool-room work. The carriage has three bearings on the bed, the third bearing giving additional strength to the heavily ribbed cross-bridge. All the bearings are hand scraped. This lathe can also be furnished without an oil pan and with the regular style legs.

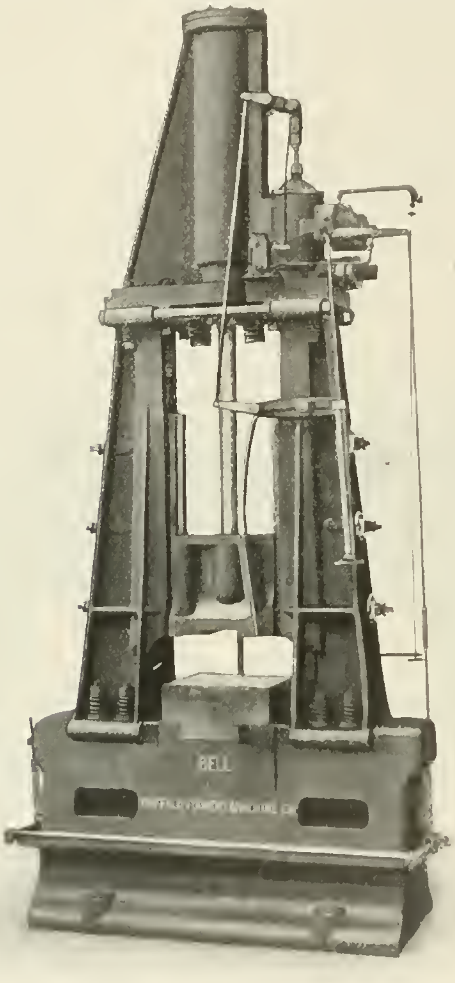


Miami Valley 14-inch Lathe

BUFFALO STEAM DROP-HAMMER

The Buffalo Foundry & Machine Co., 63 Winchester Ave., Buffalo, N. Y., has designed a new line of steam drop-hammers. A 1500-pound size, having a cylinder 10½ inches in diameter and a stroke of 42 inches, is illustrated herewith. The anvil base of this hammer is an open-hearth steel casting, the weight of which, as compared with the weight of the falling parts, is approximately in the ratio of 20 to 1. The lower die-holder is a hammered steel forging and is secured to the anvil base by a heavy steel tapered key. The frames or columns of the machine are open-hearth steel castings having recesses into which adjustable V-shaped guides are snugly fitted for guiding the hammer head. These guides have a taper gib between them and the column for taking up wear. The hammer head, of vanadium steel, is of ample length. The piston and its rod are made from a solid nickel-chrome vanadium steel forging, having an elastic limit of 85,000 pounds and a tensile strength of 120,000 pounds. This forging is carefully heat-treated before machining. The frames are held at the top by two cross tie-bolts and a steel cap-plate, the outer end of which is gibbed both to the cylinder and the frame. The cylinder is heavily proportioned and strongly ribbed.

The valve motion is of the well-known balanced piston valve type and has a removable sleeve in the piston valve chest. Expansion or stuffing-box joints are provided for the steam and exhaust pipes, and the exhaust pipe is arranged so that no water can remain in the bottom of the steam cylinder. The hammer has an automatic force feed oil pump which forces the oil into the throttle valve chest. This oil pump is operated by the movement of the hammer itself. The throttle valve chest is provided with a by-pass so arranged that after the throttle valve is closed, the by-pass will allow just enough steam to enter the cylinder to hold the hammer head at the top of the stroke; or, if desired, the amount of steam can be increased in order to keep the hammer operating on a very short stroke at the top. The by-pass can also be closed entirely, thus allowing the hammer to come to rest. The columns are securely attached to the base-plate and to each other, as well as to the cylinder at the top. The distribution of metal throughout the design has been worked out very carefully to enable the hammer to withstand the hard and unusual strains encountered in steam drop-hammer work.



Buffalo 1500-pound Steam Drop hammer

BROWN ELECTRIC RECORDING INSTRUMENT

A new type of electric recording instrument especially adapted for use as a recording electric pyrometer, recording volt-meter, or ammeter, has been designed by the Brown Instrument Co., Philadelphia, Pa. This instrument is intended to be mounted on the wall or switchboard, and the general arrangement is such that it can be used by an inexperienced workman.

The principal parts are mounted on the door instead of in the case, so that the recording pen is entirely out of the way when the chart which receives the record is changed; consequently, there is no danger of bending the pen when removing the chart. The clock mechanism and chart remain in the case, and, as soon as the door is thrown open, the entire voltmeter system and the inking device are swung aside with it, thus permitting the old chart to be easily removed and a new one substituted. Fig. 1 shows this recorder with the door closed and ready for operation, while Fig. 2 shows the door open for the insertion of a new chart. The millivoltmeter system which is used in this recorder is a simplified form of the D'Arsonval system.

In the operation of the instrument, the recording pen comes in contact with the paper momentarily only, thus producing a dotted line and eliminating friction between the pen and chart. An inking pad is placed beside the pen, carrying sufficient ink for a week's supply, and this pad touches the pen point frequently, thus keeping it damp. When the door is closed, the arm seen at the left in Fig. 2 (which is operated by the clock mechanism), comes in contact, automatically, with the inking device, and every half minute, or quarter minute, if preferred, it pushes the inking pad away from the pen permitting it to swing freely. The arm then falls, allowing the inking pad by its own weight to press the recording pen against the paper.

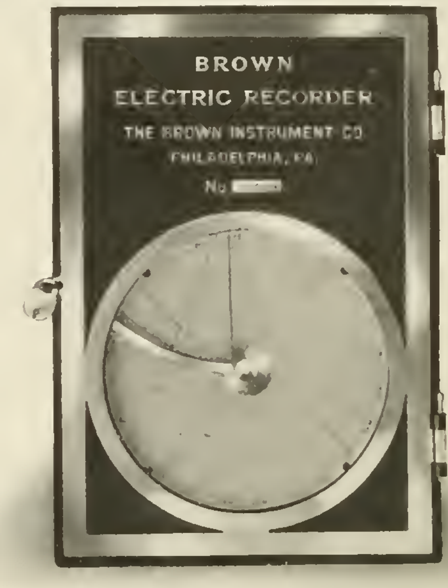


Fig. 1. Brown Electric Recording Instrument

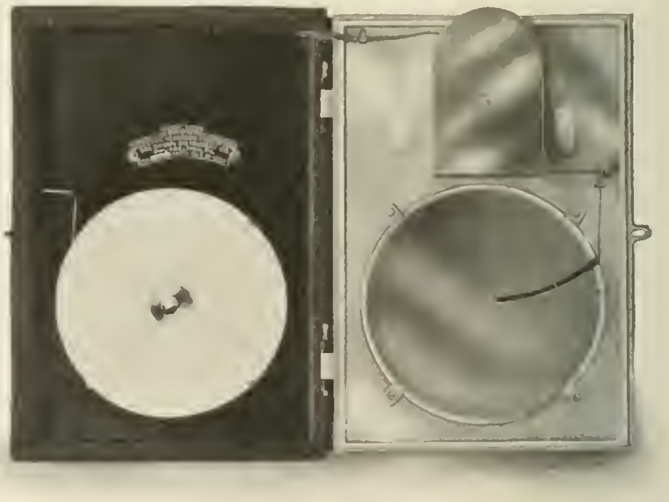


Fig. 2. Electric Recorder with Door Opened

The general arrangement of this new recorder is very simple, as the illustrations show; this is a particularly desirable feature for instruments of this kind.

DERIHON HARDNESS TESTING PRESS

In the April, 1910, number of MACHINERY, a Derihon portable ball press for testing the hardness of metals was illustrated and described. This machine was designed for laboratory work and is not intended for general use. Another type of Derihon press has now been brought out, which is especially adapted for shop use. It is very strongly constructed and is practically "fool-proof," there being no parts to get out of adjustment or become deranged. This new design, which is illustrated in Figs. 1 and 2, has been placed on the market by H. A. Elliott, 507 Majestic Building, Detroit, Mich., who is the American representative of the G. Derihon Forge Works, of Loncin, Belgium.

This machine operates on the Brinell principle which, in brief, consists in forcing, with a standard pressure, a hardened steel ball, of standard diameter, into the metal being tested. The diameters of the impressions made by the ball in the different metals tested are then measured for comparing the hardness. This machine is very simple in its operation as well as in its construction. The hardened ball *B*, Fig. 2, which is forced into the part being tested, is held in a yoke *A* by a cap screwed on the end as shown. This yoke is suspended from a counterweighted arm *C* by a ball and socket connection giving a universal movement. Passing through the yoke and resting on its lower end, there is a lever *D*, which is fulcrumed at *c* and carries a grooved pulley at the rear. Passing over this pulley is a small cable *E*, attached at *a* to a circular counterweight *F*, which is free to swing eccentrically about pivot *H*. The other end of this cable is fastened to a windlass *G* which is connected through gearing with a crank *K*.

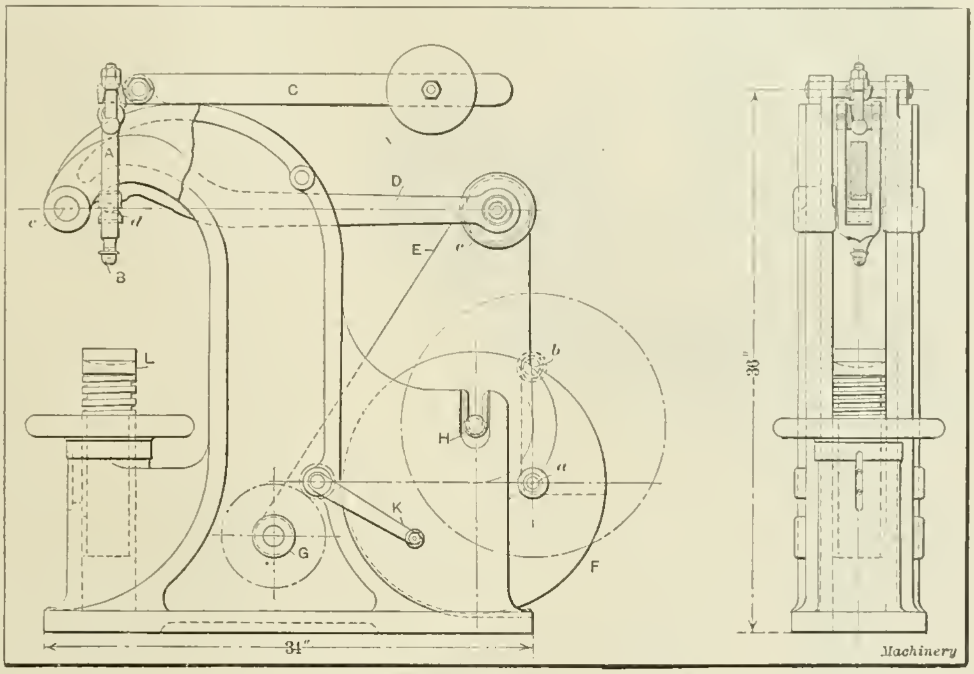


Fig. 2. Side and Front Elevations of Hardness Testing Machine

The piece to be tested is placed on the screw *L* which is then adjusted vertically, high enough to bring the part into contact with the ball. The weight *F* is then raised by turning crank *K* and this imparts a downward pull on lever *D*, which forces the ball against the part being tested. The weight of counterweight *F* has been calculated so as to give a load of 661 pounds at *e*, and as the length *c–e* of the lever is ten times the distance *c–d* between the pivot and fulcrum, the ball receives a pressure of about 6610 pounds. The function of the counterweighted compensating lever *C* is to maintain the yoke *A* in a vertical position.

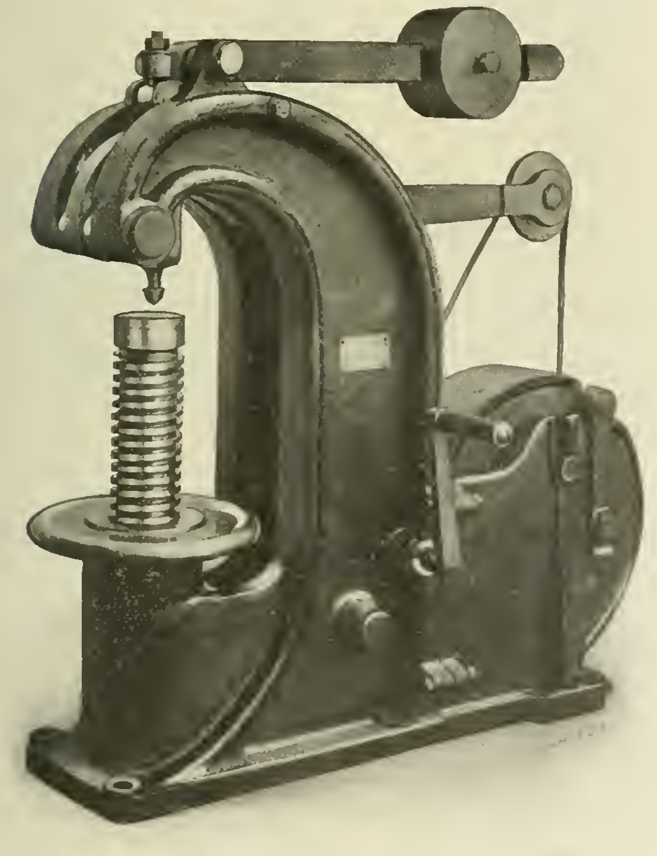


Fig. 1. Derihon Ball Press for Testing the Hardness of Metals

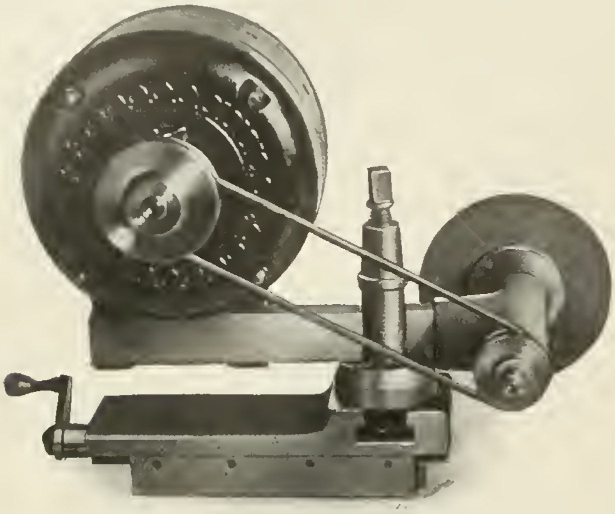
In order to secure accurate tests which will enable a true comparison of the hardness of different materials to be made, there are two conditions which must be fulfilled. The pressure on the ball must be applied gradually, and after it has reached the required maximum, it must be maintained without any fluctuation. The method of obtaining this gradual application of pressure and then a constant load, is very simple. When the circular counterweight *F* is raised by turning windlass *G*, the weight is rotated about the eccentric axis *H*, and the point *a* where the cable is attached, passes gradually through the arc shown, to position *b*. At the beginning of this movement there is no load on cable *E*, but when point *b* is reached, the cable supports the entire weight of *F* which is imparted to lever *D*. It will thus be seen that during the movement from *a* to *b*, which requires three turns of the crank *K*, the load of the counterweight is gradually removed from the pivot *H* to the cable, and, finally, the entire load of 661 pounds is supported by lever *D*. The second requirement of a constant load, fulfills itself. If the operator continues to turn crank *K* after the counterweight has reached position *b*, the load will not be increased above the required maximum, as the continued movement would only result in raising counterweight *F*, which is pivoted in an open slot, without increasing the load.

This machine is very strongly built, and weighs about 1057 pounds. It can be quickly operated without producing any shock whatever, which is an essential point in a testing machine. At the Derihon plants in Belgium and France, this type of machine has been in operation for over a year and has given satisfactory results. It is also in use in England and Germany.

MOTOR-DRIVEN LATHE CENTER GRINDER

The small grinder shown in the accompanying view is intended primarily for grinding lathe centers, though it can also be used for cutter and reamer grinding, etc. The grinder is shown in position on the compound rest of a lathe. The motor is mounted on an extension of the bar which carries the grinding spindle, and it drives the wheel by an endless belt, operating on grooved pulleys. This arrangement permits the use of a standard motor, and the emery wheel can be operated at any desired speed by the use of the proper size pulleys. The emery wheel is not affected by vibration from the motor, as it is when mounted directly on the motor shaft. The wheel is traversed at the proper angle for grinding centers, by swiveling the compound rest and using the regular screw feed.

The centers of lathes having plain rests can be ground by taking a succession of cuts equal to the width of the wheel. A tooth rest is furnished for grinding milling cutters, reamers, etc. This grinder is built in two sizes having wheels ¼ by 4 inches and ⅜ by 6 inches, respectively. It is manufactured by the Willey Machine Co., Jeffersonville, Ind.



Motor-driven Center Grinder mounted in Toolpost

PRENTICE BROTHERS RADIAL DRILLING MACHINE

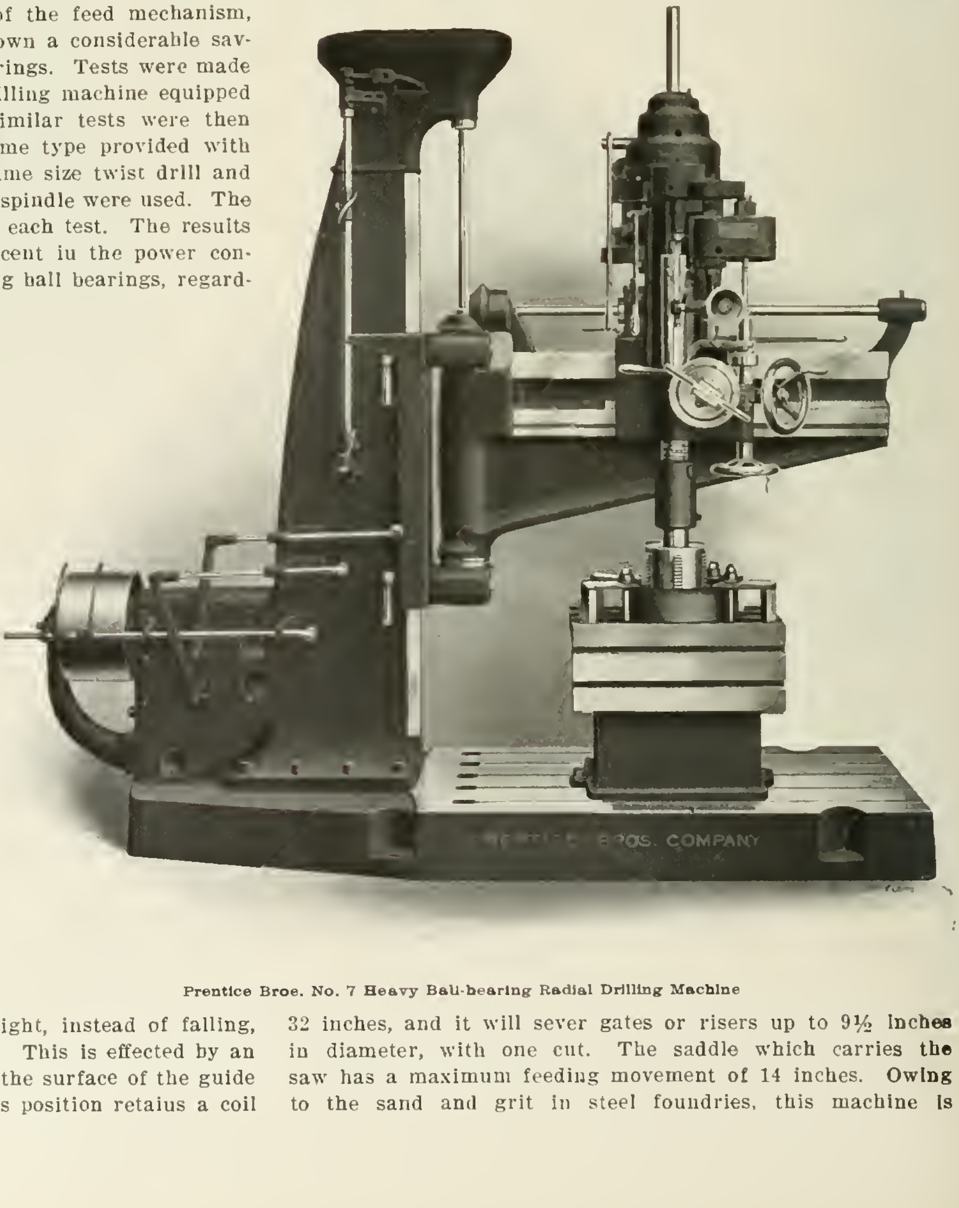
The Prentice Bros. Co., of Worcester, Mass., has brought out a radial drilling machine that embodies several new and important features. The machine is equipped with ball bearings throughout, with the exception of the feed mechanism, and carefully conducted tests have shown a considerable saving of power as the result of these bearings. Tests were made on a 26-inch upright all-gear-driven drilling machine equipped with ball bearings throughout, and similar tests were then made on a 26-inch machine of the same type provided with bronze bearings. In both cases the same size twist drill and corresponding feeds and speeds for the spindle were used. The material drilled was also the same for each test. The results showed a saving of at least fifty per cent in the power consumption when using a machine having ball bearings, regardless of the size of the twist drill used. The same results were also obtained from tests made on a radial drilling machine.

As an illustration of the power of this new design, an 8-inch pipe tap was securely fastened to the spindle nose, as shown in the illustration, so that the end of the tap just entered a straight hole in a flange 3 inches thick; then without any difficulty, the tap was driven through the 3-inch flange, not only cutting the thread, but also reaming its own taper from the straight hole in the flange.

In the design of this machine, the protection of the operator has been carefully considered, guards and safety devices having been incorporated at all dangerous points. To eliminate any possibility of injury by the unexpected falling of the spindle counterbalance weight, a simple but effective contrivance has been provided. If the weight chain should part, the weight, instead of falling, would be instantly locked to its guide. This is effected by an eccentric part that is held away from the surface of the guide by the weight itself, and while in this position retains a coil spring under tension. In case the chain breaks, the coil spring acts on the eccentric, forcing it against the notched side of the guide. A safety stop motion for the vertical adjustment of the arm is also provided, so that if the saddle should accidentally be moved too high or too low, the tumbler gears at the top of the column would automatically be disengaged. This disengagement is effected by a finger securely fastened to the saddle that comes in contact with the spiral surface of a cam on the regular shifter rod, thus disengaging the gearing.

This machine has sixteen spindle speeds, four of which are obtained by a speed box, this number being multiplied by four through changes obtained in the head. The back-gears together with the high- and low-speed gearing, give the four changes in the head. The high- and low-speed ratios are placed in the head so that when heavy work is being done, all the shafting and gears back of the head are relieved from excessive stresses, and when the spindle is operating at high speeds for drilling small holes, the shafts and gears are relieved from excessive speeds.

This design has eight geared feed changes, friction back-gears, and a friction tapping attachment which may be engaged or disengaged while the machine is in motion. There is also a quick-return device and automatic stop motion, a patent roller clutch which will permit feeding by hand ahead of the engaged power feed, and a dial depth gage which always reads from zero. The gearing is all carefully guarded. Suitable and efficient binding devices are provided, as well as permanently located wrenches, and the operating levers are centrally located.



Prentice Bros. No. 7 Heavy Ball-bearing Radial Drilling Machine

NEWTON COLD METAL SAWING MACHINE

A cold saw designed especially for steel foundries is shown in Fig. 1. The diameter of the saw used in this machine is 32 inches, and it will sever gates or risers up to 9½ inches in diameter, with one cut. The saddle which carries the saw has a maximum feeding movement of 14 inches. Owing to the sand and grit in steel foundries, this machine is fitted with exceptionally large shears and the bearings are bushed where necessary. The spline shafts are also fitted with collars which rotate with the shafts in the bearings and prevent the escape of oil.

The spindle revolves in bushed capped bearings and it is supported at each end. The driving spindle gear is mounted between these bearings as shown in Fig. 2 which illustrates the driving mechanism. The spindle is fitted on the saw end with three circular keys for driving the blade and there are, in addition, three bolt holes for holding the blade to the flange. On the opposite end of the spindle, adjusting nuts are provided for taking up wear. The drive to the spindle is by means of broad steel gears, and the teeth of the driving pinion meshing with the spindle gear are cut on the solid worm-wheel shaft as shown. The driving worm-wheel is a solid bronze casting and the driving worm is of hardened steel. Both the worm and worm-wheel are encased for continuous lubrication.

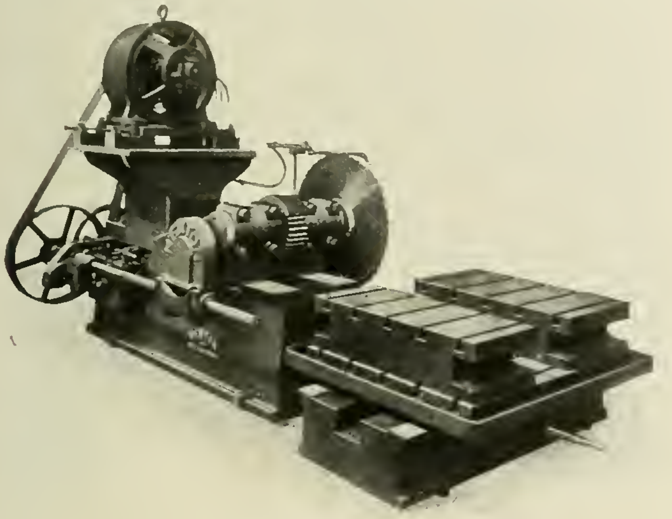


Fig. 1. Newton Cold Saw for Steel Foundries

The saddle is of heavy construction and has square bearings on the base with under-locking gibs cast solid, and the adjustments are made by taper shoes. The saddle is fitted with an adjustable automatic safety release for the feed, and a fast traverse. The feed-screw has a bearing at both ends so that it is always in tension. The machine is fitted with a geared feed having six changes and a quick return. By the use of a double-throw switch or reversing motor the fast power traverse is available in either direction. The driving motor of this machine is mounted on a bracket that can be adjusted to vary the tension of the belt. The particular saw illustrated is driven by a Fairbanks-Morse ten-horsepower induction motor, operating at 1200 revolutions per minute.

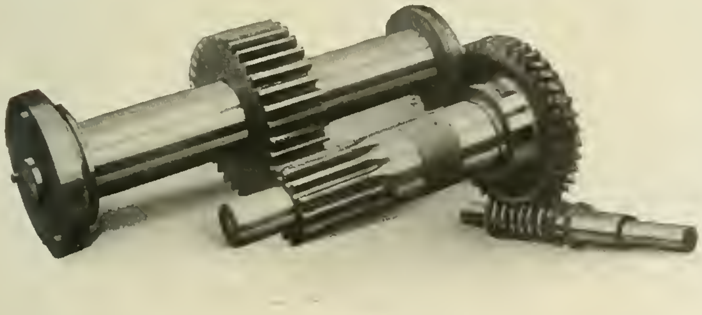


Fig. 2. Saw Spindle-driving Mechanism

The work-table is 36 inches wide by 48 inches long and is entirely surrounded by an oil pan. It has a hand cross adjustment of 20 inches. The auxiliary parallels for supporting the work are each 16 inches wide, 36 inches long and 9 inches high. These parallels permit clamping the work close to the saw-blade on each side, which is particularly desirable when making two cuts in one piece at the same setting. During tests, this machine made a number of cuts through a 5½-inch steel bar (0.35 carbon) in one minute and thirty-five seconds. This sawing machine is built by the Newton Machine Tool Works, Inc., Philadelphia, Pa.

WASHBURN MULTIPLE SPINDLE DRILLING MACHINE

The multiple spindle sensitive drill press illustrated herewith is manufactured by the Washburn Shops of the Worcester Polytechnic Institute. This machine is equipped with a belt tightener which allows an instantaneous variation of the tension, the latter being controlled by automatically locked tighteners operated through a rack and pinion. The countershaft is made a part of the machine, being located at the rear of the column. The drive from the countershaft is by an open belt to a jack-shaft and then by quarter turn to the spindle pulley. Both the countershaft and the jack-shaft are provided with ring oiling bearings.

The spindle pulley runs in an oil bath, and is of an entirely new construction. Referring to Fig. 2, the pulley *A* is keyed to the spindle *B* at *C*. The quill *D* is driven into the column *E* at *F*, the column having been bored for this purpose in line with the head bracket. The tension of the belt on the pulley is taken by the quill so that the spindle runs absolutely free. The flange *G*, instead of being a part of the pulley, is made a part of the quill. Concentric with the bearing *D* and within the pulley there is a ring *J*. The space between this ring and the bearing *D* forms an oil cup, and therefore the bearing *D* is always flooded with oil. This ring also acts as a retainer and prevents the oil from spattering.

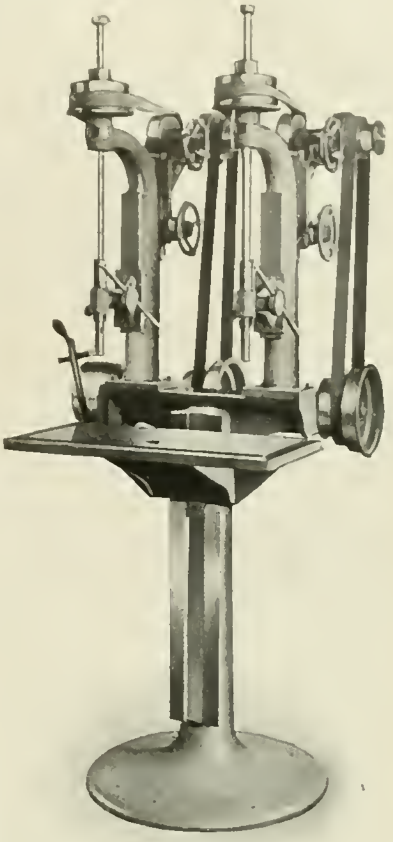


Fig. 1. Washburn Multiple Spindle Drill Press

The machine has a capacity for holes up to 9/16 inch in diameter and the spindle is bored to fit a No. 1 Morse taper. With the recommended speed of 610 revolutions per minute for the countershaft, the spindle speeds are 610, 1016 and 1830 revolutions per minute. The two-spindle machine weighs 715 pounds. The greatest distance to the spindle is 40 inches, and the distance from the center of the post to the center of the

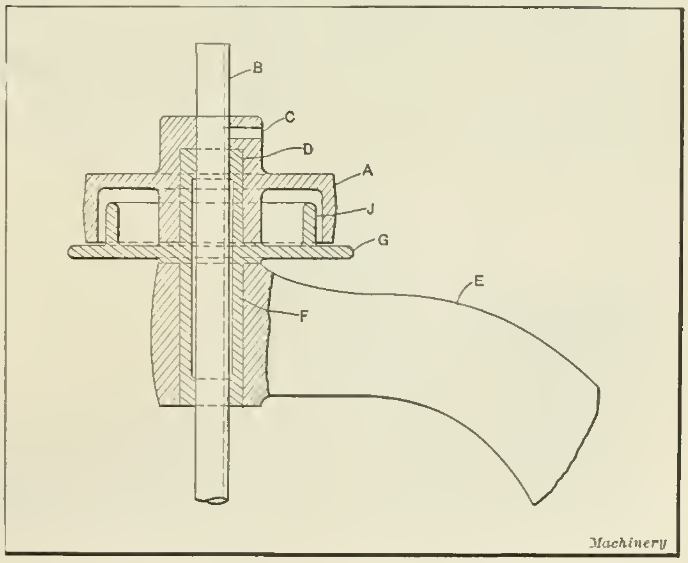


Fig. 2. Sectional View of Spindle-driving Pulley

spindle, 8 inches. The spindle feed is 3 inches. The size of the table is 14 by 28 inches. This design is made with two, three and four spindles.

DRESES RADIAL DRILLING MACHINES

The design of plain radial drilling machine shown in Fig. 1 is a recent development of the Dreses Machine Tool Co., Cincinnati, O. These radials are built in 5-, 6- and 7-foot sizes, the particular machine illustrated being a 6-foot size. One of the important improvements of this design is the addition of a third bearing for the head. This third bearing, which is formed in the back-gear bracket as shown in Fig. 2, gives additional support to the head and prevents bending or straining the rear shaft and rapid wear of the bevel gears and their bearings. It also distributes the torsional strain over the whole arm. The head has long and wide bearings on the face of the arm as well. The clamping and releasing of the head is done by a single handle which is located on the left side. By means of a compound spiral gear arrangement, the head is easily traversed on the arm. Another noteworthy improvement is the provision of a ball bearing on which the spindle driving gear rests and revolves, in order to reduce the friction to which this gear is subjected on account of the pull exerted on it when the spindle feeds down.

The spindle runs in phosphor-bronze bearings contained in a steel sleeve, and the feeding rack is cut directly into this sleeve to bring the pressure close to the center. The all-geared feed mechanism is entirely enclosed, and provides eight changes which are varied by the small handle seen on the feed shaft and multiplied by the crank directly above it. Both of these controlling handles are within convenient reach. The feed worm runs in an oil bath. The quick-advancing and return device has four levers any one of which engages or disengages the feed instantly, and these levers also form a pilot wheel for operating the spindle by hand. By means of a ratchet clutch, the hand feed works ahead of the power feed. The automatic stop and depth gage has a swinging dog attached to an extension on the spindle sleeve, which is brought into contact with an adjustable dog on the feed bar. Fixed to this adjustable dog is a graduated scale by means of which a predetermined depth of hole can be gaged from zero. When holes of different depths are to be drilled, several dogs can be placed on the feed bar; these are then successively engaged with the swinging dog. A safety release for the end of the feed is provided.

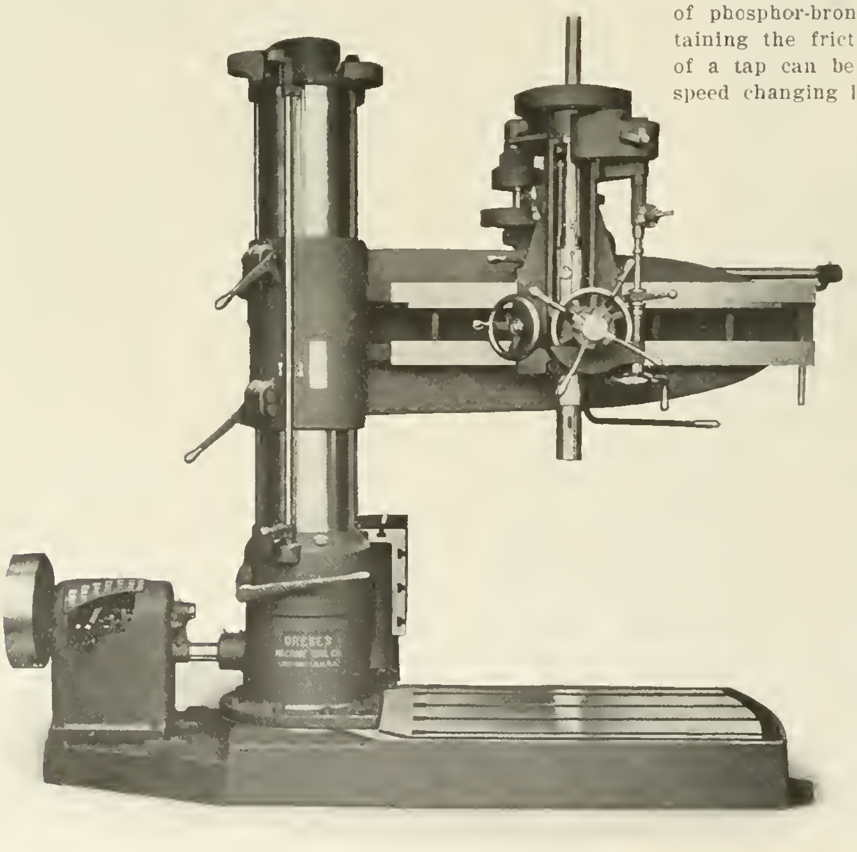


Fig. 1. Dreses 6-foot Radial Drilling Machine

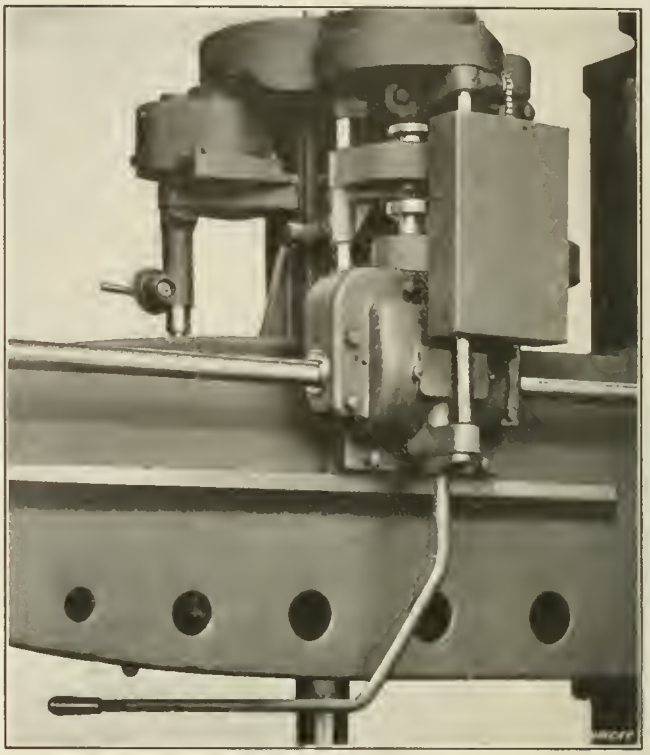


Fig. 2. Rear View of Head showing Third Bearing on the Arm

The starting, stopping and tapping mechanism is of the friction type. It is embodied in the head and operated by the horizontal lever seen below the arm. The friction bands are double expanding, and of large diameter. They are made of phosphor-bronze to avoid cutting. The bevel gears containing the frictions run in an oil bath. The backing out of a tap can be accelerated in a ratio of 2½ to 1 by the speed changing lever in the head.

The head has three speed changes, giving a total of twenty-one changes to the spindle. The arrangement is patterned after automobile transmission gearing, and the changes can be made while the machine is running. The speed variator at the rear of the column is of the well-known tumbler gear type and gives seven changes. It is provided with this company's self-releasing over-take clutch, and the gear teeth are of the 20-degree involute pointed form, giving strength and easy engagement.

The arm is a box parabolic shape. The elevating mechanism is controlled by a conveniently located handle, and there is an automatic knock-out at the top and bottom. The thrust of the elevating screw is taken by a ball bearing. The outer column of this machine swings on an inner fixed column which extends nearly to the top, and there is a third central bearing which increases the rigidity of the swinging member. Both the fixed and swinging columns are enlarged at the lower end which provides room for a large roller bearing and insures firm and easy clamping. No pressure is exerted on the taper rollers of the column bearing, in clamping, and they are protected from chips and dust by a cover.

The power and rigidity of this new design is indicated by the following tests: An 8-inch pipe tap was driven through a 2½-inch plate, as indicated in Fig. 3, by the 6-foot machine, and during another test a 4-inch high-speed drill, operating at a cutting speed of 100 feet per minute, was forced through cast iron with a feed of 0.027 inch per revolution. In accordance with modern practice, all bevel gears are planed, and the spur gears are cut with special cutters. The pinions and small gears are made of forged steel and hardened, and other gears subjected to severe duty are of crucible cast steel. All bearings have removable phosphor-bronze bushings, and the gears are all covered.

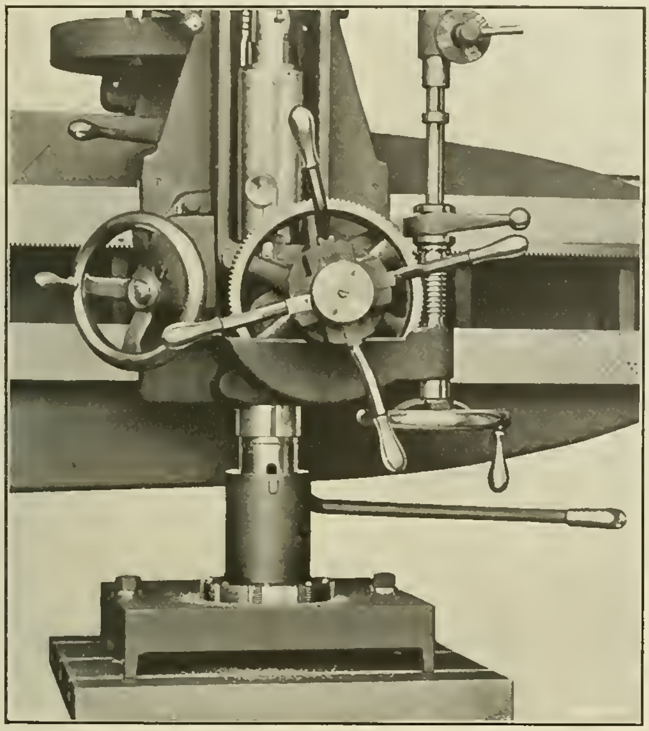


Fig. 3 Dreses Six-foot Radial driving an Eight-inch Pipe Tap

BATTERY TRUCK CRANE

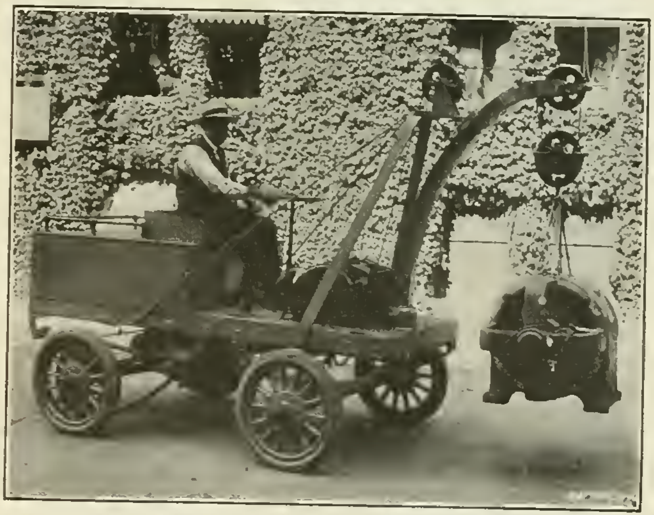
The battery truck crane is a device for handling expeditiously and at low cost freight or any materials within its capacity which have to be lifted and moved through moderate distances. This crane, which is shown in the accompanying view, is applicable to manufacturing plants and many other places, such as railway and machine terminals, etc. It is the product of the General Electric Co., Schenectady, N. Y. The crane proper is mounted on the front end of an electrically propelled car. The crane is free to swing, and its hook is raised and lowered by a 1-ton hoist located at the rear of the base. The motors for operating the hoist and propelling the car are driven from a battery mounted on the rear end. This crane may be used effectively either for hoisting, hoisting and carrying on the hook, or for towing trailers.

In case the material, which may be sub-divided into parcels of one ton or less, has to be deposited within a 6- or 8-foot radius and this action does not require moving the load through a vertical distance of over 10 feet, the car is moved to an advantageous position, the brakes are set and the car remains stationary while the boom of the crane is moved back and forth between the "picking-up" and depositing points. In this manner the crane can be employed to load and unload railway cars, wagons, trailers, etc. As a practical example of what can be accomplished, 300 castings aggregating 65,000 pounds were unloaded from a gondola in five hours, giving an average of 1.2 lift per minute. As another illustration, a box car was loaded with sixty-four 800-pound barrels of plumbago in twenty-five minutes, and four cars were loaded in two and one-half hours, which included "spotting" the cars.

When material in small or large quantities has to be moved less than 400 feet, or in small quantities to any distance, the article is lifted by the hook, conveyed to its destination by the car and deposited on the floor or wherever desired. The short wheel-base of the car permits making short turns, so that the car can be driven about shop aisles or around piles of material in a storage yard. The flexibility and speed of the crane adapts it to factories, even though they are fully equipped with ordinary cranes and an industrial railway. By this "pick-up-and-run" system, sixty 800-pound barrels of plumbago were moved 300 feet in one hour, one helper only being required. In a store-room, boxes of angle and flat iron weighing about 1000 pounds each, were stacked in assorted and orderly piles at the rate of forty boxes an hour.

For the miscellaneous transfer of large quantities of material through a distance of over, say, 400 feet, the battery truck crane can be used for towing trailers in trains of about four. Where the quantity of material removed is large enough to warrant it, two or more trains can be used advantageously in order to eliminate any waiting at the junction points. For example, as soon as one set of trailers is delivered, the car immediately starts with the empty trailers that were brought on the previous trip. The number of trailers per train and the number of trains to get the most efficient operation would, of course, depend on the distance, character of the load, and time required for loading and unloading.

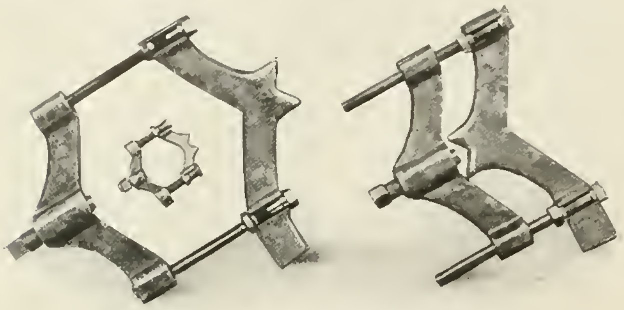
This crane is designed to give a high draw-bar pull, its maximum pull being 2000 pounds, which is equal to that of a five-ton locomotive on rails and is sufficient to "spot" a car and to readily handle loads of from five to eight tons on trailers. Trailers of special design having a capacity of three tons are employed in this work. The wheels are 24 inches in diameter, have a 5-inch face width, and are equipped with roller bearings. The deck is 12 feet long, 4 feet wide and is 29 inches from the ground. The crane is equipped with special attachments to suit the character of the work. These consist of rope and chain slings, barrel tons, bale grapples, box hooks and snatch blocks. For special work, other equipment is designed and built to meet individual requirements. The height of the crane can also be made to suit local conditions, and booms of different lengths can be supplied. The trailers can also be modified to suit elevations and other limiting features. This crane has all the advantages of an electrically operated car. It is odorless, practicaly noiseless and is free from explosions which might cause fire. The battery charging may be left to a night watchman. Where direct current is available, a simple panel and rheostat serves for charging apparatus, and for alternating current a rectifier panel is used to transform the current before charging.



General Electric Battery Truck Crane

BARTER GRINDER DOG

The grinder dog shown in the illustration is provided with a double jaw, the position of which can be reversed to adapt the dog for large or small work. This jaw has a large vee on one side and a small one on the other, so that by simply changing the position of the jaw, as shown in the view to the right, very small work can be held. The two drop-forged parts which form the dog are held together by side screws that provide additional adjustment. These screws are held in place by check-nuts which prevent them from shifting after they are set to a given size. These dogs are made in four sizes having capacities up to 1½ inch, 2½, 4 and 7 inches. The three largest sizes are brass lined. The binder screw also has a brass tip which is held in place by a pin passing through the screw. The faceplate driving pin bears against a projection on the reversible jaw. This dog is made by T. S. Barter, 1 Holt Ave., Worcester, Mass.



Grinder Dog having Reversible Jaw which adapts it to Large or Small Work

SIBLEY ALL-GEARED DRILLING MACHINE

A box column all-geared drilling machine, built by the Sibley Machine Tool Co., 8 Tutt St., South Bend, Ind., is shown in Fig. 1 of the accompanying engravings. This machine has a direct drive, the speed-box being located at the top of the column, and in the design, all parts not affecting the range or convenience have been eliminated. All gears are enclosed and run in oil, and all bearings are provided with self-oiling devices. The method of lubricating the crown gears is indicated by the sectional view, Fig. 2.

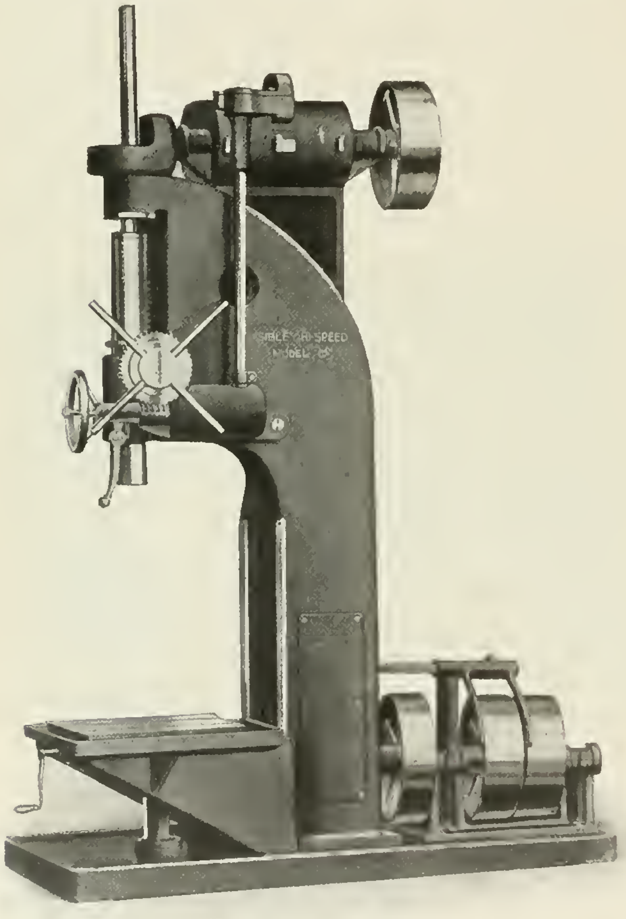


Fig. 1 All-geared Drilling Machine, built by Sibley Machine Tool Co.

By locating the speed box on top of the column, only one pair of bevel gears is needed to deliver the power to the spindle. Any one of eight speeds can be selected instantly without running through the intermediate changes. Six long split bushings of special bronze, having ninety-seven square inches of bearing surface, carry the main gear shafts, which are made of high carbon steel. The entire mechanism operates in an oil bath, and hoods at the ends of the bearings catch the surplus oil which returns to the case through large drains.

The spindle is made of high carbon steel and is finished by grinding, as is also the graduated spindle sleeve. The spindle runs in two bronze bearings which have self-oiling devices and it is equipped with a ball thrust collar. The feed mechanism derives its power from the main driving shaft which directly rotates the spindle, and it is geared down in such large ratios that a powerful feed is obtained. The semi-steel feed gears are always in mesh, and changes are effected by means of a patented internal key which will not stick or bind. Four changes are obtained by moving a small knob in the center of the handwheel, and this knob also has a neutral position. The spindle has an automatic tripping mechanism for drilling to any predetermined depth. This consists of an adjustable collar on the graduated spindle sleeve, which trips a latch so that the entire mechanism swings down from the worm-gear on a large hinge pin. The worm-gear is made of a special bronze alloy.

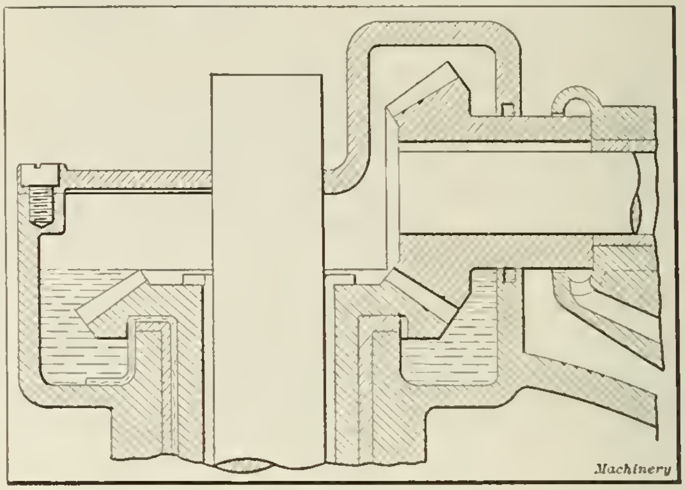


Fig. 2. Section showing Method of Lubricating Crown Gears

The various controlling levers are so arranged that the starting or stopping of the machine or changes of speed and feed can be made from the operating position in front. The countershaft bearings have self-oiling devices, and a self-oiling loose pulley is provided. The pump and tank for supplying the lubricant to the cutting tool and all pipes are enclosed within the column, as shown in Fig. 3. The cutting compound returns to the enclosed tank through a drain in the table. There are no exposed moving parts on this machine except the pulleys and spindle, and the various members have been designed to carry several times the maximum load.

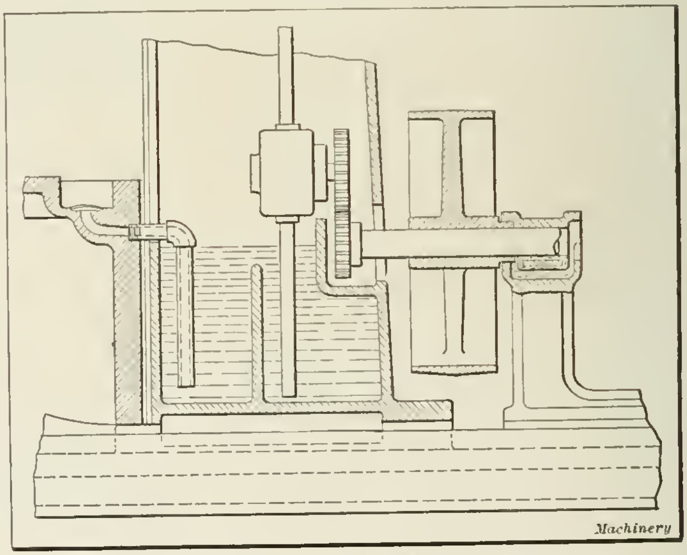


Fig. 3. Section of Column showing Oil Tank and Enclosed Pump

This machine is guaranteed by the manufacturers to drive the best high-speed steel drills, varying from ¾ to 1¾ inch in size, at their most efficient speeds and feeds. The principal dimensions are as follows: Swing, 24 inches; maximum distance from the spindle to the table, 27 inches; feed of the spindle, 12 inches; feeds per revolution of the spindle, 0.008 inch, 0.015 inch, 0.024 inch and 0.032 inch; smallest diameter of the spindle, 1¾ inch; diameter of the sleeve, 3⅜ inches; working surface of the table, 16 by 20 inches; vertical traverse of the table, 20 inches; diameter of all pulleys, 13 inches; face width of all pulleys, 4½ inches; spindle speeds, 75 to 450 revolutions per minute; height over all, 6 feet, 10 inches; weight, 2200 pounds; and floor space, 29 by 57 inches.

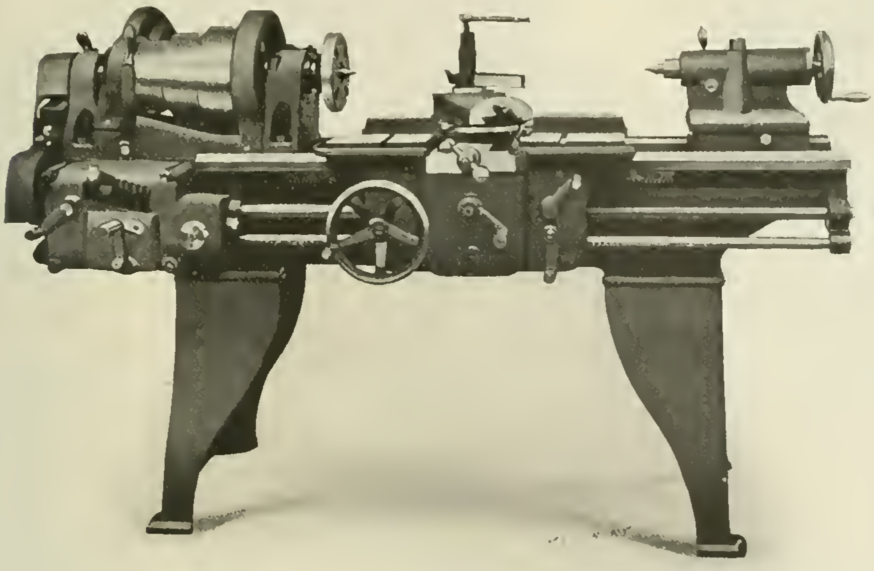


Fig. 1. Sixteen-inch Lathe, built by John B. Morris Machine Tool Co.

MORRIS SIXTEEN-INCH QUICK-CHANGE ENGINE LATHE

The John B. Morris Machine Tool Co., Cincinnati, O., is now manufacturing a new design of quick-change engine lathe. This lathe, a view of which is shown in Fig. 1, conforms in general to the practice of the leading lathe builders, but a number of features have been incorporated in the design for increasing the productive capacity.

The headstock, front and rear views of which are shown in Fig. 2, is reinforced with an improved system of longitudinal and cross ribs which extend down below the shears of the bed, and it is equipped with back-gears of the double-friction type. The ratios of these gears are such as to insure ample driving power. The frictions in the gears are of the toggle lever type and have an automatic adjustment for wear. The driving cone is three-stepped and is intended for a 3½-inch driving belt. The spindle boxes are made of phosphor-bronze and are oiled continuously from large oil wells located in the pedestals. The front spindle bearing is 2¾ inches in diameter and 4½ inches long. The reverse plate is mounted on the outside of the head, as the illustrations show, and it is a double-walled one-piece casting, supporting the gear studs at each end.

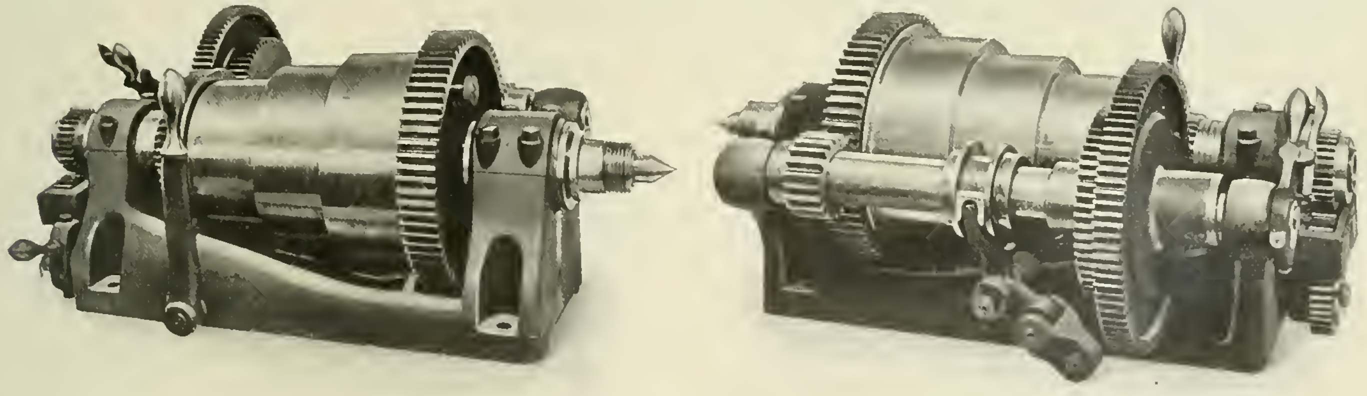


Fig. 2. Front and Rear Views of the Headstock

The quick-change-gear mechanism illustrated in Fig. 3, consists of the usual cone and tumbler-gear combined with a novel system of sliding gears through which forty-five changes for feeding or thread-cutting are obtained by the use of twenty-one gears. All the feed changes are controlled by means of the three levers seen at the front of the gear-box. The one at the left is only used to secure the extreme range. The total range of the machine for thread-cutting is from two to sixty threads per inch. The lathe is fitted with the usual quadrant and quadrant-gear for connecting with the spindle, so that it is possible, by the use of additional gears, to cut special threads if necessary. A new feature in connection with this mechanism is the method of engaging or disengaging the feed-rod and lead-screw. This is effected by means of a sliding gear operated by a knurled handle seen at the extreme right of the box, and the arrangement is such that when the lead-screw is in operation, the feed-rod is at rest and *vice versa*.

The quick-change box is a complete mechanism in itself, and can be taken off the bed without disturbing the adjustment of the lead-screw or feed-rod.

The apron (see Fig. 4) is a one-piece box section casting and all studs and gears are supported by bearings at each end. It is supplied with the usual bevel gear reverse mechanism which interlocks with the half-nut so that it is impossible to engage the lead-screw and feed-rod at the same time. To overcome the difficulty of manipulating the revolving knurls for engaging and disengaging the feeds, a novel arrangement of clutches is employed. These clutches have frictions of the expanding ring type, 5 inches in diameter, which are engaged by a toggle lever movement that insures ample driving power for the heaviest cuts. The shifting mechanism for these frictions consists of a single crank handle located at the center of the apron. When this lever is thrown to the right, it engages the longitudinal feed, and when it is thrown to the left, it engages the cross feed. Since this lever is stationary at all times, it enables the operator to work up to a shoulder without the necessity of throwing out the feed and running up the carriage by hand; and in addition it is in a convenient position for manipulation, at all times. There is a positive stop which makes it impossible to throw the lever from one feed to the other without first pulling out the plunger pin in the handle, which therefore cannot be shifted directly from the longitudinal to the cross feed position or *vice versa*.

The carriage, upper and lower views of which are shown in Fig. 5, has a bearing 26½ inches on the bed, and is carried on a V at the front and on a flat surface at the back of the bed. It is held in position by a long flat clamp at the back and by means of two taper gibs at the front which bear on a machined surface directly under the front V. These gibs, by their location, make it impossible for the carriage to lift, and they will not throw the carriage out of alignment if not properly adjusted. The front V is unusually large, being 1½ inch in width, and the wide flat bearing at the back gives the carriage an exceptionally large bearing surface. The bridge is very wide and drops down in a deep double-box section between the shears. Since the ways for the tailstock are dropped down below the ways for the carriage, it is not necessary to notch the bridge for clearance.

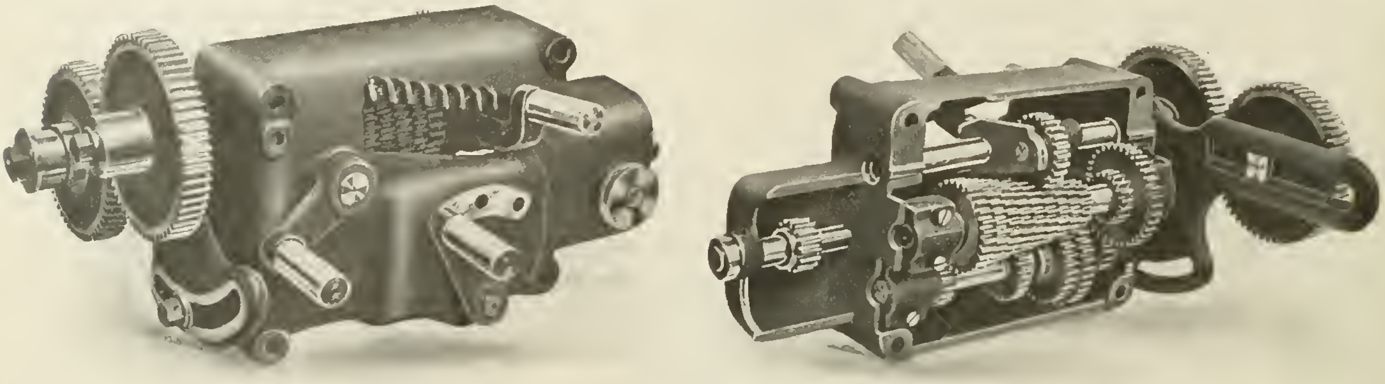


Fig. 3. Quick-change Mechanism giving Forty-five Changes

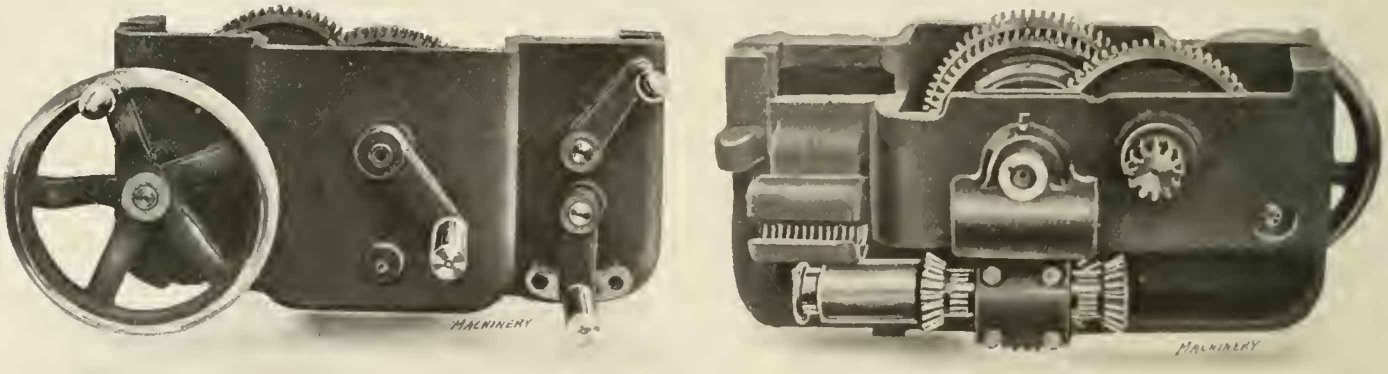


Fig. 4. Front and Rear Views of Apron

The compound rest is made heavy to withstand the strains imposed upon it by the modern high-speed steels. The clamping device for the swivel is operated by a single bolt which is so located as to be conveniently operated. The clamping mechanism consists of a V-shaped clamping ring similar to that usually found on round column radial drills. This device, in addition to being very effective, leaves the bottom slide more rigid than it would be with the T-slot turned in it; at the same time the compound rest can be adjusted quickly.

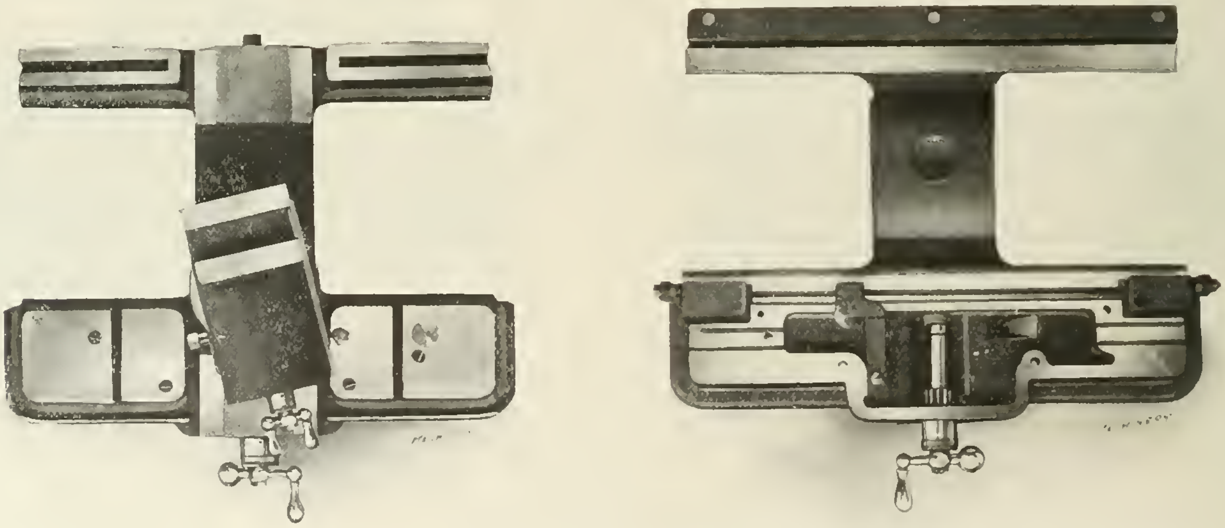


Fig. 5. Views showing both Sides of the Carriage

The tailstock is very massive and is arranged with the usual set-over for turning tapers. Its spindle is of steel 2 3/16 inches in diameter and it is clamped by means of a taper plug of the same construction as that usually found on the overarm of milling machines. The tailstock is clamped to the bed by two large bolts which are directly in front of and behind the tailstock spindle. These bolts reach to the top of the tailstock, where the nuts are in a convenient place for the operator.

The bed is 11¾ inches deep and 14½ inches wide, and is strongly ribbed with cross girths. The front girth, which is directly under the front spindle bearing, extends clear up to the top of the ways in order to resist the twisting strain on the bed at this point. The legs are set in from the ends of the bed, as shown, thus shortening the span between supports on the bed and making use of the familiar cantilever form of construction.

The feed gears throughout the machine are made of steel and are exceptionally heavy, the lightest gear in this mechanism having nine diametral pitch. That the machine is capable of continuous operation under heavy cuts is indicated by the statement that it will handle, without difficulty, a cut ¼ inch deep in 0.60 point carbon steel, with a 1/8-inch feed, at a peripheral speed of seventy-five feet per minute.

This lathe swings 16½ inches over shears and 10 inches over the carriage. With a six-foot bed it takes 2 feet 8 inches between the centers, and weighs, approximately, 2100 pounds.

CASEHARDENING EQUIPMENT

An oil furnace equipment designed and built by Walter Macleod & Co., Cincinnati, O., for the Warner Mfg. Co., of Toledo, O., is illustrated herewith. This equipment, which is for casehardening and heat-treating automobile transmission and steering gears, consists of five casehardening furnaces built in battery form, two heat-treating furnaces, one steel fan pressure blower directly connected to the driving motor, a rotary oil pump geared to the blower shaft, a multiple indicating pyrometer outfit, one 12,000-gallon oil storage tank, and a meter for determining the consumption of fuel.

The casehardening furnaces, which are shown in Fig. 1, have a capacity (at 1560 degrees F.), for 190 sets of transmissions per day of twenty-four hours. During this period there is an oil consumption of 840 gallons, which is equal to 4.4 gallons per set, so that each set, with oil at 2¼ cents per gallon, costs 9.9 cents. Each of these furnaces has a heating chamber 54 inches wide by 72 inches long. Granulated raw bone is used as a carbonizing material, and the average penetration obtained is 1/32 inch. The heat-treating furnaces (Fig. 2) are used for various classes of heat-treating work. These have an average oil consumption of 4 gallons per hour, and the heating chambers measure 32 by 49 inches.

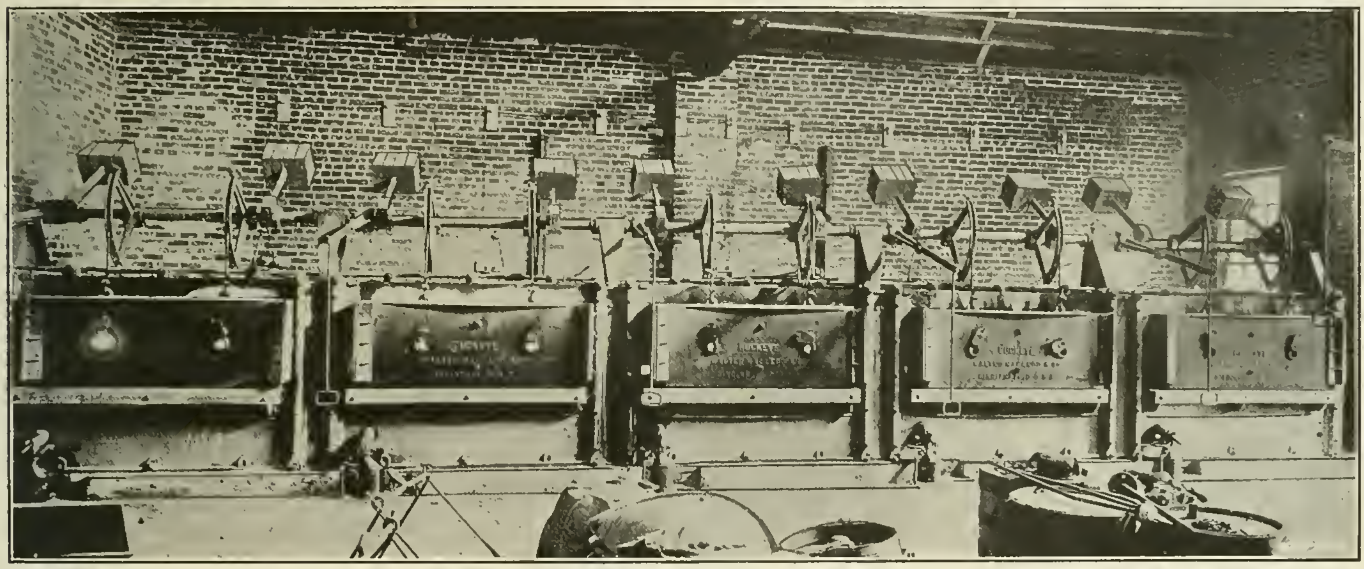


Fig. 1. Battery of Casehardening Furnaces built by Walter Macleod & Co.

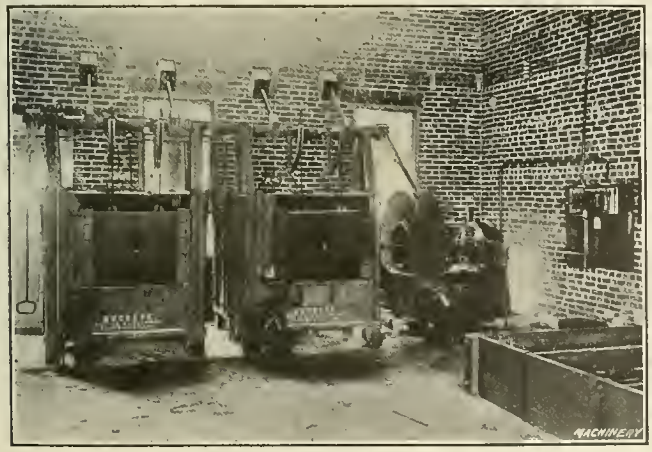


Fig. 2. Heat-treating Furnaces

All these furnaces are built of the best grade of firebrick, and are encased in heavy sectional, cast-iron ribbed plates, held in position by bolting strips and tie-rods in the usual manner. They are of the semi-muffled type, the combustion chamber occupying a position adjacent to the heating chamber. The gases are carried to the arch of the heating chamber, and after heating the material, pass into flues in the side walls, which lead under the hearth into the top of the furnace. As the natural tendency of hot gases is to rise, combustion chambers are usually built on or below the hearth line with varying results. The principal objection to this arrangement is the expense of renewing the hearth and baffle blocks every few weeks. The hearth in the type of furnace here illustrated is practically a solid foundation built of common standard-shape firebrick, and as only the top course requires renewal the expense is comparatively slight.

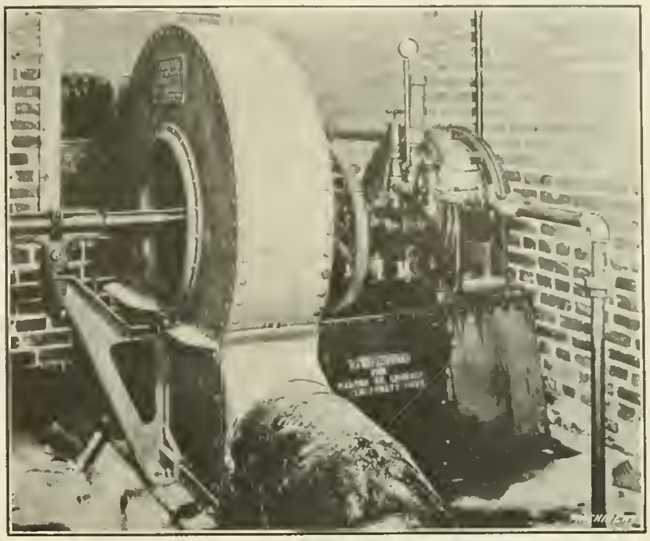


Fig. 3. Motor-driven Blower and Oil Pump

The combustion chamber is constructed so that the heat is not bottled up, but is retarded just long enough to permit the gases to fill the chamber and escape with a uniform pressure through the different ports leading into the heating chamber. The covering for these ports is also formed of standard-shape firebrick and can be removed in a few minutes, while the furnace is hot, if necessary. One oil burner is required for each furnace. This is placed in front, parallel with the combustion chamber, and an auxiliary air blast enters the opposite end, thus taking the place of a baffle. The air blast is controlled by a valve located just below the oil burner so that the furnace is conveniently regulated. The oil burners are the company's standard pressure blower type, and, in this instance, operate with an air pressure of 9 ounces.

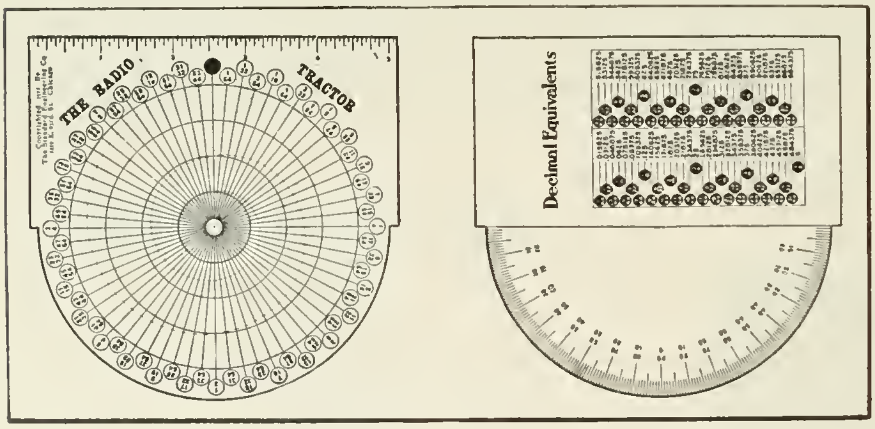
These furnaces are operated at a temperature of 1560 degrees F., with a variation not exceeding 20 degrees throughout the hearth. This result is made possible by thermo-couples that are inserted in each corner of the furnace. The casehardening furnaces are operated at 1560 degrees F., but this temperature decreases 250 degrees during discharging periods; the normal operating temperature, however, is regained in thirty minutes.

The oil and air supply is furnished by an electrically driven unit illustrated in Fig. 3. This consists of a steel fan type blower, directly connected to a 15-horsepower motor. The motor is mounted on a pedestal attached to the side of the blower. A rotary oil pump is also mounted on this pedestal and it is driven from the blower shaft through gearing. This blower has a maximum capacity much in excess of the present requirements, to provide for additional furnaces if necessary. At the present speed of 1460 revolutions per minute, 2830 cubic feet of free air per minute is supplied at a pressure of 9 ounces. The oil pump is fitted with a check valve, relief valve, pressure gage, primer, etc., and draws oil from a central storage supply. A meter is located in the supply line for the furnace and is so arranged that it can be either cut out or used continuously. The capacity of the pump is 9 gallons per minute at 180 revolutions per minute, and the pressure is 40 pounds.

The pyrometer outfit, which is made by the Taylor Instrument Co., consists of a wall-type multiple indicator and base metal thermo-couples, there being one for each chamber. The temperature is indicated periodically. The use of properly calibrated pyrometers in work of this nature is of considerable importance, owing to the necessity of maintaining the temperature accurately.

RADIO-TRACTOR FOR DRAFTSMEN

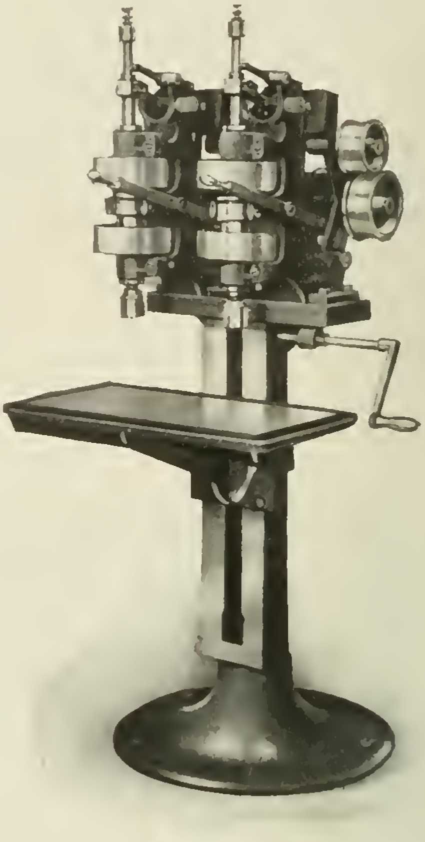
The "radio-tractor" is an instrument which is intended to save time and eliminate errors when setting dividers to the radii of circles. This instrument has four concentric circles as shown in the view to the left, which have diameters of 1, 2, 3 and 4 inches, respectively. These circles are intersected by sixty-four radial lines representing sixty-fourths of an inch. Each of these radial lines, beginning with the one representing 0 has divisions which, between the 1- and 2-inch circles, advance from the center by 128ths of an inch, thus forming a spiral. Between the 2- and 4-inch circles there is another set of divisions which advance by 64ths of an inch, each division being 1/64 inch farther from the center than the preceding one; consequently, the distance from the center to a division between circles 1 and 2, is one-half the distance between the center and a division on the same radial line between circles 2 and 4. Therefore, the radius of a circle, say 55/64 in diameter would be the distance from the 1-inch circle to the division inside the 2-inch circle of the radial line marked 55/64, whereas the radius of a circle 1 55/64 would be the distance from the center to the same division. In case the radius of a circle 2 55/64 inch in diameter were wanted, the dividers, instead of being set from the center, would be set by the 1-inch circle on the opposite side of the center, care being taken to keep them on a radial line. In this way the radius of any circle up to 8 inches in diameter may be obtained within 1/64 inch. One edge of the radio-tractor has a half size scale (6 inches = 1 foot) which is very convenient especially for detail drafting. The opposite side of the instrument is a protractor as shown in the view to the right, and there is also a table of decimal equivalents. This instrument is made on durable bristol board and celluloid, and the scales are accurately graduated. It is a product of the Standard Engineering Co., 1410 E. 63rd St., Chicago, Ill.



Instrument to facilitate setting Dividers to the Radii of Circles

GARVIN TWO-HEAD AUTOMATIC TAPPING MACHINE

The two-head automatic tapping machine illustrated herewith has recently been added to the standard line of tapping machines manufactured by the Garvin Machine Co., Spring and Varick Sts., New York. This machine, with two heads, practically doubles the capacity of a single-head machine. It operates automatically after the tap is once started, so that the operator can insert another piece for the second spindle to work on while the first hole is being tapped. In this way the two spindles are kept at work continuously, and the output, as compared with a single machine, is increased over fifty per cent. This machine can also be used to advantage for tapping pieces having two holes of different sizes, as the work needs to be handled only once.



Garvin Two-head Automatic Tapping Machine

Each of the spindles is fitted with two friction pulleys driven in opposite directions by a continuous belt connecting with an overhead countershaft. Between these pulleys there is a friction clutch keyed to the spindle, and this clutch is connected by a toggle arrangement with a lever seen at the right of each head. As there is an adjustment that gives any drive desired, an extra safety device to prevent breaking the taps is unnecessary. The tap is started by the hand lever, and it is tripped and reversed automatically at any predetermined point, by an adjustable screw-stop on the upper end of the spindle, which trips a reversing lever at the top of the machine.

The spindles are fitted with a positive drive chuck for holding the taps. The table is adjusted vertically by a screw motion, and it is surrounded by an oil groove as shown. The machine, when using U. S. standard taps, will tap holes varying from 1/16 to 3/8 inch in cast iron, and from 1/16 to 1/4 inch in steel, to the depth of 1½ inch. After a tap is inserted in the work, the machine requires no attention until the hole is finished. It operates satisfactorily at high speed, and is reliable and safe, the breaking of taps being reduced to a minimum.

* * *

One of the most marvelous things is the burning of a jet of hydrogen gas in liquid air. The smoke that arises from the combustion floats off in the air as pure snow. A flame burning brilliantly in the midst of a liquid, with snow given off for smoke!—*Compressed Air Magazine.*

NEW MACHINERY AND TOOLS NOTES

Planer: Whitcomb-Blaisdell Machine Tool Co., Worcester, Mass. Special planer for textile rolls, having a table equipped with multiple, automatic-indexing centers, and twelve planing tools.

Insert Chuck Jaws: Keystone Mfg. Co., Clearfield, Pa. Insert jaws which are placed in an ordinary chuck for holding very small bolts or rods. Three sets of these jaws are made, with capacities varying from 1/8 inch to 11/16 inch.

Vernier for Boring Mill: Cleveland Machine Tool Co., Cleveland, O. This company is attaching a combination vernier scale to its boring mills to facilitate setting the head accurately. By means of the vernier attachment, measurements within 0.001 inch can be taken.

Lathe Dog: West Steel Casting Co., Cleveland, O. Safety lathe dog, the set-screw of which is guarded to avoid the accidents which often result from the lack of such protection. The set-screw can be adjusted by an ordinary wrench. These dogs are of crucible cast steel and are made in standard sizes.

Self-oiling Pulley: Edward Cunningham & Co., Canton, Mass. This pulley is so designed that as it revolves, the oil is thrown outward in the oil chamber by centrifugal force. The oil is then caught by tubes through which it is forced to the oil grooves and along the shaft, finally returning to the oil chamber.

Wheel Guards: Ransom Mfg. Co., Oshkosh, Wis. Cast steel emery wheel guards arranged for exhaust pipe connections. These guards are adjustable so that as the wheel wears, they can be set back to allow the operator to get close to the wheel. The upper plate is removable, thus permitting wheels to be changed without disturbing the main guard.

Lathe: Whitcomb-Blaisdell Machine Tool Co., Worcester, Mass. Fourteen-inch by six-foot lathe driven by a single pulley and having three spindle speeds obtained by means of sliding gears. The spindle is provided with a brake which acts on the rim of the faceplate and is engaged by the action of the shifter rod. The lathe is surrounded by a large oil pan and is equipped with a pump.

Oil-groove Milling Attachment: National Machine Tool Co., 128 Opera Place, Cincinnati, O. Attachment for milling oil grooves in loose pulleys, etc. Grooves are cut at the rate of approximately 6 inches per minute. By means of an eccentric bushing and four shoes, the tool may be used in ten different diameters of holes. This attachment is used in the drilling machine the same as the keyseating tool made by this company.

Adjustable Triangle: Adjustable Triangle Co., P. O. Box 23, Sta. H., New York. Adjustable 45-degree triangle so arranged that the hypotenuse side can be moved along the base to make any angle with it between 45 and 90 degrees, while at the same time, angles between 0 and 45 degrees are made with the vertical side. Graduations in half degrees on the upper edge of the base, show the position of the adjustable member.

Combination Wrench: Atwood Wrench, Tool & Stamping Co., Conneaut, O. Adjustable wrench designed for pipe and other work. It will take either square or hexagon nuts and does not have to be taken off the nut in advancing. The adjustable jaw has a serrated disk with pinions on each side which engage corresponding racks cut in the handle. The pressure on the handle causes the disk to rotate towards the fixed jaw so that the grip is increased in proportion to the pressure on the handle.

Riddle Oscillator: Hanna Engineering Works, 2059 Elston Ave., Chicago, Ill. Motor-driven oscillator for foundry riddles designed to simulate the action of a molder when screening sand by hand. The action is said to keep the sand in motion continuously which tends to clear the screen meshes to a great extent. The oscillator is furnished with a motor for any of the ordinary electric currents available, and a switch as well as a piece of cable and plug for attaching to a lighting circuit, are included in the equipment.

Operation Recorder: Thwing Instrument Co., Philadelphia, Pa. Instrument for recording the idle and running time of tools. A chart on which the time is carefully recorded is divided into hour spaces, having ten-minute subdivisions. This chart is mounted on a 16-inch drum actuated by a clock. A simple form of contact switch attached to the shifting lever of each machine, through a battery and electro-magnet, closes the circuit as soon as the machine is started, thereby causing the recording pen of the instrument to move from the "idle" to the "operating" position.

Jointer: B. M. Root Co., York, Pa. Jointer designed for pattern shops and other wood-working establishments. The mechanism for adjusting the front table as well as the fence are important features. When the binders of the table base are free, the entire front table mechanism is moved to and from the cutter cylinder, without changing the height of the table, by means of a handwheel at the front. When the table base is fastened, the same handwheel changes the elevation. The cutter cylinder is a steel forging, and is made either square or in the safety round type. Two knives are used with either style. This machine is built in several different sizes.

Gages: W. H. Nichols, Waltham, Mass. External and internal thread gages made in various sizes. Short cylindrical plug gages designed especially for testing holes when grinding. The plugs are mounted on very short handles so that they can be inserted for testing, by running the wheel back a comparatively short distance. Internal gage for testing annular ball races and similar work. It consists of two legs hinged at one end and carrying at the short end a pair of spherical contact points. When using the gage, the jaws are opened until these points make contact with the work, the finished size of which is shown by the contact of the outer ends.

Automatic Screw Machine: B. C. Ames Co., Waltham, Mass. Automatic screw machine designed for producing small high-grade screws, such as are used in watches, small instruments, etc. It makes the screw complete including the slotting operation. Screws as small as 0.017 inch diameter and having 240 threads per inch, are regularly made on this machine, and it is capable of cutting screws as large as 0.070 inch diameter and having 70 threads per inch. It has a wire capacity through the chuck of 0.125 inch. The slotting operation is so timed that it is performed while the succeeding screw is being formed into shape, no extra time being required.

Vertical Surface Grinder: Hemming Bros. Co., New Haven, Conn. Vertical grinder with a capacity for work 12 inches wide and 3 feet long. The spindle, which is provided with ball thrust bearings, is connected through bevel gearing with the horizontal shaft which, in turn, is driven by a four-inch belt. The driving pinion is of raw-hide and meshes with a large bevel gear on the upper end of the spindle. Eight variations of power feed for the table are available, varying from 2 to 10 feet per minute. The table can be adjusted vertically either by hand or power. The platen is entirely surrounded by a pan for catching the cooling water which is fed to the work through the hollow spindle.

Riveter: F. B. Shuster Co., New Haven, Conn. Riveting machine designed for heading both ends of a headless rivet or piece of wire simultaneously. The heading operation is effected by a reciprocating hammer and a rotating hammer held against endwise movement in an anvil carrier bolted to the table. The most important feature is the combination and working of the cylinder and hammer rod with the lowering revolving attachment. The direct and central application of the power, combined with the positive rotary motion of the hammer, causes a regularly applied "breaking-down" action, thus forming perfect heads. The lower revolving fixture may be removed and the machine used for heading one end of a rivet.

Riveters: Hemming Bros. Co., New Haven, Conn. Long-stroke riveter of the elastic rotary-blow type. The force of the blow is controlled by a foot-treadle. Heads of almost any shape can be produced, and the machine will make tight joints or rivet so lightly as to allow the parts to swivel. When heads are to be formed at both ends of a rivet, a lower revolving fixture is supplied. High-speed riveter also of the elastic rotary-blow type. The hammer rod is positively driven by a sprocket and chain, and spinning blows can be delivered at the rate of 6000 per minute. Either a horizontal or vertical table can be attached, and the riveter can also be equipped with a lower revolving fixture for forming two heads simultaneously.

Needle Grooving Machine: Langelier Mfg. Co., Providence, R. I. Special machine for grooving sewing machine needle blades. The one-piece frame of the machine has at the top a slide cross arm, similar to an open side planer, which carries the two cutter heads. A disk, side-acting segment cam feeds each of the cutters to its proper depth. The cutter spindles are driven by a round leather belt and run at a speed of 1050 revolutions per minute. As soon as the grooving operation is completed, the needle is ejected and falls into a trough that leads to a receiving pan. This movement is immediately followed by the feeding of another needle into the work vise. Four needles are grooved per minute, and one operator is able to load the feeding dials for four or five machines.

Continuous Reading Caliper: Blanchard Machine Co., Boston, Mass. Continuous reading caliper, especially designed for the vertical surface grinder built by this company. It gives a continuous measurement while grinding is in progress, thus showing just how much stock must be removed. A hardened steel button rests lightly on the work and connects with a dial gage at the top of the caliper. The zero mark of the dial is first set to agree with the pointer when the button is resting on a size block or a finished piece of the correct thickness. The gage, therefore, shows the amount by which the work differs from the finished size, or the stock that must be removed. As the grinding proceeds, the pointer approaches the zero mark and coincides with it when the finished size is reached. The caliper is held to the machine table and can be swung out of the way when inserting work, without interfering with its adjustment for size.

GEAR-DRIVEN AXLE FOR MOTOR TRUCKS

A rear axle for motor trucks has been designed by the Hindley worm gear department of the Otis Elevator Co., Philadelphia, Pa., to replace the jack-shaft and chain drive which has been used so extensively on commercial trucks. This new axle, which is shown assembled and in detail in Figs. 1 and 2 has a central spiral gear drive which was adopted because of the impracticability of obtaining the required ratios with the bevel gear drive. The driving gears of the axle illustrated, which is designed for 1½- or 2-ton trucks, have a ratio of either 6 to 1 or 8⅔ to 1, depending on the capacity of the truck. This change of gear ratio is the only difference in the axles used on the 1½- and 2-ton sizes.

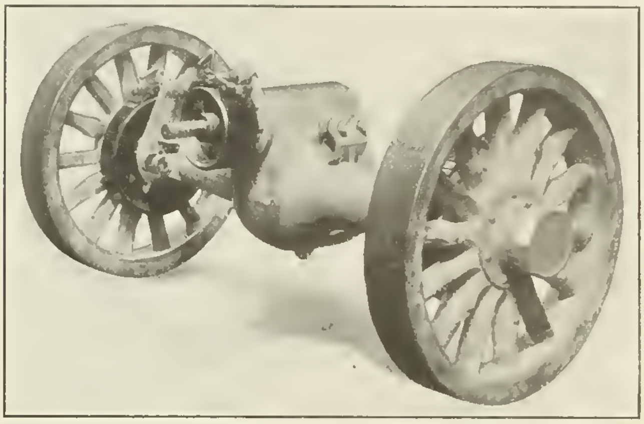


Fig. 1. Motor Truck Axle with Central Spiral Gear Drive

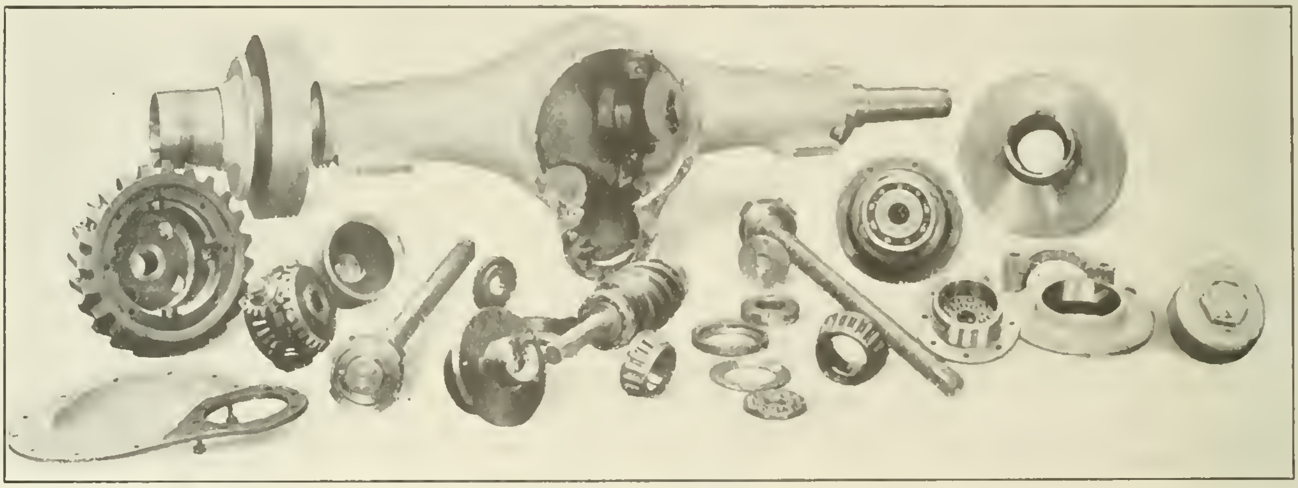


Fig. 2. Various Parts of the Motor Truck Axle

The general arrangement of this axle is shown in Figs. 2 and 3. The differential mechanism is of the bevel gear type, and it is contained in a crucible steel casing which is bolted to the worm-wheel. The gears are made of 0.35 carbon, 3½ nickel steel and are oil tempered. The bevel gears on each side of the differential engage the squared ends of the "live" or driving axles, which have flanged outer ends with projections that lock into the wheel hubs. These axles are also made of 0.35 carbon, 3½ nickel steel and have oil tempered ends. The wheel hubs are of cast steel and are mounted on extra large Standard roller bearings. The outer of these bearings abuts against a collar screwed on the end of the axle casing and the inner bearing rests against a shoulder on the stationary axle sleeve. The wheel itself is firmly riveted between the solid inner hub flange and an outer flange. The end of the hub is closed by a screw cap.

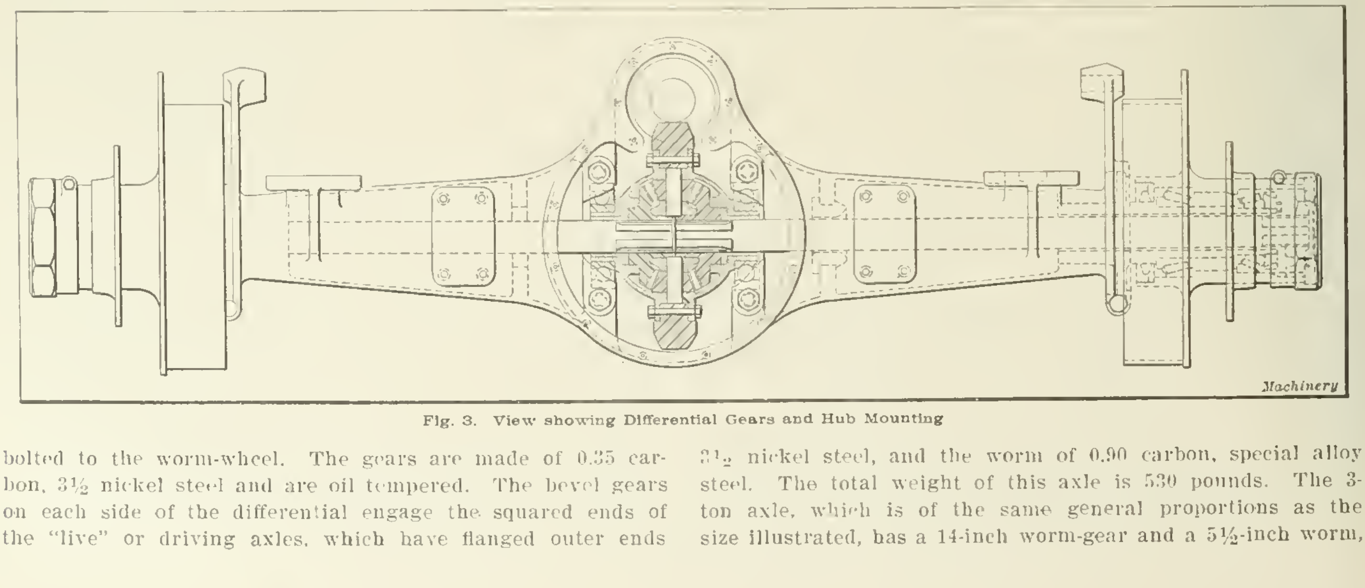


Fig. 3. View showing Differential Gears and Hub Mounting

The worm-shaft is mounted in annular ball bearings having ⅝ inch balls, and it is provided with thrust bearings on each side, as shown in Fig. 5. The thrust bearings are equipped with balls of the same diameter and have manganese-bronze ball retainers. The axle casing is a one-piece steel casting which entirely encloses all the mechanism and protects it from dust. By removing a cover-plate bolted on the rear side of the enlarged central part of the casing, the gears can all be taken out after the bearing caps which hold the differential ball bearings in place have been removed. The worm-gears for the 1½- and 2-ton axle are 12 inches in diameter, and the worm has a diameter of 4½ inches and a pitch of 1½ inch. The worm-wheel is made of 0.35 carbon, 3½ nickel steel, and the worm of 0.90 carbon, special alloy steel. The total weight of this axle is 530 pounds. The 3-ton axle, which is of the same general proportions as the size illustrated, has a 14-inch worm-gear and a 5½-inch worm,

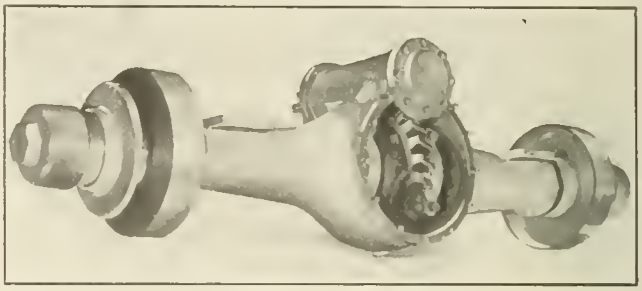


Fig. 4. Rear View of Axle with Cover Removed

and weighs 600 pounds. The axle is fitted with emergency duplex band brakes on the rear wheels and regular service brakes on the worm-shaft, as shown in Fig. 1.

The point of superiority claimed for the worm-gear drive is that any uneven loading of the truck or uneven road conditions do not affect the alignment of the drive, because the gears are in the center of the axle, thus making a straight-line transmission from the motor to the gear-box. On the other hand, the chain drive, which is on the outside of the frame, is thrown out of line by the unevenness of the road or unbalanced loading. In fact, the chain drive is practically never in alignment when the truck is in motion, except for very short periods, which tends to wear the chains and sprockets irregularly. The chain drive is also exposed to the dust and road grit, whereas the gear-driven axle is entirely enclosed.

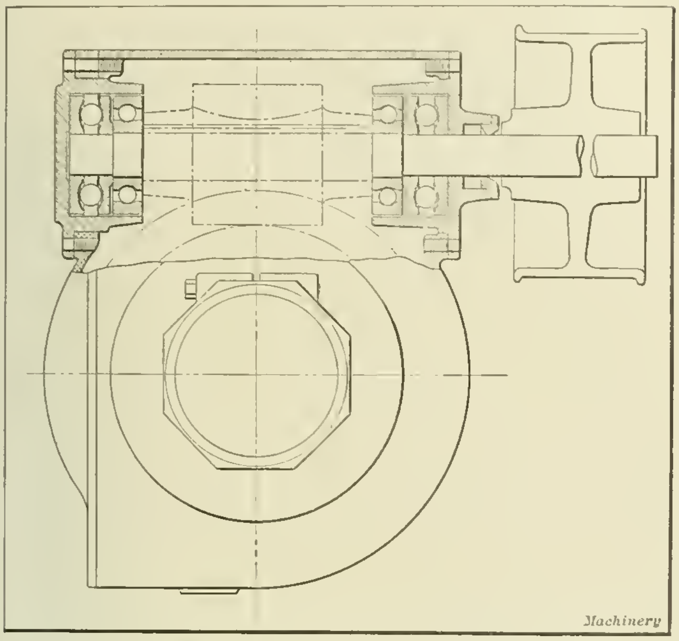


Fig. 5. Sectional View of Worm Radial and Thrust Bearings

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A. S. M. E. MACHINE SHOP PRACTICE COMMITTEE

The American Society of Mechanical Engineers is expanding its activities into many fields of engineering that it has not heretofore specifically recognized. Among these is machine shop practice. The committee recently appointed is as follows: F. E. Rogers (Editor MACHINERY), chairman; L. D. Burlingame (Brown & Sharpe Mfg. Co.); W. L. Clark (Niles-Bement-Pond Co.); W. H. Diefendorf (New Process Raw Hide Co.); A. L. DeLeeuw (Cincinnati Milling Machine Co.); F. L. Eberhardt (Gould & Eberhardt); F. A. Errington; A. A. Fuller (Providence Engineering Works); H. D. Gordon (Jenkins Bros.); H. K. Hathaway (Tabor Mfg. Co.); E. J. Kearney (Kearney & Trecker); Wm. Lodge (Lodge & Shipley Machine Tool Co.).

* * *

THE AMERICAN MACHINIST'S THEATER PARTY

On Wednesday evening, October 11, the *American Machinist* entertained the members of the National Machine Tool Builders' Association and the National Supply and Machinery Dealers' Association and their friends, with a "Trip Around the World" at the New York Hippodrome, where a most enjoyable evening was spent by everybody. The Hippodrome performance this year eclipses all previous efforts. Rapid and startling changes of scenery, marvelous color effects, extraordinary juggling feats and beautiful costumes were only a few of the features of a highly successful entertainment.

* * *

What is claimed to be the world's deepest boring is a hole 7347 feet deep drilled in Upper Silesia. The boring was undertaken to determine the relations of coal beds and was performed by the Prussian government.

THE NATIONAL MACHINE TOOL BUILDERS' ASSOCIATION CONVENTION

The tenth annual convention of the National Machine Tool Builders' Association was held at the Hotel Astor, New York, Tuesday and Wednesday, October 10 and 11. The meeting was called to order by President F. A. Geier, who made a brief address on trade conditions and the aims of the association. Secretary Charles E. Hildreth spoke in his usual forceful and interesting manner, and read as part of his address a paper by Mr. Charles F. Hilker "The Spirit of Optimism and Its Effect Upon Trade," this being an every-cloud-has-a-silver-lining essay on trade conditions, pointing out the folly of being unduly depressed by a short period of so-called "hard times."

The technical program was devoted to subjects closely relating to shop and factory administrations, consisting of the following papers and discussions:

"Task Work as a Basis of Proper Management," by Henry L. Gantt. (Abstract will be published later.)

"Shop Hygiene as a Factor in Efficiency," by Dr. Winthrop Talbot. (See abstract in this number.)

A description of the physical inspection system and emergency hospital of the Norton Co., Worcester, Mass., by Dr. Clark.

"Standardization of Machine Tools for the Benefit of the User," by L. P. Alford. (See abstract in this number.)

The reading and discussion of papers was followed by an executive session devoted to "heart to heart talks on trade conditions."

The third session in the morning of the second day of the meeting was given up to the following: Lathe, sensitive drilling machine, boring machine, gear cutting machine, grinding machine, hand screw machine, radial drilling machine, planing machine, milling machine, shaping machine, vertical drilling machine and turret lathe committee meetings.

In the afternoon session new members were elected, making thirteen elected to membership at this meeting, and the total membership 166:

E. E. Bartlett Co., South Boston, Mass.
Beaudry & Co., Inc., Boston, Mass.
Cleveland Punch & Shear Works, Cleveland, Ohio.
Ferracute Machine Co. Bridgeton, N. J.
Hilles & Jones Co., Wilmington, Del.
Lenox Machine Co., Marshalltown, Iowa.
National Machinery Co., Tiffin, Ohio.
New Britain Machine Co., New Britain, Conn.
Rowbottom Machine Co., Waterbury, Conn.
Smith & Mills, Cincinnati, Ohio.
Standard Machinery Co., Bowling Green, Ohio.
H. B. Underwood & Co., Philadelphia, Pa.
Watson-Stillman Co., New York City.

A resolution was passed that the annual meetings of the association be three days instead of two, as in the past, and that the semi-annual meeting be two or three days at the option of the executive committee.

The motion was made and passed that the association hire a permanent secretary to devote his whole time to the work of the association. The executive committee was directed to find the desired man and hire him as soon as possible.

The following officers were elected: President, E. P. Bullard, Jr., Bullard Machine Tool Co., Bridgeport, Conn.; vice-president, Fred A. Geier, Cincinnati Milling Machine Co., Cincinnati, Ohio; second vice-president, A. T. Barnes, W. F. & John Barnes Co., Rockford, Ill.; treasurer, A. E. Newton, Prentice Bros. Co., Worcester, Mass.; secretary, Charles E. Hildreth, Whitcomb-Blaisdell Machine Tool Co., Worcester, Mass.

The next semi-annual or spring meeting will be held in Atlantic City, N. J.

* * *

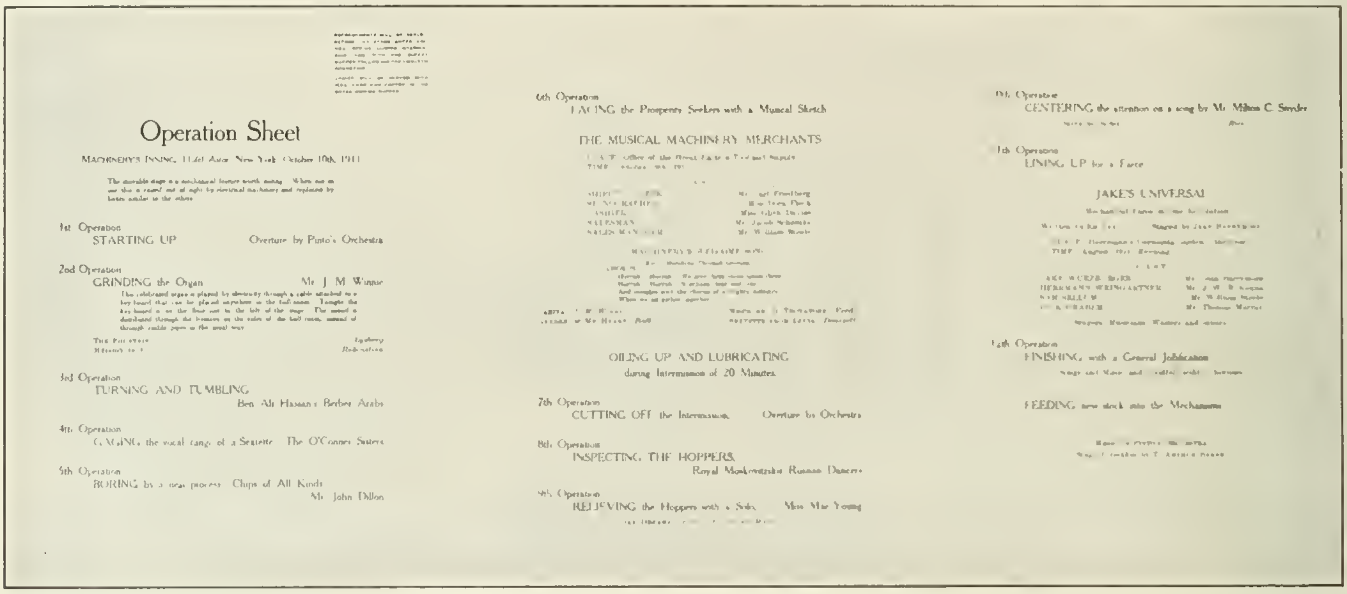
A manufacturer of shapers alleges that many users of machine tools do not exercise the best judgment in selecting shaper equipment. So much has been said of the advantages of high-speed steel and the need of heavy strong machine tools for economical production that buyers of new equipment are likely to select the heaviest available machines. In the case of shapers it is a mistake to get the heaviest type for a large class of shaper work. Many of the jobs that go into the shaper require light cuts. On such work the heavy shaper is at a disadvantage; it eats up power and is slow in action as compared with the lighter or standard shapers.

MACHINERY'S NINTH ANNUAL ENTERTAINMENT

For eight years MACHINERY'S outing has been held on the day following the National Machine Tool Builders' convention; but as it was thought this year that the sessions might extend over three days, in order not to interfere with the proposed arrangement the outing was discontinued and an evening entertainment substituted, which was held in the grand ball room of the Hotel Astor, on October 10, and attended by about six hundred and fifty machine tool builders, dealers and others connected with the machinery industry.

The purpose of MACHINERY'S annual entertainment is to promote good fellowship among the principals and executives in the industry; and to facilitate this, instead of having fixed seats in rows there were a hundred or more small tables, at which refreshments were served during the stage performance, and ample space was provided for those present to move about and meet their friends. Supper was served after the close of the stage entertainment. Seats were provided for the ladies in the boxes where they could overlook the stage and the whole assemblage, and where refreshments were served during the evening.

The grand ball room of the Hotel Astor is well adapted to this purpose, as it contains at one end a movable stage operated by electricity, which is replaced by boxes when not in use. MACHINERY'S entertainment consisted of eleven acts, including an original musical sketch and a farce, which contained a number of good-natured hits on well-known people in the machinery industry. The program was gotten up in the form of a Shop Operation Sheet, which is reproduced herewith.



Operation Sheet

MACHINERY'S INNING, Hotel Astor, New York, October 10th, 1911

1st Operation
STARTING UP — Overture by Pinto's Orchestra

2nd Operation
GRINDING the Organ — Mr. J. M. Winne

3rd Operation
TURNING AND TUMBLING — Ben Ali Hassan's Berber Arabs

4th Operation
GAGING the vocal range of a Sextette — The O'Connor Sisters

5th Operation
BORING by a new process — Chips of All Kinds — Mr. John Dillon

6th Operation
FACING the Prosperity Seekers with a Musical Sketch

THE MUSICAL MACHINERY MERCHANTS

OILING UP AND LUBRICATING
during Intermission of 20 Minutes

7th Operation
CUTTING OFF the Intermission — Overture by Orchestra

8th Operation
INSPECTING THE HOPPERS — Royal Moskovitzki Russian Dancers

9th Operation
RELIEVING the Hoppers with a Solo — Miss Mae Young

10th Operation
CENTERING the attention on a song by Mr. Milton C. Snyder

11th Operation
LINING UP for a Farce

JAKE'S UNIVERSAL

12th Operation
FINISHING with a General Jollification

FEEDING new stock into the Mechanism

The Program of MACHINERY'S Ninth Annual Entertainment, made up as a Shop Operation Sheet

A feature of the evening was the voting of a cup, as an expression of good-will by those present to one of their number. Mr. Amos Whitney was the recipient.

* * *

An Eastern textile finishing mill using calendering rolls has trouble with the rolls breaking, despite the fact that they are made with necks nine inches in diameter. The cause was found to be excessive weights placed on the pressure mechanism by the operator. It appears that in England the standard weight required for finishing certain grades of cloth is 200 pounds. The leverage of the machine being 40 to 1, the weight of 200 pounds imposes a load on the rolls of 8000 pounds. The English workmen insisted on using the 200-pound weight on machines built in this country with greatly increased leverage, the leverage being 200 to 1; the result, of course, is a load five times as great as on the English design of machine. Argument did not avail with these workmen trained to do their work in a certain prescribed manner. They would strike rather than use any other but the weights that they were taught should be used for a given operation.

STANDARDIZATION OF MACHINE TOOLS FOR THE BENEFIT OF THE USER*†

Standardization of product is a necessity in manufacturing. It is the starting point in every attempt to produce great quantities of parts cheaply and uniformly, and the advantages are readily recognized. There are similar advantages in the standardization of processes and tools used in manufacturing. The following six important principles should be observed in the standardization of machine tools:

1. Standardize corresponding designations and capacities, and establish a method of power rating.
2. Standardize devices for holding cutting tools.
3. Standardize devices for holding work and fixtures.
4. Standardize operating movements.
5. Standardize parts concerned in the setting up of machines with reference to the permanent shop equipment.
6. Accept the geometric progression as a fundamental requisite in designing feeds and speeds.

Discussion of the First Principle

The first principle aims at a standardization of corresponding machine designations and capacities, and the establishing of a method of power rating. In 1903, action was taken by a number of milling machine manufacturers to establish the maximum feed travels for various sizes of knee-and-column milling machines. For example, the maximum feed travels for a No. 2 universal machine were fixed as follows: Longitudinal, 25 inches; cross, 8 inches; vertical, 18 inches. This was a start toward standardizing designations and capacities. The resulting uniformity is of advantage to the buyer in comparing the various makes of machines designated as Nos. 1, 2, 3, 4, etc. But this is only a beginning.

To illustrate the point, let me ask what is a 14-inch, 6-foot bed engine lathe? To answer my own question, I don't know. From data that have been prepared comparing some of the dimensions of a number of 14-inch, 6-foot bed engine lathes, it is found that the diametral swing over the bed ranges from 14⅛ to 16¼ inches, the swing over the plain carriage from 7½ to 10¾ inches, and the maximum distance between centers from 1 foot, 6 inches, to 3 feet 3 inches. From the user's standpoint it is as important to know the diameter that can be swung and turned over the carriage as it is to know the maximum diameter that can be swung over the ways; and the length of the bed is of no more interest than the height of the lathe hand that operates the machine.

Turning to the question of power rating, the user should have some means of distinguishing between the relative capacity for removing metal and mechanical efficiency of machines of the same dimensional capacity. If he asks for bids on a 20-inch, 10-foot engine lathe, and in one case is quoted $600 and in another $450, he should have some means of knowing that the difference in price represents a difference in metal removing capacity of the tool. Let me call attention to that I propose the establishing of a *method* of rating, not the establishing or standardizing of ratings themselves. We have light-powered and heavy-powered machines; each kind has its field, but there should be some way to differentiate them except by name.

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* Abstract of paper by Mr. L. P. Alford, read before the convention of the National Machine Tool Builders' Association, New York, October 10, 1911.

† See MACHINERY, October, 1904, "Standard Nose Threads for Lathe Spindles."

Discussion of the Second Principle

The second principle refers to standardization of devices for holding cutting tools. The small-tool equipment of a shop represents a large investment. The more adaptable this equipment is, the greater the number of hours each small tool can be at work and, therefore, the greater the operating efficiency of the shop. The interchangeability of lathe tools and tool-holders throughout the tool-posts of all lathes of a given size, the interchangeability of milling cutters and their collets among machines of different makes, the interchangeability of drill chucks throughout all the drilling machines of a given department, and so on, represents a real increase in efficiency which is so apparent as to merely need mention to be recognized. To show that this principle has already influenced design, I have but to refer to the taper of the hole in the spindles of milling machines. The Morse taper is extensively used in drilling machine spindles. In ten 14-inch engine lathes investigated, the majority of the tool-post slots were found to be made for ½ by 1¼-inch tools.

Discussion of the Third Principle

The third principle refers to the standardization of devices for holding work and fixtures. The arguments presented in favor of standardizing the devices for holding cutting tools apply here with even greater force, for the devices and fixtures for holding work are individually more expensive than are separate cutting tools. Consider the advantages of chucks interchangeable throughout all of the lathes of a given size in a lathe department, or the advantage of uniform T-slots throughout all kinds of machine tools of relatively the same size. A milling fixture could then be used on any milling machine of a given number, and holding-down bolts could be standardized as regards the sizes of the heads, with the full assurance that they could be used on a milling machine, drilling machine, planer or lathe, as the case may be. In addition to the saving in original investment and the increased flexibility of the equipment, there is an attendant saving in the time required on the part of the workmen to find devices that can be used.

To show that something has been done in recognition of this principle, I have but to refer to the table slots of milling machines. On the milling machines investigated, the table slots were uniformly ⅝ inch.

Discussion of the Fourth Principle

The fourth principle refers to the standardization of operating movements. Rapid repetition work depends very largely upon the sense of touch of the operator. Often-repeated movements become, to a great degree, involuntary. It, therefore, follows that a standardization of the operating movements of machine tools will contribute to an operator's speed by making his motions, to a certain extent, involuntary, and permitting him to change from one make of machine to another without any disturbance of the habits that he has formed. On all standard lathes, the same direction of motion of the footstock handle should advance the spindle toward the head. Similarly a definite direction of motion of the handwheel on the carriage should advance the carriage toward the head, and so on.

To show that this principle has been recognized, in the engine lathes investigated the direction of motion of the operating handles was uniform to produce a corresponding movement of the operating parts.

Discussion of the Fifth Principle

The fifth principle sets forth the standardization of parts concerned with the setting up of machines with reference to permanent shop equipment. There are only a few points to be considered here, such as the spread of the bolt holes in the feet of the countershaft hangers, the drop of the shifter rod, and for motor-driven tools, the dimensions of the motor feed pads. I need not dwell upon the advantage to the user in being able to buy a machine that meets his needs from a machine tool builder, and a motor adapted to the machine from an electrical machinery manufacturer, and assemble them himself, knowing that they will fit.

Discussion of the Sixth Principle

The sixth principle refers to an acceptation of the geometric progression as a fundamental requisite in determining relations throughout the chosen ranges for feeds and speeds. I have reason to believe that this principle is very generally recognized, especially among those producing milling machines, but there seems to be a wide difference in the ratios aimed at.

The following lists of features to be considered for standardization are for the four fundamental machines, lathes, planers, drilling machines, and milling machines. This does not imply that standardization cannot be carried on in connection with other machines; on the contrary, the principles laid down are of such a nature that they can and should be applied to all classes of machine tools that are of a fixed type and made by a number of builders. The real work of determining dimensions is a long, tedious task, and cannot be done in a weak-kneed, faltering manner; but personal experience in the work of standardization has taught me that the difficulties in the way are always magnified. The way is easily found if there is a will. What follows is suggestive only.

Engine Lathe Features to be Standardized

Designations and capacities might be linked together by giving three dimensions: First, the swing over the ways; second, the swing over the plain carriage; third, the maximum distance between centers. Thus a 14-inch, 6-foot bed engine lathe would become, say, a 14-inch by 8-inch by 3-foot engine lathe. The maximum swing over the ways should be fixed for each nominal swing; the other dimensions should be exact.

As a suggestion merely, is it necessary to have so many nominal sizes of lathes as are now built and listed? As now arranged, these sizes roughly form an arithmetical progression, having a common difference of two inches. Has anyone considered arranging these sizes in a geometric progression with the direct purpose of reducing their number? If anyone is interested in this, let him start a progression with ten inches and apply the ratio 1.2.

A standard method of power rating might be to give the horsepower of the driving belt for the machine; this power should be figured by means of a given formula with given factors for single, double and triple belts. This same rating could apply whether the machine was belt-driven or motor-driven, because a given type and size of machine is usually built for both methods of applying power. This will permit a careful designer to develop a design that will have a proper relation between power and rigidity. It will also permit the user to compare mechanical efficiencies.

For each nominal size of lathe the following details of designs should be standardized: Diameter, thread, and length of the spindle nose; taper of hole in spindle; diameter of hole through spindle; taper of centers; hole, keyway, face, pitch, and kind of teeth of change gears for the ordinary screw-cutting type; number of threads per inch of lead-screw; size of T-slots in wings of carriage; direction of motion of operating handles; and controlling movements of footstock spindle, carriage, tool-block and compound rest.

Vertical Drilling Machine Features to be Standardized

The features of vertical drilling machines that should be standardized for each nominal size are: Dimensions of table and of finished surface of base; distance from center of spindle to face of column; method of power rating; dimensions of the spindle nose; taper of hole in spindle; number, arrangement, and size of T-slots in the table and base; maximum distance from spindle to table and from spindle to base; and direction of motion of operating handles.

Planer Features to be Standardized

The features to be standardized in connection with planers are: Method of rating; method of stating capacity; number and size of T-slots in the platen; dimensions of reamed holes in platen; and direction of motion of operating handles.

Milling Machine Features to be Standardized

In the planer, drilling machine, shaper and lathe, we have a precedent for a form of designation that of itself indicates capacity. Is there any good reason why the milling machine should not be styled in a similar manner? To illustrate, is not a designation a 25 by 8 by 18-inch universal milling machine better, from the viewpoint of conveying information, than to say a No. 2 universal milling machine?

The features to be standardized in connection with milling machines are: Designation and capacity; method of rating; length and width of working face of table; maximum distance from center of spindle to table; thread on nose of spindle; diameter of nose; taper of hole; width of slot in clutch end; diameter of clutch end; distance from face of column to end of spindle nose; taper of hole in spindle of vertical attachment and index head; diameter of over-arm; distance from center of arm to center of spindle; diameter of bore for outer arbor bearings; width of face of pillar and solid angle of edges; distance face extends above spindle center; number, size and spacing of table slots; diameter and thread of drawn-in bolt; and general position and direction of motion of operating handles.

Inter-size and Inter-class Standardization

Thus far my argument has been directed toward standardization within the general limits of a given size of a given kind of machine. We must also consider the advantages of inter-class standardization. Turning to details of design, a 5/8 inch T-slot should have the same dimensions whether it is in a milling machine table, a drilling machine base, a planer platen, in the wings of an engine-lathe carriage, or in the table of a shaping machine.

If there is an advantage in being able to exchange chucks throughout the individual machines of a lathe department, is there not an added advantage if these same chucks can be used on certain sizes of milling machines? To put it a little more concretely, why should not the spindle noses of 16-inch engine lathes and No. 2 milling machines be identical?

Referring to our fifth principle of standardization, should not the space of the holes in the feet of countershaft hangers for countershafts of approximately the same weight and subjected to the same stresses, be uniform without reference to the machines with which they are used? Again, should not the pads for the feet of a 3-horsepower motor to be applied to a lathe be identical with those for a similar 3-horsepower motor to be used on a milling machine?

As another general point, no screw or other part should be tolerated that has a travel of such a length that a hole must be cut in the floor to accommodate it. Machine users cannot countenance the cutting of holes in shop floors, particularly in buildings where the materials of construction are fire resisting.

* * *

SHOP HYGIENE AS A FACTOR IN EFFICIENCY[*]

In shop hygiene we deal first with general conditions such as ventilation, heating, cleanliness, lighting, plumbing, lavatories, and dressing rooms, and second, with special conditions such as good drinking water, shop clothing, machinery guards, and medical and surgical treatment.

Whatever measures are adopted for improving the conditions of labor benefit the business. They are undertaken in a spirit of service—not of charity. It is difficult to conceive of any phrase more unconsciously hypocritical than the common expression, "We have done a great deal for our employes," when the fact is rather: "We have done a great deal to make conditions favorable for profitable work." This spirit of service—and it is truly service of the broadest type—should be recognized by a substitution of the words "industrial service" for "industrial welfare work." It is more brief, accurate, and clear.

In investigating shop conditions among even the most progressive concerns, and taking into consideration not only hygiene and sanitation, but those physical conditions, as well, which affect thought, interest, attention and concentration, we are confronted on every hand by evidence of appalling waste. No one can do his work as well in a stuffy, ill-smelling, uncomfortable room, as he can where the air is fresh and pure, and has the right degree of moisture and heat. Working under bad air conditions fosters inattention, inaccuracy, and neglect. The workman is practically forced into these faults through the physical conditions under which he works, yet he is blamed and criticized and frequently loses his job because of them.

If it is worth while to employ a mill-wright especially to attend to the belts and the transmission of power in general, it is certainly worth while in every shop to appoint a competent and interested man to look after the ventilation, and the temperature and moisture of the air, and also the illumination and cleanliness of the plant. In many shops with the best methods of ventilation, installed at large expense, no one is appointed to see that this expensive apparatus is given the attention necessary to insure comfort to the working force, or else, if this work is in the hands of any particular man, it is likely to be a man selected for the job because he is cheap. This is true even of the better class of plants, and poor ventilation is as frequent in the executive offices as in the work shop.

The relation of temperature to moisture, and the air movement in a room are important factors in the provision of comfortable working conditions. Satisfactory conditions are not determined entirely by the number of cubic feet of fresh air per second brought into the establishment. As a result of careful study made by Mr. Royce W. Gilbert, it may be said, roughly, that the maximum of comfort due to air conditions is a temperature of from 65 to 70 degrees F., accompanied by 50 to 60 per cent humidity, and a draft of air at the rate of from two to five feet per minute.

Methods of cleaning which do not simply move the dirt from one place to another should be adopted. The corn broom, and dry dusters are dust *movers*, not dust *removers*. Dry sweeping is a germ distributor, and should never be permitted in a room where there are human beings. In one shop the employes were kept idle for fifteen minutes before twelve o'clock on Saturday (in order not to have them leave before noon) and during that fifteen minutes vigorous sweeping was going on, filling the air with germ-laden dust carrying colds, bronchitis, pneumonia, diptheria, and consumption, and infecting the workers with less power of resistance.

It cannot be considered good shop practice to be without accommodations where the workers can keep shop clothing or change and dry their wet foot-gear. Due to investigations undertaken during the last six months, it has been found that a large percentage of sickness is caused through the workers' taking cold by being obliged to work in rain-soaked garments, or by going out-doors in clothing that they have worn all day in the shop. This is not only true of women workers, but also of men.

Under the general head of sanitation and hygiene naturally would come the consideration of dressing-rooms, lavatories, and plumbing. All up-to-date shops have individual lockers for the workmen. The preferable form is the locker closed on the sides with solid partitions, but with perforated metal doors throughout the whole length of the front for inspection and cleanliness. The trend in the best organized shops is toward individual wash-basins; they increase the self-respect of the workmen and help to attract a better class of labor.

* * *

The situation in the shipbuilding industry has recently undergone a marked and gratifying change for the better. The great shipyards like the Newport News Ship Building & Dry Dock Co., Newport News, Va., the Maryland Steel Co., Sparrows Point, Md., the New York Ship Building Co., Camden, N. J., and others have so much work on hand that they can scarcely lay another keel for from twelve to eighteen months, and it looks as if prosperity had come to stay.

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[*] Extracts from a paper by Dr. Winthrop Talbot, read before the convention of the National Machine Tool Builders' Association, New York, October 10, 1911.

THE USE OF MAGNALIUM IN AERONAUTIC MOTORS*

The heaviest part of a flying machine is the power plant, and, therefore, the efforts made toward reducing its weight have been mainly centered upon reducing the weight of the motor. Aluminum or aluminum alloys have been used wherever it was possible to substitute these alloys for heavier metals, such as iron. The latest method of reducing the weight has been by the successful use of magnalium, an aluminum alloy, for the cylinders. The attempt to use aluminum or aluminum alloys for gasoline engine cylinders is not new, but for years it has been unsuccessful. It was not possible to get castings of aluminum that were dense enough to hold the pressure immediately following the explosion in the cylinder, because castings of aluminum are of a porous nature, although the pores may be very small. An aluminum casting will crystallize under constant pounding or vibration, and in a short time become brittle. Therefore, if such castings were used in a cylinder, the constant blows caused by the explosions would soon make the cylinder very brittle, and it would finally crack. Another objection to aluminum was that the metal would not wear, and for many years cast iron or steel seemed to be the only metal that could be successfully used in cylinders.

Attempts have been made to cast cylinders of aluminum, using a cast-iron sleeve to take the wear and to hold the pressure of the gas. This in some instances proved unsuccessful because of the difference of expansion between the two metals. The only method of casting an aluminum cylinder with a cast-iron liner successfully seems to be to heat the liner with a torch or in a furnace, and then to pour the aluminum rather cold; pouring aluminum cold, however, was never calculated to bring about the best results in the castings.

Within the last year magnalium, which is manufactured in Germany, and which is composed principally of aluminum alloyed with a small proportion of magnesium, has been successfully used for aeroplane engine cylinders. The metal is not only lighter than aluminum castings, but even lighter than pure aluminum, because it contains magnesium. The metal weighs about one-third of what iron weighs. A magnalium cylinder with an iron piston and iron piston rings seems to give better wear than an iron cylinder under the same conditions. After a few hours running, the bore of a magnalium cylinder seems to take on a very high mirror polish, which is similar in appearance to the polish of a high percentage tin alloy bearing metal, which has had a steel shaft running in it for a long time.

An interesting fact in connection with the use of this metal for cylinders is that there are instances on record where a cylinder was not reamed carefully enough, but the engine was assembled and run, and instead of the cylinder being scored, it was the piston and the piston rings which were scored so badly that they had to be replaced after the inside of the cylinder had been burnished. The burnishing of the inside of the cylinder seems to be a very desirable feature in connection with the use of this metal.

Castings of magnalium seem to be much denser than those of any other aluminum alloy and they hold the pressure produced in the cylinder without giving trouble. The metal is much tougher than aluminum. Sometimes in the foundry a core will shift in a casting, and it becomes necessary to break up and remelt the casting. In the case of other aluminum alloys this is very easily done, because one or two blows with the sledge hammer will readily demolish the casting. With magnalium, however, it has been found necessary, in order to break up a casting, to heat it several hundred degrees, and it requires from ten to fifty times the amount of sledging to break it up.

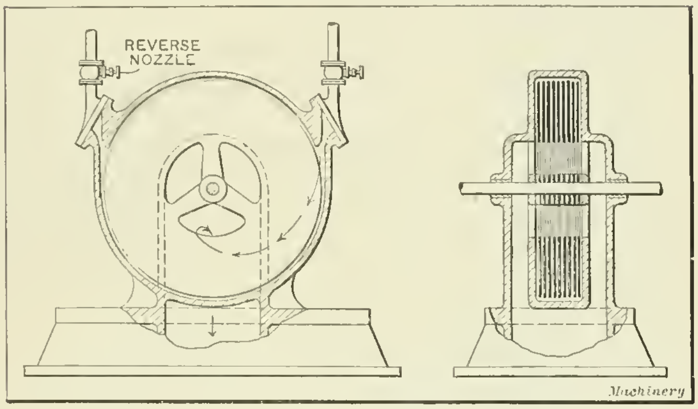
The metal is about 12½ per cent lighter than castings of aluminum, containing 93 per cent aluminum and 7 per cent copper. The metal is also considerably stronger than castings of this alloy. Another interesting fact in connection with the use of this metal in cylinders is that the thermal conductivity of magnalium is from seven to eight times that of iron. This simplifies the cooling problem. On account of the toughness and strength of the metal, it is being used not only for cylinders, but also for crank-cases, water pumps, intake manifolds, and various other parts.

The metal can be given and maintains a high polish, and cylinders of this metal, when finished on the outside, give a motor a very handsome appearance; but most important of all, the use of this metal for cylinders makes a considerable reduction in the weight of the average aeroplane engine, because, as a general rule, the weight of the cylinders is a large proportion of the weight of the motor.

* * *

THE TESLA STEAM TURBINE

Experiments with a novel design of steam turbine have been made by Mr. Nikola Tesla, who is well known in the electrical field on account of the part he has played in the developments in connection with the rotating magnetic field and other alternating current subjects. A diagrammatical section of the Tesla steam turbine is shown in the accompanying illustration. The steam is expanded in a nozzle and the heat energy is thus converted into kinetic energy. The rotor of the steam turbine simply consists of a number of thin flat disks, the inlet for the steam being at the outer periphery of these disks and the outlet being at their center, as indicated. The high velocity steam escaping from the nozzle is caused to impinge tangentially on the edges of the disks, and in order to escape it must find a path from the periphery of the disks to the central outlet. The velocity energy of the steam produces a rotary motion of the disks, due to molecular drag on the surface, and hence the path of the steam from the outside to the inside of the disks will be a spiral one. Expressing the matter in popular terms, we may say that the action is due simply to the friction of the steam against the sides of the disks as the steam moves from the outside periphery to the center along a spiral path.



Diagrammatical Sections of the Tesla Steam Turbine

The arrangement shown in the illustration permits of easy and convenient reversal, as it is only necessary to provide a duplicate nozzle discharging against the opposite side of the disks as indicated. When the machine is at rest, or is running slowly, as in starting, the steam takes the shortest path from nozzle to exhaust, and thus develops a comparatively large torque. As the machine speeds up, the difference in velocity between the steam and the disks decreases, and the centrifugal force tends to lengthen the spiral path of the steam, so that a given amount of steam may make several revolutions with the disks before finally passing out through the exhaust opening.

A turbine of this type has been tested at the Waterside Station of the New York Edison Co. The rotor of the tested turbine has 25 disks, each 18 inches in diameter. The assembled turbine occupies a floor space of 20 by 35 inches and is about 5 feet high, completely installed. With steam at 125 pounds gage pressure per square inch exhausting into the atmosphere, 200 horsepower was developed with a speed of 9000 R. P. M. The steam consumption was 38 pounds per horsepower-hour. The weight of the turbine is 400 pounds, giving a unit weight of only 2 pounds per horsepower. While the steam consumption at present is rather high, Mr. Tesla believes that with moderate superheat and a degree of vacuum the same as that ordinarily used in a turbine plant, the steam consumption can be reduced materially.

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*See MACHINERY, April, 1911, engineering edition, "Light-weight Alloys for Aerial Engines and Aeroplanes"; January, 1911, engineering edition, "Light Alloys for Airship Construction"; July, 1908, engineering edition, "Magnalium."

The principle employed is not limited to steam turbines. It can be applied as well to a type of centrifugal pump, having a series of smooth flat disks revolving in a casing, these disks having no vanes or other impelling projections. The motion of the water is produced simply by the friction or molecular adhesion between the disks and the fluid. In this case the fluid is, of course, taken in at the center of the disks and forced along a spiral path to the outside periphery.

* * *

PRIME FACTORS OF NUMBERS

To determine the prime factors of a given number, if it have any other than itself and unity, seems to have been one of the first problems to attract the attention of mathematicians. From the days of Eratosthenes, the inventor of factor tables, to the present time the interest in the problem has never flagged. In spite of the fact that in the nature of things a complete solution is hardly to be expected, scarcely a year passes in which some new device for finding the factors of a given number is not published. The net result of all these centuries of effort is perhaps insignificant. The examination of a number beyond the reach of tables, even with the most efficient methods, is still a tedious and difficult task. The list of primes above 10,000,000 with the exception of a few of special form, must be considered as practically unknown. The highest prime so far identified is $2^{61}-1$, a number containing nineteen digits.—*Extract from Preface of Factor Table for the First* 10,000,000 *by D. N. Lehmer, Publication, No.* 105 *of the Carnegie Institution of Washington,* 1909.

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TRAINING TECHNICAL GRADUATES AT THE WESTINGHOUSE WORKS

In a paper presented before the annual convention of the Society for the Promotion of Engineering Education, at Pittsburg, Pa., June, 1911, by Messrs. C. F. Scott and C. R. Dooley, the method used by the Westinghouse Electric & Mfg. Co., for adapting technical graduates to the industries, was described. The two-year special apprentice course for technical graduates which was adopted by the company several years ago has been modified to a certain extent, principally by supplementing the factory and testing-room experience with actual class-room instruction, and by specializing the training during the latter part of the course so as to adapt it to the particular work which the young engineer expects to follow later.

For the last ten or fifteen years the Westinghouse Co. has received annually several hundred technical graduates who have been regularly employed in the factories. During this course the young men were formerly transferred from department to department, gaining a general knowledge of the construction in use in electrical apparatus and of business methods. Little was done, however, in the way of systematic instruction bearing directly on factory and office work. It has been found, however, that for several reasons a modification of this plan is a step towards more thorough training. One of these reasons is that electrical apparatus is at the present time of so many kinds and so specialized that ordinary shop work will not give the student sufficient instruction. His point of view is apt to be that of the workman who only knows the construction of the coil he winds or the arc lamp he assembles, but who does not appreciate why the apparatus is made as it is in order to be reliable, efficient and durable. The time available in the various departments in the factory is too short to enable the student to cover the whole ground thoroughly and, therefore, is likely to be superficial, if too many departments are included.

For these reasons, the new special apprentice course includes two periods, of which the first is given over to general training in the factory confined to a few departments, and the second is a special course fitting the men for the engineering, sales or other departments. The work is supplemented by class-room instruction during working hours for about four hours a week. Six hours per week outside of the regular working hours are also required to be devoted to assigned reading or study, or technical meetings. The technical instruction supplements directly the work of the factory. Men who are working on a particular kind of apparatus have an instruction period devoted to it each week. Books or appropriate articles on the subject are assigned for reading, and a list of questions is given to the students to be answered.

The experience during this first period places both the young man and the company in a position to make an intelligent selection of the department for which he is best fitted, and in the second period he is trained especially for the engineering, sales or other departments. That these methods of training are a valuable addition to the regular college work is evident, and it is to be regretted that it is possible only for very large concerns to thus systematically educate men for positions in the mechanical and electrical engineering field.

* * *

PERSONALS

George S. Delaney, general superintendent of the Stevens-Duryea Co., Chicopee Falls, Mass., has resigned his position after being six years in the company's employ.

Theodore Brown, for the past ten years mechanical engineer with the Richardson Mfg. Co., Worcester, Mass., has resigned to become shop manager of the Harvesting Machinery Co., East Moline, Ill.

Erik Oberg, associate editor of MACHINERY, read a paper on "The Prevention of Accidents in the Industries," before the American Society of Swedish Engineers, Brooklyn, N. Y., October 21.

J. Cecil Nuckols, for the past seven years advertising manager of the S. Obermayer Co., Cincinnati, Ohio, has resigned to become advertising and sales manager of the Otis Hidden Co., Louisville, Ky.

Halsted Little, for many years associated with the sales department of Manning, Maxwell & Moore, Inc., has been appointed Eastern sales agent for the Detroit Twist Drill Co., with offices at 30 Church St., Room 604, New York.

Prof. H. B. Smith, professor of electrical engineering at the Worcester Polytechnic Institute, has been granted a two-years leave of absence for study and travel. He sailed in September for Europe where he expects to spend the time.

F. J. McGrail, formerly of the H. R. Worthington Co., Harrison, N. J., and for the past two and one-half years foundry superintendent of the Struthers-Wells Co., Warren, Pa., has resigned to become foundry superintendent for the Erie Foundry Co., Erie, Pa.

C. R. Vincent, for several years president of the Ball & Wood Co., Elizabethport, N. J., has assumed the managership of the monel metal department of the Ruggles-Coles Engineering Co., 50 Church St., New York, general agents for the Bayonne Casting Co.

Einar Morin, well-known to the readers of MACHINERY as the author of the series of articles "Jigs and Fixtures" published in MACHINERY some years ago, has been made superintendent of the works of Vagn & Maskinfabriks Aktiebolaget, Falun, Sweden, builders of locomotives and railway cars.

Claude E. Cox, factory manager of the H. E. Wilcox Motor Car Co., Minneapolis, Minn., has resigned to become resident manager of the engineering laboratories of the General Electric Co., Detroit, Mich., which are being conducted by Arthur D. Little, Inc., Boston, Mass. Mr. Cox is the designer of the "Overland" and "Interstate" cars, and brings to his new connection an intimate knowledge of motor car construction.

* * *

OBITUARIES

Charles Koegel, senior member of Charles Koegel & Son, Holyoke, Mass., manufacturer of paper machinery, died at his home in Holyoke recently.

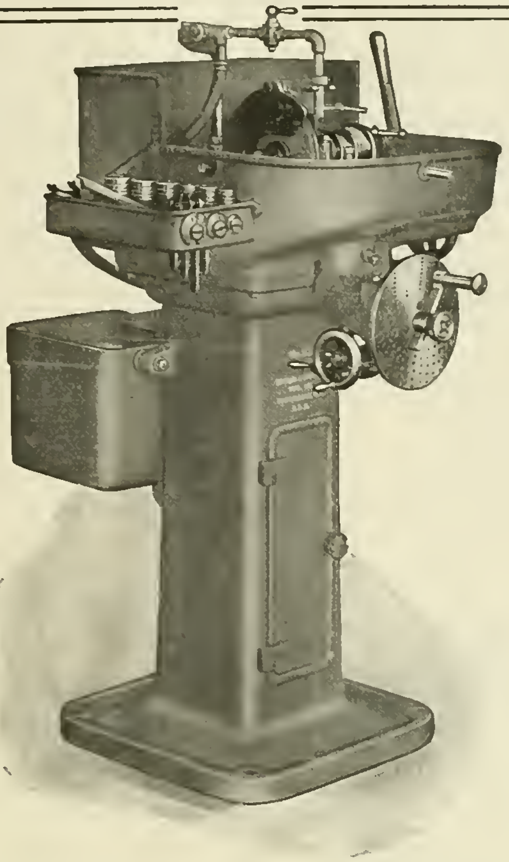
Robert Mather, chairman of the board of directors of the Westinghouse Electric & Mfg. Co., Pittsburg, Pa., died of peritonitis at his home in New York, October 24, aged fifty-two years.

John Souther died at his home in Newton, Mass., September 12. Mr. Souther established the Globe Locomotive Works in 1831 in South Boston. During the Civil War he built the machinery and iron work for sixteen war vessels. He was the inventor of the automatic sprinkler for fire protection and invented machinery for making ice. He retired from active work in 1881.

C. Franklin Weiler, secretary and treasurer of the Cortland Corundum Wheel Co., Cortland, N. Y., died at Saranac Lake, Sunday, September 17, of tuberculosis, after an illness of about two years, aged thirty-nine years. Mr. Weiler became associated with the company at its organization in March,

The indexing mechanism, which accurately spaces the teeth, is an exclusive feature of this machine

Grinds
Cutter
Teeth
Radial



Grinds
Cutter
Teeth
Equidistant

No. 23 GEAR CUTTER GRINDING MACHINE

All formed cutters, especially gear cutters, must be ground with the teeth equidistant, or one or two teeth will do all the work bringing extra strain on them and so weakening the cutter.

This machine grinds the teeth equidistant because of the accurate indexing mechanism, located on the front of the machine within instant reach of the operator.

An index plate providing for all numbers of teeth from 5 to 18, a graduated sector arm and a fine adjustment by means of the small hand wheel insure accuracy.

We will be glad to send you a circular describing this machine fully.

BROWN & SHARPE MFG. CO.
PROVIDENCE, RHODE ISLAND, U. S. A.

1902, and by close attention to the growing needs of the company gradually worked his way up until elected to the position he held at his death. The funeral services were held at his late home in Cortland on Friday, September 22.

* * *

COMING EVENTS

November 2-4.—Annual meeting of the International Society for the Promotion of Industrial Education, Cincinnati, Ohio. R. T. Davis, secretary, 18 W. 44th St., New York.

December 5-8. Annual meeting of the American Society of Mechanical Engineers in New York. Calvin W. Rice, secretary, 29 West 39th St.

December 5-8.—Annual meeting of the National Gas and Gasoline Engine Trades Association at the Hotel Hollenden, Cleveland, Ohio. An exhibit of accessories will be an important feature of the convention. Albert Stritmatter, secretary, 224 E. Seventh St., Cincinnati, Ohio.

January 18-20, 1912.—Annual meeting of the Society of Automobile Engineers in New York. Coker F. Clarkson, general manager, 1451 Broadway, New York.

September 2-7, 1912.—Sixth Congress of the International Association for Testing Materials at the Engineering Societies Building, 29 W. 39th St., New York. One of the important functions of this association is to establish standard specifications for materials used in manufacture and construction. The cooperation of engineers and others who are engaged in the purchase and use of the raw materials of the trades, is requested. The annual dues are $2, with no initiation fee. Mr. H. F. J. Porter, secretary, 1 Madison Ave., New York.

SOCIETIES AND COLLEGES

American Museum of Safety, 29 W. 39th St., New York. Safety leaflet No. 1 on presses and punches, illustrating safety devices for preventing the maiming of operators.

American Railway Tool Foremen's Association. Official proceedings of the third annual convention, Chicago, Ill., July 11-13, 1911. Mr. H. Bray, secretary and treasurer, N. Y., N. H. & H. R. R., New Haven, Conn.

University of Pittsburg, Pittsburg, Pa., through its department of industrial research, under the direction of Prof. Robert Kennedy Duncan, is undertaking a scientific study of the problem of smoke prevention in all its various phases. The study will extend over a period of at least two years and as much longer as is deemed necessary to accomplish the end in view. Because of the great importance of the subject and the wide field to be covered, Prof. Duncan is desirous of being put in touch with people who are working along these lines.

Williamson Free School of Mechanical Trades, Williamson School Post Office, Delaware Co., Pa. Bulletin No. 9 containing standing of the classes of 1910 and 1911. The class of 1910, consisting of fifty-one members, was graduated on March 26, and within six months after graduation the members were earning an average of $16.60 per week. Eighteen months after graduation the general average was $18.05. The class of 1911 consisted of sixty-five members, graduated on March 25. Six months after graduation the average was $15.57, notwithstanding the depression of business.

American Museum of Safety, 29 W. 39th St., New York. Catalogue of exhibits in the museum. These comprise full-size apparatus models and working models of a great variety of apparatus; photographs, drawings and blueprints of safety devices; library reports and publications. The list of exhibitors comprises one hundred and sixty-one well-known concerns. The museum is non-commercial, and is not a show-room for patented safety devices. It has a special charter from the state of New York. It is the aim of the promoters of the museum to show only those means and methods of accident prevention that are sanctioned by practical use and the advice of competent engineers.

Wentworth Institute, Boston, Mass. Catalogue 1911-12. This new institution for industrial education was founded by Arioch Wentworth "for the purpose of furnishing education in the mechanical arts." The catalogue is illustrated with views showing the shop equipment, and students at work. Day classes are provided for carpentry and building, patternmaking, machine work, foundry practice, electric wiring, plumbing, machine construction and tool design, electrical construction and operation; and evening classes in carpentry and building, patternmaking, machine work, tool-making, foundry practice, electric wiring, and plumbing. Evening technical courses are: practical mathematics, mechanical drawing, machine design practical mechanics, strength and properties of materials, the steam engine and the operation of power plants, applied electricity, and electrical machinery.

Lewis Institute, Chicago, Ill., has just issued a schedule of continuation courses which will be given evenings and Saturdays, beginning October 9, 1911. The schedule includes engineering, chemistry, physics, mathematics, drawing, languages, and household arts. The courses are arranged so that they can be taken independently or in connection with regular college work or in series to form a logical development of the subject. In general, the courses are designed to afford those who are employed an opportunity to continue their vocational studies. Of the total enrollment of 3200 during the past season, over 1800 were enrolled in the continuation classes. The engineering series includes: Engineering principles; electrical measurements; direct-current machinery; rotary convertors in sub-station work; alternating-current principles; transformers and transmission lines; alternating-current motors, and generators; steam engine testing; internal combustion engine; structural steel design; concrete reinforced. The mechanic arts series includes: Mechanical and architectural drawing; machinery drawing; machine design; lathe and milling machine work; tool and die making; pattern making; foundry and forge work.

NEW BOOKS AND PAMPHLETS

Tests of Nickel-Steel Riveted Joints. By Arthur N. Talbot and Herbert F. Moore. 53 pages, 6 by 9 inches. 22 illustrations and diagrams. Published by the University of Illinois, Urbana, Ill., as Bulletin No. 49.

This bulletin gives the results of tests for slip and strength of 106 nickel-steel riveted joints and 70 chrome-nickel-steel joints. The tests of nickel-steel joints were undertaken at the request of the board of engineers of the Quebec Bridge, and those of chrome-nickel-steel joints at the request of the Pennsylvania Steel Co. The tests were made in tension and in alternated tension and compression. It was found that noticeable slip of rivet occurred at loads within the ordinary working stress and that the slip was much greater under loads alternated in direction than under tests in one direction only. The slip of joints seemed to depend upon the workmanship rather than on the material. The nickel-steel and the chrome-nickel-steel joints showed higher ultimate strength and much higher resistance to bending of the rivets than the joints of ordinary structural steel. The conclusion to be drawn seemed to be that in rivet joints designed on the basis of ultimate strength, the use of rivets and plates of nickel-steel may be of advantage, but that in riveted joints designed on the basis of frictional hold for rivets against slip, there is little advantage in using special rivets of great strength.

CATALOGUES AND CIRCULARS

Gisholt Machine Co., Madison, Wis. Leaflet illustrating installations of boring mills.

Gilbert & Barker Mfg. Co., Springfield, Mass. Folder illustrating a Gilbert & Barker oil fuel furnace.

D. M. Watkins & Co., 95 Pine St., Providence, R. I. Card illustrating Watkin's automatic safety attachment for drop hammers.

Green Fuel Economizer Co., Matteawan, N. Y. Samples of Green's temperature pendants for determining the temperature of flue gases.

Westinghouse Electric & Mfg. Co., Pittsburg, Pa. Leaflet No. 2371 treats of Type Q engine-driven direct-current interpole generators manufactured by the company.

Lutter & Gies Co., Milwaukee, Wis. Circular of Milwaukee wet tool grinder with motor drive. The water in this grinder is applied on the wheel when grinding, by an air jet.

American Foundry Co., Leipsic, Ohio. Circular of the "Buckeye" electric breast drill for either alternating current or direct current. These drills are reversible and can be used for tapping.

General Electric Co., Schenectady, N. Y. Bulletin No. 4873 on "Control Apparatus for Steel Mills," describing automatic compensators, contactors, master controllers, rheostatic controllers, etc.

Joseph Dixon Crucible Co., Jersey City, N. J. Card giving the melting points of metals and their specific gravities. The melting points are given in both the Centigrade and Fahrenheit scales.

Erie Forge Co., Erie, Pa. Photograph of a metal scrap yard, the purpose of which is to show the character of the scrap used in the company's manufacture of open-hearth steel, which is especially low in phosphorus and sulphur.

Garvin Machine Co., Spring & Varick Sts., New York. Circulars of the Garvin plain milling machine No. 2-A; vertical milling machine No. 22; rapid screw-slotting machine; plain milling machines Nos. 13 and 13½, and cutter and surface grinders.

Richardson-Phenix Co., Milwaukee, Wis. Treatise on the Richardson system of lubrication illustrating applications to Corliss engines and gas engines, and showing the filters, oil pump, sight feed oilers, and other apparatus forming parts of the system.

Makutchan Roller Bearing Co., Hobart, Ind. Circular of the Makutchan roller bearings for lineshafts, etc. Makutchan bearings are provided with double tapered rollers having a groove in the center which engages a rib in the bearing that keeps the rollers in alignment.

Standard Roller Bearing Co., Philadelphia, Pa. Bulletin No. 26 on the application of roller bearings to car journals, illustrated with drawings and halftones. The subject of roller bearings for railway cars is of much general interest, and engineers will find the bulletin of value.

Westinghouse Electric & Mfg. Co., Pittsburg, Pa. Folder No. 4186 illustrating and describing an auxiliary line switch for use on trolley cars equipped with ordinary drum-type controllers. The auxiliary line switch is electro-pneumatically operated, and is mounted underneath the car.

American Swiss File & Tool Co., 24 John St., New York. Interesting pamphlet illustrated in colors entitled: "The True Story of an Industrial Soldier, by a Graduate of the College of Hardnox." This original and interesting piece of literature will well repay perusal. Sent free upon request.

William A. Peck, 141-145 Brewery St., New Haven, Conn. Catalogue of mechanics' tools comprising nail sets, prick punches, wood scrapers, combination calipers and dividers, tap and reamer wrench, screw driver bits, center finder, machinists' jack screw, plumb-bobs, "Midget" screwdrivers, etc.

W. A. Whitney Mfg. Co., Rockford, Ill. Postcard illustrating the Whitney portable band-punch made in two sizes. The No. 1 punch has a capacity to punch a 9/16-inch hole through a 1/4-inch boiler plate, and weighs 21 pounds. The No. 2 punch has a capacity for punching 5/16-inch holes through 1/4-inch iron and weighs 12 pounds.

Brown Hoisting Machinery Co., Cleveland, Ohio. Catalogue of "Brownhoist" locomotive cranes illustrating many applications of the 20-, 15-, and 10-ton types with various equipments of handling devices including grab buckets, lifting magnets, etc. A three-ton locomotive crane is also illustrated, and electric work car cranes of five tons capacity.

National Tube Co., Frick Bldg., Pittsburg, Pa. Bulletin No. 6 on pipe threading dies illustrating the differences between pipe properly and improperly threaded, and showing how pipe dies should be made and set. Information is given on lip, chip space, clearance, lead, number of chasers, oil, etc.; sent on request to all interested in pipe threading.

McCrosky Reamer Co., Meadville, Pa. Catalogue of adjustable reamers, chucks and collets, expanding mandrels, and universal lamp brackets, treating specifically hand reamers, machine reamers, shell reamers, cylinder reamers, "Wizard" quick-change chucks and collets, turret tap holder, taps, "Wizard" variable-speed reversing tapping attachment, expanding mandrels, etc.

Adams-Bagnall Electric Co., Cleveland, Ohio. Catalogue No. 100 on regenerative flame lamps giving specifications for direct-current multiple, alternating-current multiple and direct-current multiple series lamps; also circular on "Abolites" which are provided with a metallic reflector support with a positioning device by which the reflector can be properly set for various lengths of Mazda lamp bases.

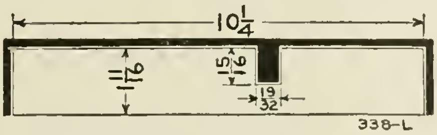
Westinghouse Electric & Mfg. Co., Pittsburg, Pa. Folder No. 4184 illustrating and describing the spider armature construction used by the company, its railway motor brush holders, armatures and axle bearings and unit switch control system, both for 600 and 1200 volts. The comparative advantages of interpole and non-interpole railway motors and all-box frame *vs.* split frame motors are discussed.

Crocker-Wheeler Co., Ampere, N. J. Booklet on induction motors illustrating and describing the Crocker-Wheeler magnetic bridge system of induction motor construction which increases the power factor without reducing the clearance of the rotor. Engineers concerned with electric motor installation will find the booklet of unusual interest and value, it being virtually a little treatise on the characteristics of open and closed slot induction motors.

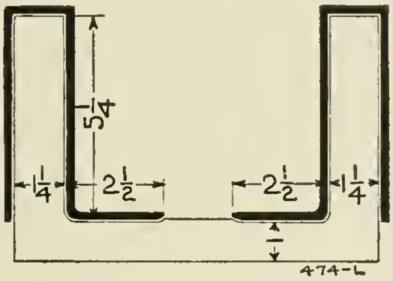
Hisey-Wolf Machine Co., Cincinnati, Ohio. Catalogue of Hisey portable electric machine tools, illustrated with views of the new plant and a large variety of styles of electric tools, comprising tool-post grinders for lathes and planers, bench grinders, pedestal grinders, wet tool grinders, aerial grinders, flexible shaft tools, electric hand or breast drills, screw feed electric drills, portable bench drills, electric Scotch radial drills, glass working tools, etc.

Some Examples of Work done on the

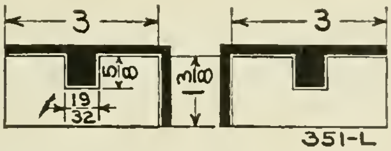
No. 4 Plain High Power Cincinnati Miller



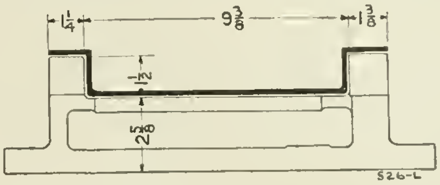
Material, cast iron.
Total width of cut, 13 5-8 inches.
Also one slot, 15-16 inch x 19-32 inch.
Depth of cut, 3-16 inch.
Length of each piece, 14 inches.
Cutters, 8 inch, 3 1-2 inch, 5 3-4 inch diameter.
38 R.P.M., feed 6 1-8 inches per minute.
Total metal removed per minute, 78 cubic inches.
Actual cutting time, 3 minutes per piece.



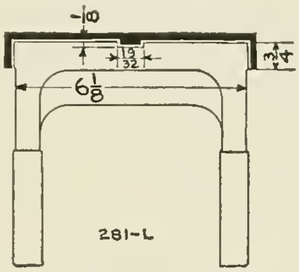
Material, cast iron.
Total width of cut, 23 inches.
Depth of cut, 1-8 inch.
Length of piece, 12 1-2 inches.
Largest cutters, 13 1-2 inch diameter.
14 R.P.M., 4 3-4 inch feed.
Metal removed per minute, 11 1-2 cubic inches.
Eight surfaces milled at one time.
Final finishing cut brings them accurate within .001 inch.
Total time roughing, per piece, 6 minutes.
Actual cutting time, 3.3 minutes.



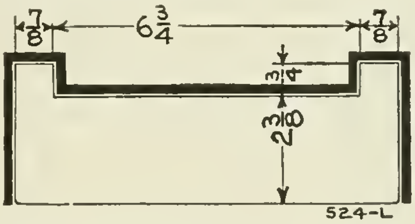
Material, cast iron.
Total width of cut, 8 3-4 inches.
Also two slots, 19-32 inch x 5-8 inch.
Depth of cut, 3-16 inch.
Length of piece, 25 inches.
Cutters, 8 1-4 inches, 4 1-4 inches, 3 inches in diameter.
38 R.P.M., 6 1-8 inch feed.
Metal removed per minute, 15 cubic inches.
Total time, including chucking per piece, 7 minutes.
Actual cutting time, per piece, 2.4 minutes.



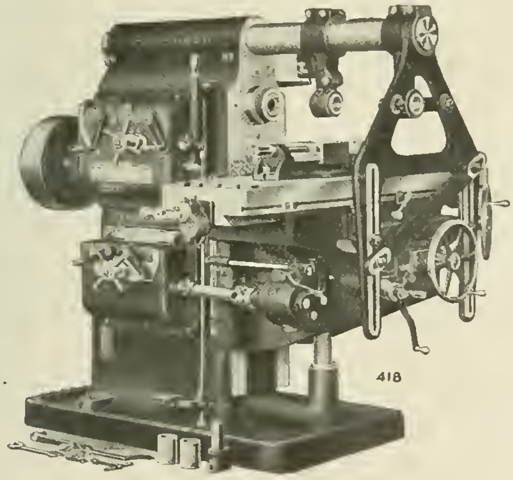
Material, cast iron.
Total width of cut, 15 inches.
Depth of cut, 3-18 inch.
Length of piece, 6 inches.
Largest cutter, 6 inch diameter, 9 3-8 inch face.
32 R.P.M., feed 4 3-4 inches per minute.
Metal removed per minute, 13 1-4 cubic inches.
Actual cutting time, 2 1-2 minutes.
Total time per piece, 4 1-4 minutes.



Material, cast iron.
Total width of cut, 7 5-8 inches.
Also tongue slot, 19-32 inch x 1-6 inch
Length of piece, 6 1-2 inches.
Depth of cut, maximum, 3-18 inch.
Largest cutters, 4 1-2 inch diameter.
45 R.P.M., feed, 7 inches per minute.
Height of work above table, 7 1-2 inches.
Metal removed per minute, 10 1-2 cubic inches.
Actual cutting time, 1.3 minutes.
Total time per piece, 5 minutes.



Material, cast iron.
Total width of cut, 16 3-8 inches.
Depth of cut, maximum, 3-16 inch.
Length of each piece, 6 1-4 inches.
Largest cutter, 10 1-2 inches diameter.
21 R.P.M , 8.3 inch feed.
Metal removed per minute, 19 cubic inches.
Actual cutting time per piece, 1 3-4 minutes.



As compared with all others, our High Power Millers are—

Handier, because all the levers are within easy reach of the operator's usual position. The feed levers always indicate the direction of table travel; the indexes are truly direct-reading, and the treadle facilitates speed changing.

More rigid, because they are designed on the box section principle throughout.

More durable, because all driving gears are steel, and those most used for speed changing are nickel steel and hardened. All iron castings are now made in our own foundry and are of the highest quality.

The Cincinnati Milling Machine Co., Cincinnati, Ohio, U. S. A.

EUROPEAN AGENTS—Alfred H. Schutte, Cologne, Brussels, Milan, Paris and Barcelona. Donauwerk Ernst Krause & Co., Vienna, Budapest, Prague and Berlin. Chas. Churchill & Co., London, Birmingham, Manchester, Newcastle-on-Tyne and Glasgow. CANADA AGENT—H. W. Petrie, Limited, Toronto, Montreal and Vancouver. AUSTRALIA AGENTS—Thos. McPherson & Son, Melbourne. JAPAN AGENTS—Andrews & George, Yokohama. CUBA AGENT—Adolfo B. Horn, Havana. ARGENTINE AGENTS—Adolfo Mantels & Co., Buenos Ayres.

Ingersoll-Rand Co., 11 Broadway, New York. Bulletin No. 3210 of twelve pages, describing class NE-1 power-driven single-stage straight-line air compressors. This compressor is of the type consisting of an air cylinder supported by a main frame with a piston, operated by a center crankshaft having the belt wheel on one side and the flywheel on the other. The shaft and wheels can be reversed in the bearings, if it is preferred to have the belt wheel on the opposite side.

Bristol Co., Waterbury, Conn. Condensed catalogue No. 160 on Bristol's recording instruments for pressure, temperature, electricity, time, etc. The usefulness of recording instruments has been enhanced by the improvements made in the past few years; the range of instruments now available covers practically every phase of engineering development. The catalogue should prove of value and interest to superintendents, general managers, engineers, and others concerned with the economical production and use of power, etc.

Ingersoll-Rand Co., 11 Broadway, N. Y. Bulletin No. 3007 containing twenty-four pages of descriptive matter on class "PB" power-driven air compressors, duplex type with air cylinders close coupled to the frame, and a central driving wheel. The catalogue shows several views of machines and gives tables of sizes and capacities. The distinctive features of the design are massive, powerful construction, simplicity and reserve power. Automatic control of the air pressure and regulation of output to load are provided for by governing devices.

General Electric Co., Schenectady, N. Y. Bulletin No. 4878 on cloth pinions. This new form of machine element is offered for a wide variety of applications in power transmissions where, because of noise or for other reasons, metallic gears are impractical or unde- le. The advantages claimed for the cloth pinions are: great strength, noiseless operation, freedom from damage by exposure pness, temperature changes, and vermin, elasticity of teeth, rication and long life. They are made in various styles and sizes some of which are illustrated.

Ingersoll-Rand Co., 11 Broadway, New York. Form No. 3109 illustrating and describing class NF-1 steam-driven single-stage straight-line air compressors. These compressors are of the twin flywheel, center crank, enclosed type, with steam and air cylinders arranged in tandem. The catalogue shows several views of the machine in section and gives tables of cylinder diameters, capacities and dimensions. Air inlet valves on the smaller machines are of the "direct lift" type and on the larger machines of the "hurricane inlet" type. "Cushioned direct lift" discharge valves are standard on all sizes.

Green Fuel Economizer Co., Matteawan, N. Y. Ninety-four page treatise on the hot blast system of heating and ventilating, containing valuable information for engineers and others concerned with the heating and ventilating of shops, mills, factories, etc. It contains data on temperature required in rooms for various purposes; heat transmission through building materials; heat given off by occupants and lights; standard sizes of hot blast heaters; loss of head by friction in air pipes; total weight of saturated air in pounds per cubic feet; humidities of different temperatures in the United States, etc.

Diamond Chain & Mfg. Co., 240 W. Georgia St., Indianapolis, Ind. "Power Chains and Sprockets," a treatise by Lucius M. Wainwright, president of the company. The treatise is illustrated with views showing applications of chain transmission and the manufacture of chains in the Diamond Chain & Mfg. Co.'s plant. Guards for encasing transmission chain on automobiles and auto-trucks are of suggestive value to designers, as are also the many illustrations of chain transmission applications. The treatise concludes with a catalogue of the Diamond chains which are made in a great variety of sizes and styles.

Windsor Machine Co., Windsor, Vt. Catalogue and treatise on Gridley automatic multiple spindle, single spindle and semi-automatic turret machines. Few users of turret machinery know that the credit of being the birthplace of the first commercially successful turret machine belongs to Windsor, Vt. About sixty years ago, Mr. H. D. Stone and a few associates began the manufacture of turret machines in Windsor and they have been built there continuously ever since. The various types of Gridley automatics are illustrated and details of construction and principles of operation are fully described. Users of automatic machinery, and possible users, will find this work of much interest and value.

Gardner Machine Co., Beloit, Wis. Folder entitled, "A Shop Sensation," illustrating the use of the Gardner disk grinder for finishing cast-iron box caps. These caps, weighing 23 pounds and having a surface area of 36 inches when made in the ordinary way, constitute a milling machine job, there being about ⅛-inch stock to remove. When the pattern is changed as recommended, the surface area to be machined is reduced to 17 square inches and the amount to be removed to about 1/64 inch. The milling machine proposition means ten finished pieces per hour; the grinding proposition, sixty pieces per hour: hence a large saving on the investment in the machines, as well as economy in cast iron and time is effected by the disk grinder.

Electric Controller & Mfg. Co., Cleveland, Ohio. Bulletins, Numbers 1001, 1002, 1003, 1004, 1005, 1006, 1007, 1008, 1010, 1011, 1012, 1013, 1014, 1015 on type B limit switch; alternating current controllers; type Q brakes; type G controllers; type S crane switchboard; form H dynamic breaking Dinkey controllers; type E. C. & M. automatic float switch; type E. C. & M. automatic pressure regulator; type E. C. & M. automatic motor starter, form A; type E. C. & M. automatic motor starter, form AK; type E. C. & M. automatic motor starter, form AS; type E. C. & M. automatic motor starter, form ASK; type E. C. & M. automatic motor starter, form ASB; type E. C. & M. automatic starter, form ASBK, respectively.

Gould & Eberhardt, Newark, N. J. Handy pocket device for determining the revolutions per minute of carbon-steel and high-speed steel milling cutters cutting cast iron or steel. The device consists of a celluloid envelope with openings and a card carrying a table of cutter diameters, revolutions and speeds in feet per minute. The card, being pulled out of the envelope, shows cutter diameters and work speeds successively, through the openings, for cutters, from 2 to 7½ inches diameter. The opposite side of the card carries a table of tooth parts, and openings in the envelope provide convenient means of determining the equivalent circular pitch, thickness on pitch line, addendum and total depth of teeth of diametral pitch gears.

Union Twist Drill Co., Athol, Mass. Catalogue F or book of information on twist drills, gearing and milling cutters, containing 262 pages of data of value to machine shop managers, superintendents, foremen and machinists. An idea of the scope of the catalogue is given in the following partial list of subjects: Standard keyways, milling cutters, face mills, involute cutters for gears, formulas for gears, epicycloidal gear cutters, cutters for miter and bevel gears, sprocket wheel cutters, formulas for sprocket wheels, worm hobs, generating hobs, form cutters, convex and circular cornering cutters, reamer fluting cutters, end mills, metal slitting saws, screw slotting cutters, sharpening cutters, twist drills, grinding drills, table of cutting speeds, English-Metric conversion table, decimal equivalent of listed sizes, tap drill table, formulas for 29-degree and U. S. standard screw threads, wire tables, wire gage tables, weights and other useful data.

R. K. LeBlond Machine Tool Co., Cincinnati, Ohio. Catalogue of LeBlond lathes, comprising regular stud lathes, 14- to 20-inch swing, regular standard engine lathe 14- to 24-inch swing; regular quick change engine lathe 12- to 24-inch swing; heavy-duty manufacturers' automobile lathe, 17- to 21-inch swing; heavy-duty standard engine lathe 25- to 33-inch swing; heavy-duty quick change engine lathe, 25- to 33-inch swing; heavy-duty quick change sliding bed gap lathe 19-38- and 25-50-inch swing; regular plain chucking lathe, 14- to 24-inch swing; heavy-duty quick change combination turret lathe, 17- to 33-inch swing; heavy-duty quick change special turret lathe, 17- to 33-inch swing. The catalogue is handsomely illustrated and the description of features leaves little to be desired. The arrangement of matter and cuts is lengthways of the page, making a neat and attractive appearance. A feature for special accommodation is the elevation drawing of countershafts and plan of lathe with tabulation of dimensions. This data is indispensable for customers. It is a feature that all machine tool builders should incorporate in their catalogues. ,

TRADE NOTES

L. S. Starrett Co., Athol, Mass., has issued a statement regarding the discontinuance of its use of the union label.

Hudson Export & Import Co., 91-93 Wall St., New York, is now sole agent in the United States for the RBF ball bearings.

Buffalo Copper & Brass Rolling Mill Co., Buffalo, N. Y., has opened a New York office at 1216 Flatiron Bldg., in charge of Mr. James E. Barkley.

Ready Tool Co., Bridgeport, Conn., has purchased the business of the M. B. Hill Mfg. Co., Worcester, Mass., manufacturer of a line of milling machines and lathe dogs.

Mumford Molding Machine Co., Plainfield, N. J., has appointed Mr. James T. Lee, formerly of the Hanna Engineering Works, as its Chicago representative. Mr. Lee's address is 2059 Elston Ave., Chicago, Ill.

Ruggles-Coles Engineering Co., New York, general agent for the Bayonne Casting Co., Bayonne, N. J., has received an order from Pusey & Jones Co., Wilmington, Del., for two 66-inch propellers cast of monel metal for a large private yacht.

Wiener Machinery Co., 50 Church St., New York is the representative of Ernst Schiess, Ltd., of Düsseldorf, Germany. See another part of this number, engineering edition, for illustrated account of the activities of some Düsseldorf engineering concerns.

Ames Plow Co., has built a new shop building at Framingham, Mass., and will remove its entire plant from Worcester to that place during December. The firm, first known as the Joel Nourse Co., which was founded in 1825, builds a large line of agricultural tools and machines.

Western Tool & Mfg. Co., Springfield, Ohio, manufacturer of "Champion" tool-holders, expanding mandrels, "Challenge" hacksaws, shop furniture, etc., has built an addition to its shops which will be equipped with new tools for the manufacture of metallic machine shop furniture.

Brown Hoisting Machinery Co., Cleveland, Ohio, has opened offices in Chicago and San Francisco. The Chicago office is in the Commercial National Bank Bldg., and Mr. A. M. Merryweather is the manager. The San Francisco office is in the Monadnock Bldg., and Mr. J. P. Cuse is the manager.

Kelly Reamer Co., 1555-1557 Columbus Road, Cleveland, Ohio, has recently opened offices in New York, Boston and London. The New York office is at 96 and 98 Reade St., the Boston office at 170 Oliver St., and the London office at 112 Queen Victoria St. The company reports an unusual demand for its product and indications of increasing business for the winter months.

Mesta Machine Co., Pittsburg, Pa., has received an order from the Sistersville Electric Light & Power Co., Sistersville, W. Va., for a 20-inch by 24-inch twin tandem, horizontal double-acting, four-cycle gas engine. The engine will operate with natural gas, and will drive direct a 650-kilowatt, 60-cycle, 2300-volt railway generator. The engine is rated at 1000 horsepower.

Hess-Bright Mfg. Co., Philadelphia, Pa., maker of ball bearings, announces that it has received word from the Deutsche Waffen und Munitionstabriken, for which the company is importer, that the DWF bearings have just been awarded the "Gran Premio" at the International Industrial and Trade Exhibition of Turin, this being the highest distinction.

Peerless Gear Tester Mfg. Co., Cleveland, Ohio, was recently organized with a capital of $50,000, by Worthington Hoyt, L. H. Mesker, W. B. Hale, R. L. Matthews and A. W. Kilbourne, to manufacture a gear tester invented by R. L. Swartz. The tester gives a reading in thousandths of an inch, in the variation of the pitch diameter, concentricity and thickness of teeth in both bevel and spur gears.

Machinery has opened its own offices for circulation work and the sale of its reference books at 27 Chancery Lane, London, W. C., England, where files of this journal and a complete stock of reference books will be carried. The circulation work for Great Britain will be handled from the London office in future. Messrs. Wm. Dawson & Sons, Ltd., will continue to receive subscriptions through the book and news trade.

International Motor Co., 30 Church St., New York, is an organization recently formed for selling motor trucks and furnishing service to owners. It is incorporated under the Delaware laws and capitalized at $10,000,000. The manufacturing will be carried on at the Saurer motor truck plant at Plainfield, N. J., and the Mack Bros. plant at Allentown, Pa. A combined output of 2000 trucks from the two factories is planned for the coming fiscal year.

Titanium Alloy Mfg. Co., 1225 Oliver Bldg., Pittsburg, Pa., calls attention to statistics issued by the American Iron & Steel Association, 1911, in which it is shown that titanium is the greatest of all cleansers or deoxidizers for steel. The statistics show that the tonnage of steel treated with various alloys during 1910 was: Titanium steel, 326,316 gross tons; nickel steel, 106,707; nickel-chrome steel, 52,021; chrome steel, 23,550; manganese steel, 19,360; vanadium steel, 9049; other alloy steels, 30,816; total, 567,819 gross tons.

Hetherington & Berner, Indianapolis, Ind., have completed the shops of their new plant consisting of a strictly modern machine shop, gray iron foundry, structural steel and sheet-iron shop, power house, and office building. The structures provide 65,000 square feet of floor space. The entire property consists of about four acres and s provided with 1000 or more feet of switches. The company builds asphalt paving machinery, centrifugal pumps, tile presses, special machinery, and makes structural steel work, and foundry work.

Oeking Co., 50 Church St., New York, has been incorporated to sell punching and shearing machines manufactured by the Stahlwerk Oeking of Düsseldorf. A large stock of machines will soon be on hand for prompt deliveries in Jersey City, where spacious warehouse facilities have been provided. The management of the Oeking Co. is in the hands of the Wiener Machinery Co., which has made a specialty of importing similar machines. The German Oeking works employs about 1000 men and is said to be the only manufacturer that does not depend for its steel castings upon outside steel foundries. Its steel works has a capacity of about 15,000 tons annually of steel castings which are used in its machinery department.

Supplement to MA

Tables for Article in this numbe

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MILLING RADIAL TEETH IN CUTTER BLANKS—V

Angle of Milling Cutter in Degrees	Number of Teeth in Cutter Blank	Width of Land, Radius = 1	Depth of Cut, Radius = 1	Angle of Elevation of Head	Number of Teeth in Cutter Blank	Width of Land, Radius = 1	Depth of Cut, Radius = 1	Angle of Elevation of Head	Number of Teeth in Cutter Blank	Width of Land, Radius = 1	Depth of Cut, Radius = 1	Angle of Elevation of Head
50	30	0.0150	0.1655	79° 44′	32	0.0150	0.1540	80° 24′	34	0.0150	0.1440	80° 59′
		0.0200	0.1612			0.0200	0.1498			0.0200	0.1397	
		0.0250	0.1570			0.0250	0.1455			0.0250	0.1354	
		0.0300	0.1526			0.0300	0.1413			0.0300	0.1311	
		0.0350	0.1484			0.0350	0.1370			0.0350	0.1269	
55	30	0.0150	0.1380	81° 27′	32	0.0150	0.1285	82° 0′	34	0.0150	0.1200	82° 29′
		0.0200	0.1345			0.0200	0.1249			0.0200	0.1165	
		0.0250	0.1309			0.0250	0.1214			0.0250	0.1130	
		0.0300	0.1274			0.0300	0.1179			0.0300	0.1094	
		0.0350	0.1238			0.0350	0.1142			0.0350	0.1058	
60	30	0.0150	0.1140	82° 57′	32	0.0150	0.1060	83° 24′	34	0.0150	0.0992	83° 48′
		0.0200	0.1110			0.0200	0.1036			0.0200	0.0963	
		0.0250	0.1080			0.0250	0.1012			0.0250	0.0933	
		0.0300	0.1050			0.0300	0.0977			0.0300	0.0903	
		0.0350	0.1021			0.0350	0.0942			0.0350	0.0874	
65	30	0.0150	0.0920	84° 19′	32	0.0150	0.0856	84° 41′	34	0.0150	0.0801	85° 0′
		0.0200	0.0896			0.0200	0.0832			0.0200	0.0777	
		0.0250	0.0872			0.0250	0.0808			0.0250	0.0753	
		0.0300	0.0848			0.0300	0.0785			0.0300	0.0729	
		0.0350	0.0824			0.0350	0.0761			0.0350	0.0706	
70	30	0.0150	0.0718	85° 34′	32	0.0150	0.0668	85° 51′	34	0.0150	0.0625	86° 6′
		0.0200	0.0700			0.0200	0.0650			0.0200	0.0607	
		0.0250	0.0681			0.0250	0.0631			0.0250	0.0588	
		0.0300	0.0662			0.0300	0.0612			0.0300	0.0569	
		0.0350	0.0643			0.0350	0.0594			0.0350	0.0551	
75	30	0.0150	0.0529	86° 44′	32	0.0150	0.0492	86° 57′	34	0.0150	0.0460	87° 8′
		0.0200	0.0515			0.0200	0.0479			0.0200	0.0447	
		0.0250	0.0501			0.0250	0.0465			0.0250	0.0443	
		0.0300	0.0487			0.0300	0.0451			0.0300	0.0419	
		0.0350	0.0474			0.0350	0.0437			0.0350	0.0405	
80	30	0.0150	0.0348	87° 51′	32	0.0150	0.0324	87° 59′	34	0.0150	0.0303	88° 7′
		0.0200	0.0339			0.0200	0.0315			0.0200	0.0294	
		0.0250	0.0330			0.0250	0.0306			0.0250	0.0285	
		0.0300	0.0321			0.0300	0.0297			0.0300	0.0276	
		0.0350	0.0312			0.0350	0.0288			0.0350	0.0267	
85	30	0.0150	0.0173	88° 56′	32	0.0150	0.0161	89° 0′	34	0.0150	0.0150	89° 4′
		0.0200	0.0168			0.0200	0.0157			0.0200	0.0146	
		0.0250	0.0164			0.0250	0.0152			0.0250	0.0141	
		0.0300	0.0160			0.0300	0.0148			0.0300	0.0136	
		0.0350	0.0155			0.0350	0.0143			0.0350	0.0132	

Contributed by George W. Burley

No. 149, Data Sheet, MACHINERY, December, 1911

MILLING RADIAL TEETH IN CUTTER BLANKS—VI

Angle of Milling Cutter in Degrees	Number of Teeth in Cutter Blank	Width of Land, Radius = 1	Depth of Cut, Radius = 1	Angle of Elevation of Head	Number of Teeth in Cutter Blank	Width of Land, Radius = 1	Depth of Cut, Radius = 1	Angle of Elevation of Head	Number of Teeth in Cutter Blank	Width of Land, Radius = 1	Depth of Cut, Radius = 1	Angle of Elevation of Head
50	36	0.0150	0.1352	81° 30′	38	0.0150	0.1272	81° 57′	40	0.0150	0.1201	82° 22′
		0.0200	0.1309			0.0200	0.1229			0.0200	0.1160	
		0.0250	0.1266			0.0250	0.1187			0.0250	0.1117	
		0.0300	0.1224			0.0300	0.1144			0.0300	0.1074	
		0.0350	0.1181			0.0350	0.1102			0.0350	0.1032	
55	36	0.0150	0.1127	82° 55′	38	0.0150	0.1061	83° 18	40	0.0150	0.1002	83° 38′
		0.0200	0.1091			0.0200	0.1025			0.0200	0.0967	
		0.0250	0.1056			0.0250	0.0990			0.0250	0.0932	
		0.0300	0.1021			0.0300	0.0954			0.0300	0.0896	
		0.0350	0.0985			0.0350	0.0919			0.0350	0.0861	
60	36	0.0150	0.0930	84° 9′	38	0.0150	0.0876	84° 29′	40	0.0150	0.0827	84° 45′
		0.0200	0.0900			0.0200	0.0847			0.0200	0.0798	
		0.0250	0.0871			0.0250	0.0818			0.0250	0.0769	
		0.0300	0.0832			0.0300	0.0789			0.0300	0.0739	
		0.0350	0.0812			0.0350	0.0759			0.0350	0.0710	
65	36	0.0150	0.0751	85° 18′	38	0.0150	0.0707	85° 38′	40	0.0150	0.0668	85° 46′
		0.0200	0.0728			0.0200	0.0683			0.0200	0.0645	
		0.0250	0.0704			0.0250	0.0660			0.0250	0.0621	
		0.0300	0.0680			0.0300	0.0637			0.0300	0.0597	
		0.0350	0.0656			0.0350	0.0613			0.0350	0.0574	
70	36	0.0150	0.0586	86° 19′	38	0.0150	0.0552	86° 31′	40	0.0150	0.0521	86° 42′
		0.0200	0.0568			0.0200	0.0533			0.0200	0.0503	
		0.0250	0.0549			0.0250	0.0515			0.0250	0.0485	
		0.0300	0.0531			0.0300	0.0497			0.0300	0.0467	
		0.0350	0.0512			0.0350	0.0478			0.0350	0.0448	
75	36	0.0150	0.0432	87° 18′	38	0.0150	0.0407	87° 26′	40	0.0150	0.0384	87° 34′
		0.0200	0.0418			0.0200	0.0393			0.0200	0.0370	
		0.0250	0.0404			0.0250	0.0379			0.0250	0.0357	
		0.0300	0.0390			0.0300	0.0366			0.0300	0.0344	
		0.0350	0.0377			0.0350	0.0352			0.0350	0.0330	
80	36	0.0150	0.0284	88° 13′	38	0.0150	0.0267	88° 19′	40	0.0150	0.0252	88° 24′
		0.0200	0.0275			0.0200	0.0258			0.0200	0.0244	
		0.0250	0.0266			0.0250	0.0250			0.0250	0.0235	
		0.0300	0.0256			0.0300	0.0241			0.0300	0.0226	
		0.0350	0.0245			0.0350	0.0232			0.0350	0.0217	
85	36	0.0150	0.0141	89° 7′	38	0.0150	0.0133	89° 10′	40	0.0150	0.0125	89° 12′
		0.0200	0.0136			0.0200	0.0128			0.0200	0.0121	
		0.0250	0.0132			0.0250	0.0124			0.0250	0.0117	
		0.0300	0.0128			0.0300	0.0120			0.0300	0.0113	
		0.0350	0.0123			0.0350	0.0115			0.0350	0.0108	

Contributed by George W. Burley

No. 149, Data Sheet, MACHINERY, December, 1911

MILLING RADIAL TEETH IN CUTTER BLANKS—VII

Angle of Milling Cutter in Degrees	Number of Teeth in Cutter Blank	Width of Land, Radius = 1	Depth of Cut, Radius = 1	Angle of Elevation of Head	Number of Teeth in Cutter Blank	Width of Land, Radius = 1	Depth of Cut, Radius = 1	Angle of Elevation of Head	Number of Teeth in Cutter Blank	Width of Land, Radius = 1	Depth of Cut, Radius = 1	Angle of Elevation of Head
50	42	0.0150	0.1128	82° 44′	44	0.0150	0.1079	83° 4′	46	0.0150	0.1028	83° 22′
		0.0200	0.1082			0.0200	0.1037			0.0200	0.0985	
		0.0250	0.1038			0.0250	0.0995			0.0250	0.0943	
		0.0300	0.0992			0.0300	0.0952			0.0300	0.0900	
		0.0350	0.0945			0.0350	0.0910			0.0350	0.0858	
55	42	0.0150	0.0941	83° 57′	44	0.0150	0.0900	84° 13′	46	0.0150	0.0857	84° 28′
		0.0200	0.0903			0.0200	0.0866			0.0200	0.0822	
		0.0250	0.0866			0.0250	0.0830			0.0250	0.0787	
		0.0300	0.0828			0.0300	0.0795			0.0300	0.0751	
		0.0350	0.0790			0.0350	0.0759			0.0350	0.0716	
60	42	0.0150	0.0782	85° 0′	44	0.0150	0.0742	85° 14	46	0.0150	0.0706	85° 27′
		0.0200	0.0752			0.0200	0.0712			0.0200	0.0677	
		0.0250	0.0723			0.0250	0.0682			0.0250	0.0648	
		0.0300	0.0694			0.0300	0.0653			0.0300	0.0619	
		0.0350	0.0665			0.0350	0.0625			0.0350	0.0589	
65	42	0.0150	0.0632	85° 59′	44	0.0150	0.0600	86° 9′	46	0.0150	0.0570	86° 19′
		0.0200	0.0608			0.0200	0.0577			0.0200	0.0546	
		0.0250	0.0585			0.0250	0.0553			0.0250	0.0523	
		0.0300	0.0561			0.0300	0.0529			0.0300	0.0500	
		0.0350	0.0537			0.0350	0.0505			0.0350	0.0476	
70	42	0.0150	0.0493	86° 51′	44	0.0150	0.0468	87° 0′	46	0.0150	0.0445	87° 8′
		0.0200	0.0475			0.0200	0.0450			0.0200	0.0427	
		0.0250	0.0456			0.0250	0.0431			0.0250	0.0408	
		0.0300	0.0437			0.0300	0.0412			0.0300	0.0390	
		0.0350	0.0419			0.0350	0.0394			0.0350	0.0371	
75	42	0.0150	0.0363	87° 41′	44	0.0150	0.0345	87° 48′	46	0.0150	0.0328	87° 53′
		0.0200	0.0350			0.0200	0.0332			0.0200	0.0315	
		0.0250	0.0336			0.0250	0.0318			0.0250	0.0301	
		0.0300	0.0322			0.0300	0.0304			0.0300	0.0287	
		0.0350	0.0309			0.0350	0.0290			0.0350	0.0273	
80	42	0.0150	0.0239	88° 29′	44	0.0150	0.0227	88° 33′	46	0.0150	0.0216	88° 37′
		0.0200	0.0230			0.0200	0.0218			0.0200	0.0207	
		0.0250	0.0221			0.0250	0.0209			0.0250	0.0198	
		0.0300	0.0212			0.0300	0.0200			0.0300	0.0189	
		0.0350	0.0203			0.0350	0.0191			0.0350	0.0180	
85	42	0.0150	0.0119	89° 15′	44	0.0150	0.0112	89° 17′	46	0.0150	0.0107	89° 19′
		0.0200	0.0115			0.0200	0.0108			0.0200	0.0103	
		0.0250	0.0110			0.0250	0.0104			0.0250	0.0098	
		0.0300	0.0106			0.0300	0.0099			0.0300	0.0094	
		0.0350	0.0101			0.0350	0.0095			0.0350	0.0089	

Contributed by George W. Burley

No. 149, Data Sheet, MACHINERY, December, 1911

MILLING RADIAL TEETH IN CUTTER BLANKS—VIII

Angle of Milling Cutter in Degrees	Number of Teeth in Cutter Blank	Width of Land, Radius = 1	Depth of Cut, Radius = 1	Angle of Elevation of Head	Number of Teeth in Cutter Blank	Width of Land, Radius = 1	Depth of Cut, Radius = 1	Angle of Elevation of Head	Number of Teeth in Cutter Blank	Width of Land, Radius = 1	Depth of Cut, Radius = 1	Angle of Elevation of Head
50	48	0.0150	0.0978	83° 39′	50	0.0150	0.0933	83° 55′	52	0.0150	0.0891	84° 9′
		0.0200	0.0936			0.0200	0.0891			0.0200	0.0849	
		0.0250	0.0891			0.0250	0.0849			0.0250	0.0807	
		0.0300	0.0851			0.0300	0.0806			0.0300	0.0764	
		0.0350	0.0808			0.0350	0.0764			0.0350	0.0722	
55	48	0.0150	0.0815	84° 43′	50	0.0150	0.0778	84° 56′	52	0.0150	0.0743	85° 8′
		0.0200	0.0780			0.0200	0.0743			0.0200	0.0708	
		0.0250	0.0745			0.0250	0.0708			0.0250	0.0673	
		0.0300	0.0710			0.0300	0.0673			0.0300	0.0638	
		0.0350	0.0675			0.0350	0.0637			0.0350	0.0602	
60	48	0.0150	0.0673	85° 38′	50	0.0150	0.0642	85° 49′	52	0.0150	0.0613	85° 59′
		0.0200	0.0643			0.0200	0.0613			0.0200	0.0584	
		0.0250	0.0612			0.0250	0.0584			0.0250	0.0555	
		0.0300	0.0581			0.0300	0.0555			0.0300	0.0526	
		0.0350	0.0550			0.0350	0.0525			0.0350	0.0497	
65	48	0.0150	0.0544	86° 29′	50	0.0150	0.0519	86° 37′	52	0.0150	0.0495	86° 45′
		0.0200	0.0518			0.0200	0.0495			0.0200	0.0472	
		0.0250	0.0493			0.0250	0.0471			0.0250	0.0448	
		0.0300	0.0468			0.0300	0.0447			0.0300	0.0425	
		0.0350	0.0443			0.0350	0.0424			0.0350	0.0401	
70	48	0.0150	0.0424	87° 16′	50	0.0150	0.0405	87° 22′	52	0.0150	0.0387	87° 28′
		0.0200	0.0405			0.0200	0.0386			0.0200	0.0368	
		0.0250	0.0386			0.0250	0.0368			0.0250	0.0350	
		0.0300	0.0367			0.0300	0.0350			0.0300	0.0332	
		0.0350	0.0347			0.0350	0.0331			0.0350	0.0313	
75	48	0.0150	0.0312	87° 59′	50	0.0150	0.0298	88° 4′	52	0.0150	0.0284	88° 8′
		0.0200	0.0298			0.0200	0.0284			0.0200	0.0271	
		0.0250	0.0284			0.0250	0.0271			0.0250	0.0257	
		0.0300	0.0270			0.0300	0.0257			0.0300	0.0244	
		0.0350	0.0256			0.0350	0.0244			0.0350	0.0231	
80	48	0.0150	0.0206	88° 40′	50	0.0150	0.0196	88° 43′	52	0.0150	0.0187	88° 46′
		0.0200	0.0196			0.0200	0.0187			0.0200	0.0178	
		0.0250	0.0187			0.0250	0.0178			0.0250	0.0169	
		0.0300	0.0178			0.0300	0.0169			0.0300	0.0161	
		0.0350	0.0168			0.0350	0.0160			0.0350	0.0152	
85	48	0.0150	0.0102	89° 20′	50	0.0150	0.0097	89° 22′	52	0.0150	0.0093	89° 24′
		0.0200	0.0097			0.0200	0.0093			0.0200	0.0088	
		0.0250	0.0093			0.0250	0.0088			0.0250	0.0084	
		0.0300	0.0088			0.0300	0.0084			0.0300	0.0080	
		0.0350	0.0083			0.0850	0.0080			0.0350	0.0075	

Contributed by George W. Burley

No. 149, Data Sheet, MACHINERY, December, 1911

MACHINERY
December, 1911

FOUNTAIN PEN MANUFACTURE

METHODS EMPLOYED BY THE L. E. WATERMAN CO. IN THE MANUFACTURE OF FOUNTAIN PENS

By DOUGLAS T. HAMILTON[*]

THE average user of a fountain pen little realizes the accurate work and care which are necessary to produce it. The turning of the rubber parts presents difficulties which can only be mastered by careful and accurate workmen—specialists in this line. The methods employed in the making of the gold pen point are also unique, and are well worth recording. Mr. F. P. Seymour, advertising manager of the L. E. Waterman Co., has kindly furnished us with the necessary photographs and information, which enables us to give MACHINERY's readers the opportunity of learning how fountain pens are made.

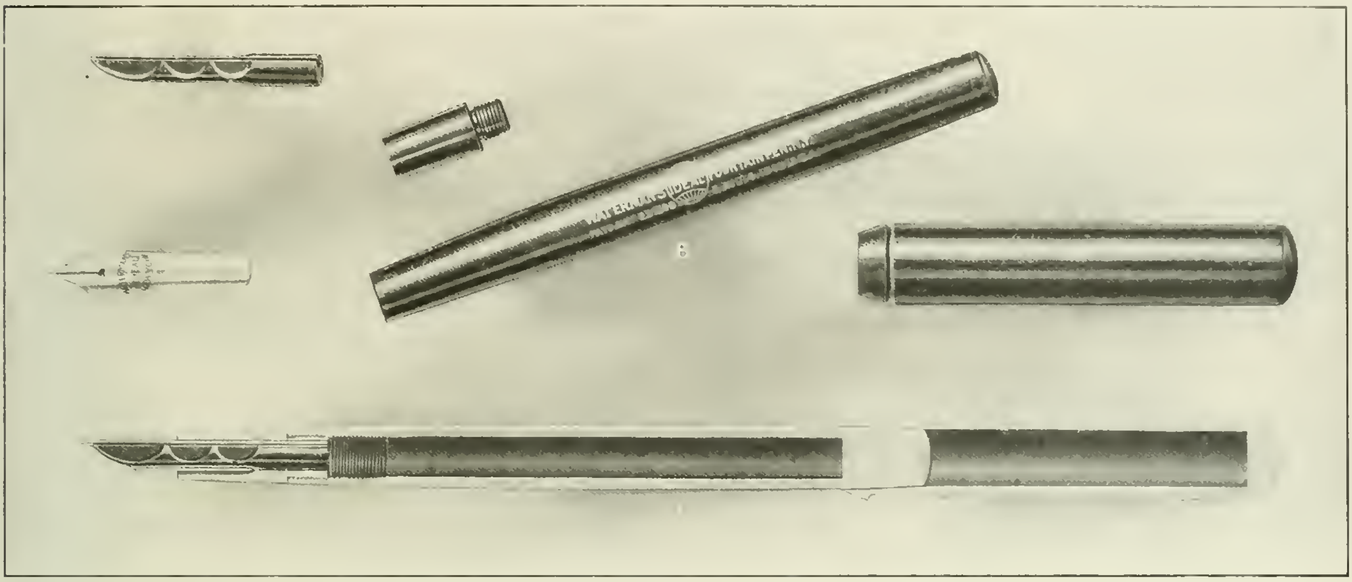
Fig. 1. Component Parts of Waterman's Ideal Fountain Pen. A is the Cap; B, the Barrel; C, the Point Section, D, the "Spoon" Feed; E, the Pen Point; and F, a Sectional View of the Assembled Parts

The L. E. Waterman Co. produces one and one-half million fountain pens a year, which requires the combined output of three large factories. The greater number of the rubber pen parts are made at the factory in Seymour, Conn., and the gold pen points in the fully equipped plant in New York City. The factory located at St. Lambert, P. Q., Canada, is required to supply the Canadian field exclusively. There are about 650 men and women employed in all three factories.

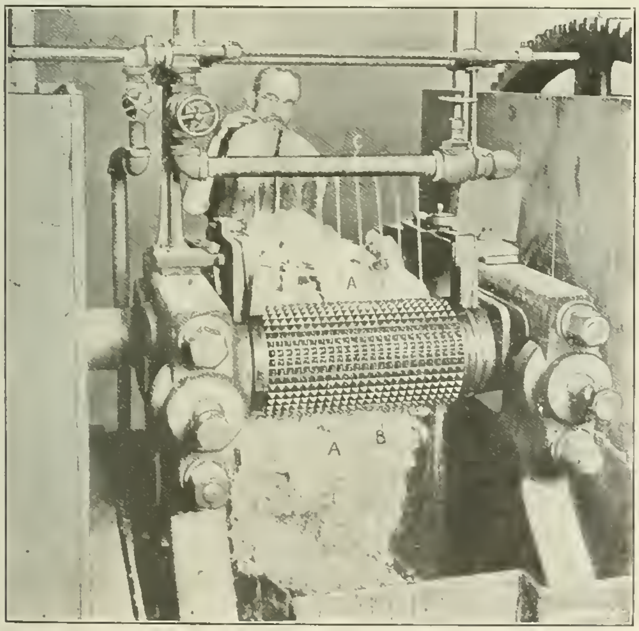

Fig. 2. Grinding and Washing the Crude Rubber "Biscuits"

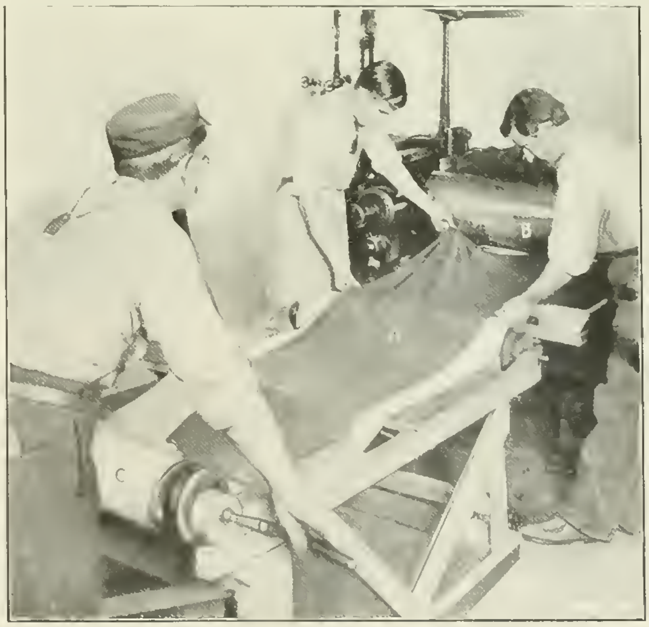

Fig. 3. Rolling the Rubber out into Sheets of the Required Thickness

Obtaining the Crude Rubber Gum

The crude "Para Beni-Bolivian" rubber gum, as it is called, is obtained from *Hevea Brasiliensis*, a large tree 60 feet high, which grows on the banks of the Beni River in Bolivia. These trees are tapped by cutting a deep horizontal slit near the base of the tree and a vertical one extending from it up the trunk; from both sides of the vertical incision slits are cut, at short distances apart, in an oblique direction. The tapping is done in the dry season, between August and February, in the evening, and the "milk," as it is called, is collected the following morning, in small shallow clay cups which are fastened below the horizontal incision by a piece of soft clay. When these cups are full, their contents are poured into a larger receptacle. Each tree yields only about two ounces of milk a day, and as the L. E. Waterman Co. uses forty tons of rubber per year, this means that upward of 3000 trees are required to produce sufficient gum—an industry of considerable magnitude in itself.

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[*] Associate Editor of MACHINERY.

To produce the rubber, a wooden stick about three feet long, provided with a flattened clay mold at the end, is dipped into the receptacle containing the gum, or milk, the liquid spreading itself evenly on the mold. The milk is then carefully dried by holding the mold over a white vapor produced by heating certain oily palm-nuts, the stick being rotated so that the milk is evenly distributed and formed into a sort of gum. Each layer of gum is allowed to become firm before any more milk is added to it. An experienced man can make five or six pounds of gum an hour. The rubber cakes, or "biscuits," thus formed, are slit open in order to remove them from the mold, and are then hung up to dry. The crude rubber is brought down the Beni River, is inspected by a Waterman representative, and is trans-shipped from the seaport Para to the Waterman factory at Seymour, Conn., at which place the crude rubber is manufactured into the rubber pen parts.

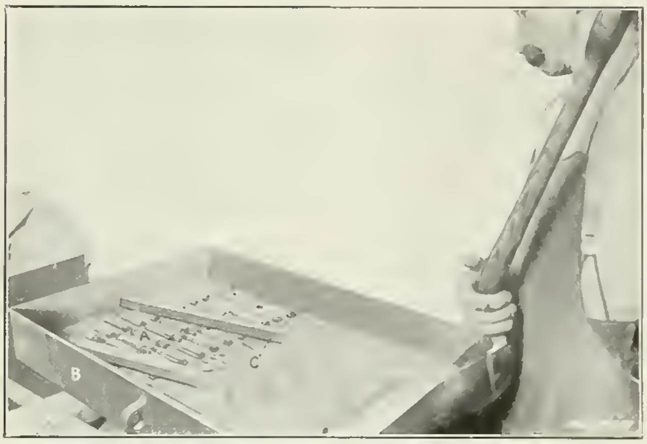

Fig. 4. Covering the Rubber-coated Arbors with Powdered Soapstone previous to Vulcanizing

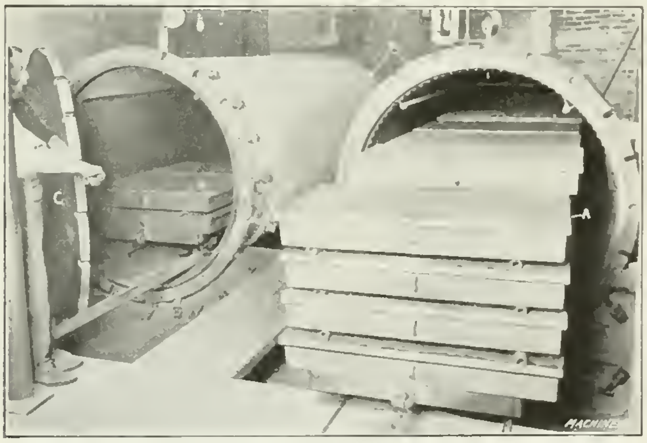

Fig. 5. Placing the Iron Boxes containing the Rubber-coated Arbors in the Vulcanizing Ovens

Washing and Grinding the Crude Rubber

After the gum has soaked in hot water for about two weeks it is taken to the grinding machine shown in Fig. 2, where it is passed through 15-horsepower grinding rolls. These grinding rolls *B*, one of which is shown, chew up the rubber *A*, and cold water, forced out of the pipe *C*, washes the dirt out of it. The rubber is put through these rolls several times until it is cleansed and thoroughly "masticated." After washing, it is placed in a heater, kept at a temperature of about 135 degrees F., where it remains a couple of weeks. Then it is put through another pair of rolls where it is again ground and the sulphur is mixed in. One of the rolls travels faster than the other, which tends to strip and separate the rubber sufficiently to allow the sulphur to work in. The correct quantity of sulphur is here mixed in, the operator tearing the rubber off as it comes through, and passing it through again. This operation is repeated until the sulphur and rubber have been thoroughly mixed. The mixing rolls are heated so that the rubber can be properly manipulated.

The rubber is now passed through the sheeting rolls, shown in Fig. 3, where it is rolled out into sheets about 1/32 inch thick. As the rubber sheet *A* passes through the rolls *B*, it is laid on cotton cloth in which it is wound. This cloth prevents it from sticking together and also keeps it clean. It is then wound on a roll *C*, so that it can be easily unrolled when cutting it up into strips for rolling on the arbors. The rolls *B* are heated by means of steam pipes passing through them as is the case in the previous operation. The rubber is kept warm and plastic throughout all these operations.

The sheets are now ready for cutting up and rolling on mandrels, which form the barrel and cap of the fountain pen. This is accomplished by boys who use heated mandrels, cut the rubber into strips sufficient for a pen cap or barrel, and roll it on these arbors to the required diameter, the rolling being done on a heated smooth steel bed. Before starting to roll the rubber on the arbor, a rubber plug of the same diameter as the arbor is stuck on the end of it, which forms the end of the barrel or cap, as the case may be, thus converting it from a tube into a shell form. Foil is then wound over the rubber to prevent the sulphur from "boiling" out, while being vulcanized.

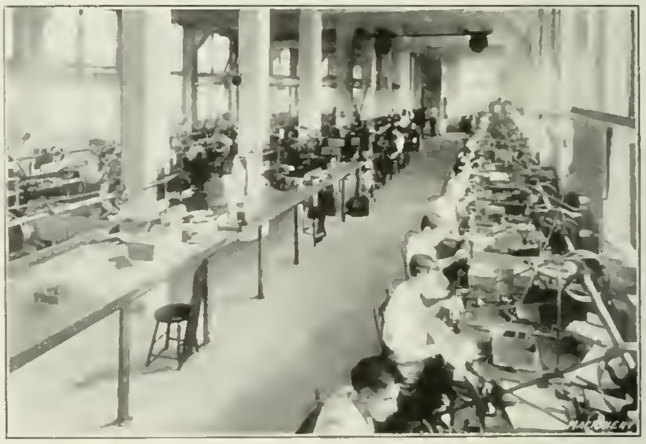

Fig. 6. A General View of the Rubber Turning Department

Following this, the arbors *A* with the rubber and foil wound on them are placed in the steel box *B*, as shown in Fig. 4, an even layer of powdered soapstone being first deposited in the box. Then the rubber-coated arbors are placed, as shown in the illustration, far enough apart so that they will not come in contact with one another, after which two wooden strips *C* are laid on top of them. More powdered soapstone is now put in, and the box is filled to the height of the top of these sticks, which act as a gage, so that the soapstone will be of an even depth. The soapstone is then tramped hard to form a mold for the parts during vulcanization. A steel cover is now locked on the box, when it is ready for placing in the vulcanizing oven.

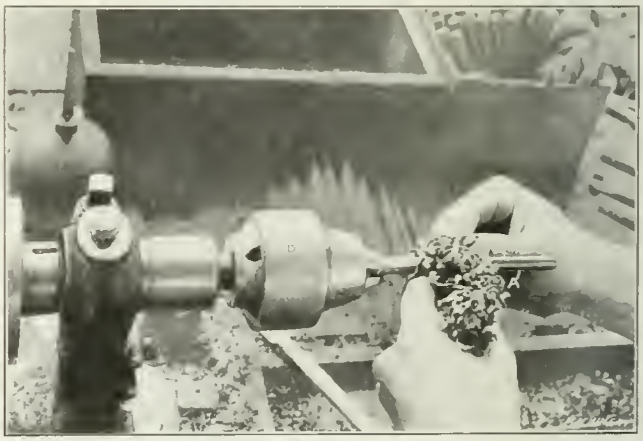

Fig. 7. Rough-turning the Rods for the "Feeds"

Vulcanizing the Rubber Pen Parts

Rubber before vulcanizing is void of shape and is of little commercial value. Until the advent of this discovery by Charles Goodyear in 1853, rubber was not used to any great extent. Vulcanizing consists essentially of mixing the required amount, about thirty-three per cent by weight, of sulphur with the crude Para rubber, and keeping this in a receptacle, which is heated to about 300 degrees F. for about fourteen hours. Of course the exact time that the rubber should be left in, to have the desired resiliency and hardness, depends on the size of the parts being vulcanized. The operator not only has to watch the pressure gage to determine the temperature, but he also has to follow the predetermined lines on a recording thermometer. The smaller the proportion of sulphur in rubber, and the lower the temperature used, the softer and more pliable the vulcanized rubber will be. For fountain pens, the rubber has to be sufficiently hard so that it cannot be easily bent out of shape, and still have sufficient resiliency so that all joints will be ink-tight. It also has to be workable.

After the rubber pen parts have been rolled on the arbors and placed in the steel boxes *A*, the latter are conveyed to the vulcanizing ovens *B* shown in Fig. 5. Here they are placed one upon the other, iron tubes separating them, on a truck which is rolled into the oven. The large iron door *C*, which the operators, at the left of the illustration, are grasping, is then placed on the end and held by swinging bolts. Steam is turned on and escapes into these ovens, and the temperature is gradually brought to about 300 degrees F. After the rubber has been vulcanized, the door is taken off and the car carrying the steel boxes is rolled out, when the rubber is stripped from the mandrel in a special gripper machine. The rubber parts are then ready for turning, after they have been sawed to the desired lengths.

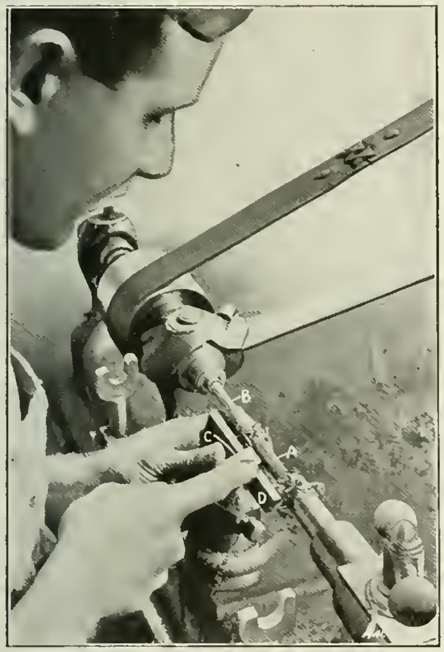

Fig. 8. Rough-turning the Rubber Cap

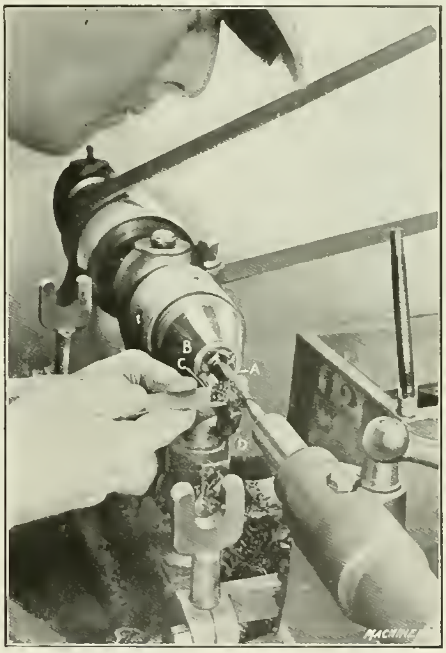

Fig. 9. Tapering the Ends of the Rubber Barrel

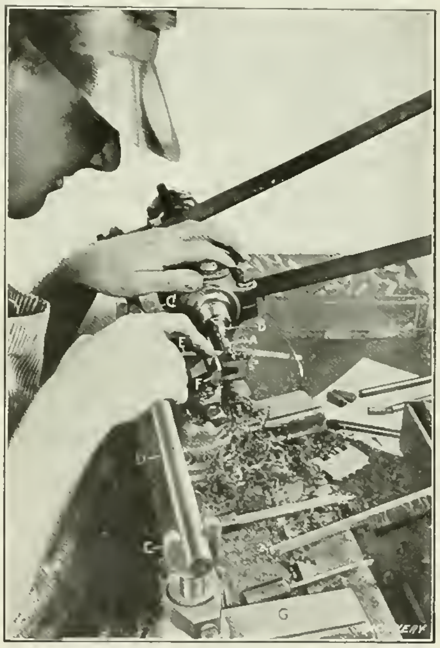

Fig. 10. Turning and Threading the Point Section

The process of rolling the rubber just described is that generally used for making the cap and barrel, but where long rubber tubes are to be made, they are extruded in a special machine.

Turning the Rubber Pen Parts

Vulcanized rubber is not only used for making fountain pens, but it is also employed to a considerable extent for other purposes, especially in the manufacture of electrical apparatus. The rubber used for fountain pens, however, is slightly softer than vulcanite, which is employed in the manufacture of electrical apparatus, but it presents just as difficult a problem in turning. No automatic machines, whatever, are used in the production of the rubber parts (with the exception of chasing), each part having to be made separately by hand, which requires the aid of experienced workmen. A general view of the rubber-turning department in the Seymour shops of the Waterman Fountain Pen Co. is shown in Fig. 6, where the turners can be seen at work making the rubber parts of the pen.

Making the Rubber Cap

The rubber cap, shown at *A* in Fig. 1, is made from a cup, as has been previously stated, and for the rough-turning operation is placed on an arbor *B* as shown in Fig. 8. The turning is accomplished with a flat hand tool *C*, the operator holding it in one hand, guiding it with the thumb of the other hand, and placing the first finger of the left hand at the back of the work to prevent the cuttings from obscuring his view of the point of the turning tool. The free end of the arbor is supported by the tailstock center. The tool *C* is held on a rest *D*, the cutting edge being slightly above the center of the work. In this operation the foil, which was used when vulcanizing to prevent the sulphur from "boiling" out, is also removed. The cap is now finish-turned with hand tools, after which it is reamed taper with a flat reamer made from Crescent tool steel. This is done so that the hole in the cap will fit the tapered ends of the barrel.

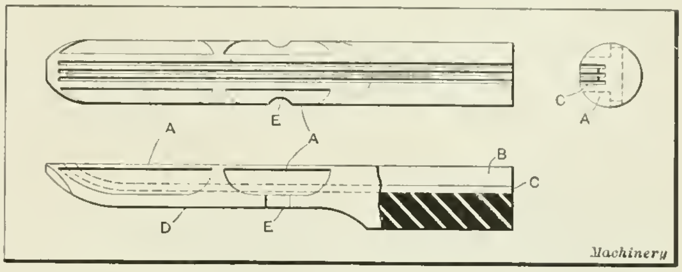

Fig. 11. The "Spoon Feed" which conveys the Ink to the Pen Point

Making the Rubber Barrel

The rubber barrel shown at *B* in Fig. 1 is rough-turned in a lathe in a similar manner to the cap shown in Fig. 8. The next operation on the barrel is to finish the two tapering ends; one end must fit the taper on the point section, while both ends must fit the tapered hole in the cap. This is accomplished as shown in Fig. 9. The barrel *A* is held in a chuck *B* in a small turning machine, and the operator, by means of a flat hand tool *C*, turns down the tapered ends to the required taper and diameter. The tool *C* is held on a rest *D*, and the taper is governed entirely by presenting the tool at the required angle. The tool is made from 1/8- by 3/4-inch Crescent tool steel hardened "glass-hard." Every time a cut is taken this tool is "touched up" on an Arkansas oilstone, so that the cutting edge is kept as "keen" as possible. If the tool is the least bit dull, it produces a ragged edge and also burns the work, discoloring it somewhat. While tapering the front end, the tailstock center is placed in the hole.

After the front end has been turned, the barrel is reversed and the rear end is turned taper and rounded off. The barrel is then ready for reaming and tapping. The reaming is done with an ordinary flat reamer in a speed lathe, while the tapping is accomplished with a tap provided with only two rows of teeth, or, in other words, two cutting edges, the tap being practically flat. This operation is done in a speed lathe which is provided with cross belts, so that the spindle can be reversed for backing out the tap. The operator holds and guides the tap by his right hand, a dog being fastened to the tap so that he can grip it securely.

Making the Point Section

The point section, shown at *C* in Fig. 1, is that part of the fountain pen which holds the nib and the feed. It is made from tubular rubber, produced by the extrusion process previously mentioned. The first operation is to rough-turn the outside. Then it is placed on an arbor, as shown in Fig. 10, where that part on which the thread is to be cut is rough- and finish-turned. The threading is also done while the point section *A* is located on the arbor *B*, and is accomplished with an ordinary flat chaser similar to that used by brass finishers.

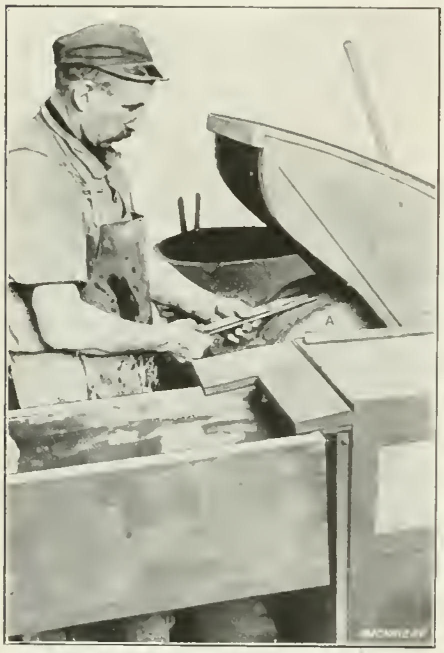

Fig. 12. Rough-polishing the Rubber Barrels on a Wet Carpet-wheel Buff

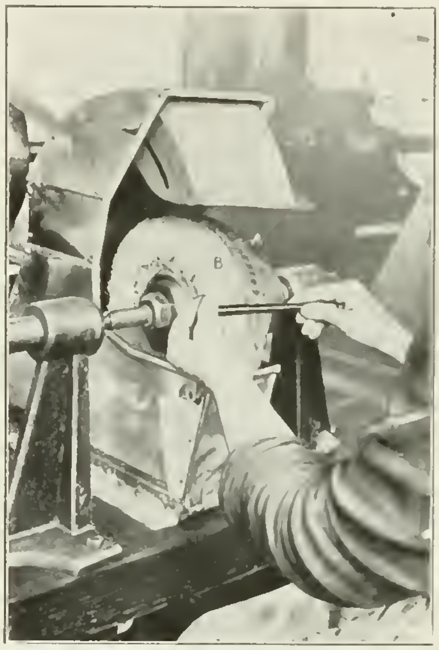

Fig. 13. Finish-polishing the Rubber Pen Parts, on a Rouge-covered and Dry Buff

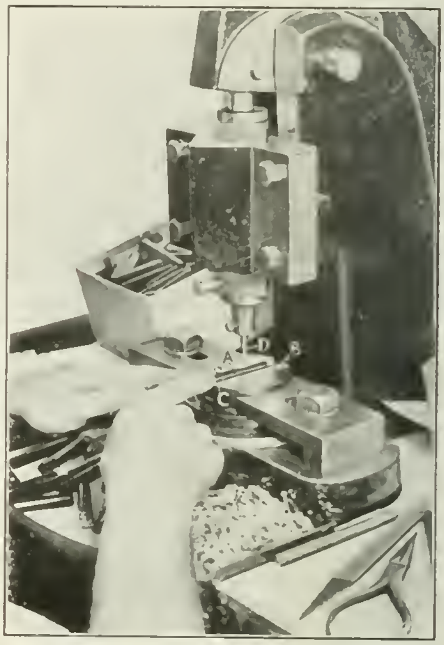

Fig. 14. Riveting the Clip-cap on the Rubber Cap

The type of turning rest used for holding turning tools is clearly shown in this illustration. It consists of U-shaped supports *C* in which a round bar *D* rests. The turning tool *E* is fastened to the bar *D* and is supported on the front end by the rest *F*. The bar *D* slides freely in the U-shaped supports *C*, which can be set so that the tool will turn tapering by changing the position of the slide-rest *G*, holding one of the supports. The thread on the point section must be perfect as regards shape, that is to say, it must be of the same included angle as the thread in the barrel so that the ink cannot leak down past the threads; it is also required to fit tightly in the barrel. After the thread has been cut, the front end is reamed to fit the feed and pen point, after which the external diameter is taper-turned to suit the taper on the barrel, the turning being accomplished in the manner previously described. These rubber turning lathes are rotated at about 2000 revolutions per minute.

Making the Feeds

The "spoon" feed, shown at *D* in Fig. 1, which conveys the ink from the barrel to the pen point, is made from solid rubber, and is cut to the required length from a rubber rod about three feet long. The cut rod is grasped in a chuck *B* as shown in Fig. 7. The turning is accomplished by a small tool made from Crescent steel, held in a holder, which the operator holds in his right hand, guiding it by the left hand as is clearly shown in the illustration. The feed is really the most important part of the fountain pen, with the exception of the pen point, and requires very accurate work. After rod *A* is turned it is again cut into short lengths. Then the pockets *A*, shown in Fig. 11—the peculiar feature of the Waterman fountain pens—are cut. The feed is held in a small fixture, and two cutters, similar in shape to an end-mill, are brought in from each side and fed to the proper depth, and then the table carrying the feed is traversed the required distance. Both pockets on each side are cut in this manner.

Following this operation, the air vent *B* is made with an ordinary slitting saw about 3/64 inch wide, the slit being made about 1/16 inch deep. The next operation is to cut the ink fissure ducts. When writing, the ink passes down these fissures *C*, while the air passes up through the slot *B*, so that every drop of ink in the pen can be used. The feed is now taken to another milling fixture where it is clamped, and the bottom surface *D* is milled to the required shape. This is done in a small miller somewhat similar in action to a profiler, with the exception that the cutter is held in a horizontal plane instead of in a vertical position. The movement of the head holding the milling cutter is controlled by cam-faced guides of the required shape. The small air ducts *E* are produced with a round file. The rubber pen parts are held to a limit of 0.001 inch, being gaged by the operator when turning. They are also again gaged by several inspection departments.

Polishing the Rubber Parts

All the rubber parts of the pen have now been made, but are in a rough condition—not polished. The first polishing operation consists in holding the rubber pen parts on arbors, and turning them around by hand while they rest on a wet carpet-wheel buff, shown in Fig. 12, on which water is flowing. Ashes and powdered pumice stone are applied to this carpet buff *A*, which removes all tool marks, but does not give a glossy or polished appearance.

The next operation consists in polishing the assembled rubber parts on a cotton-wheel buff as shown in Fig. 13. The side *A* of this cotton-wheel is coated with rouge, and is slightly dampened, while the other side *B* is dry, and is not covered with any sort of polishing material. The operator holds the pen in both hands, as shown, passing it back and forth over this cotton buff. In the illustration the operator is holding the pen on the polishing buff. When roughing down on the buff *A*, coated with rouge, the pen is held in a vertical position and is moved up and down on the face of the wheel.

After polishing, the pen is tested to see that it does not leak. The assembled pen, without the feed or pen point, is located in a tank of water, and a syringe, which has a rubber tube that fits tightly in the point section, is inserted in it. Then pen and tube are placed in the water, and the bulb is pressed, forcing air into the pen. If any bubbles are seen to rise in the water, it is evident that the pen leaks, and it either has to be repaired or discarded. This test is sufficient to expose any imperfections in the fitting of the manufactured rubber parts.

Stamping the Name on the Barrel

As far as the manufacturing operations are concerned, the holder itself is complete, with the exception of having the name stamped on it. This is accomplished in the special device shown in Fig. 15. The barrel is placed on an arbor on which it is clamped, this arbor being connected to a square slide *B* working against the tension of a spiral spring. The barrel rests between two rolls *C* and *D*, the latter roll having the stamp cut in relief, which is to be reproduced on the barrel. The handle *E* for operating the rolls is placed in the roll *D*, the latter being connected to the roll *C* by a block chain. The groove in the roll *C* is tapered slightly to correspond with that on the barrel, and fits it snugly. The illustration shows a barrel just after the stamping operation, the handle *E* being moved to the left when stamping. The rolls are held on sliding bases, *F* and *G*, which can be adjusted back and forth by the thumb-screws *H* and *I*, so that pen barrels of various diameters can have the name rolled on them in this same fixture.

Chasing the Barrel and Cap

The chasing on the Waterman fountain pens is accomplished in special chasing machines, one of which is shown in Fig. 16. The barrel or cap, as the case may be, is placed between centers. In the illustration, six barrels are being chased. The holes in these barrels *A* are placed on close-fitting arbors which have spur gears *B* fastened on the rear end. The other end of the barrel rests in a support *C*, which is counterbored to suit, and in which the barrel rotates. These plungers or supports *C* are provided with springs, so that when the thumb-screws *D* are loosened, the plunger will spring back, allowing the barrel to be removed.

As before mentioned, each arbor that carries a barrel is provided with a spur gear. These spur gears, in turn, are all driven from one central gear, which is located on the arbor *E*, the ratchet plate *F* also being held on this same arbor. A threaded sleeve fitting on the arbor *E* is cut away for part of its circumference. The full part prevents any chasing being done where the name appears on the barrel. When chasing the caps, this sleeve is entirely removed, so that the chasing may be done completely around the cap.

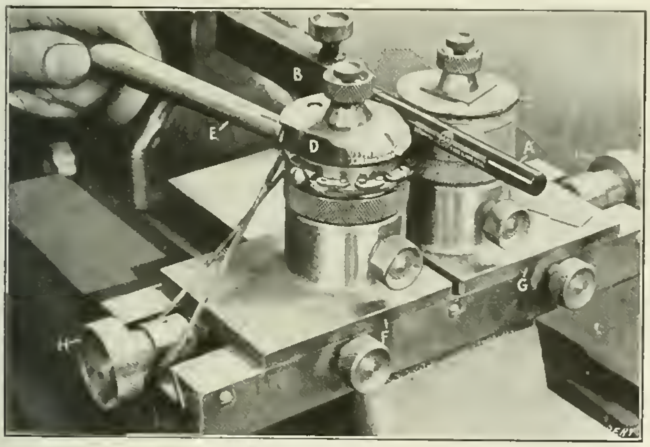

Fig. 15. Rolling the Name in the Rubber Barrel

The machine is driven by a belt running on the pulley *G*, which is provided with a tooth clutch. Another tooth clutch on the shaft at the rear meshes with this tooth clutch on the pulley, so that when they are connected the machine will operate. The rear shaft is provided with an eccentric which runs in an elongated slot cut in an arm attached to the moving table of the machine. As the pulley rotates it moves the table back and forth by means of the eccentric, and as the table moves back and forth, a spring-actuated slide *H* comes in contact with a cam block *I*, both of which are beveled as shown. This action forces the spring-actuated slide in, and as it carries a ratchet which meshes with the disk *F*, the latter is rotated. As this disk is connected to the central screw *E*, and as the screw is geared up with all of the arbors, it is evident that they all must rotate in unison.

Now directly over the center of each arbor or pen barrel is a "tool-holder" *J*, in which is held a black diamond, similar to those used in truing emery wheels except that they are finished—having a sharp cutting edge. All sorts of steel cutters have been tried without success. A steel tool will work for a short time, but as soon as it becomes dull, it tears the rubber and makes a very dirty-looking job. The head *K* in which these diamonds are held is fulcrumed at *L*, and is compressed by the plate spring *M*. Held in the front end of the head is a stud *N* carrying a roller *O* which works on the sleeve previously mentioned, and also a stud *P* which works on a rack *Q*. This rack lifts the head *K*, so that the spacing between each chased space is made.

The pattern is controlled by means of a cam *R*, held on the central stud *E*. This cam operates the rack *Q*, changing its position as the rubber barrels are rotated, and by this means the zigzag chasing effect is given to the barrels. It can, therefore, be seen that for each revolution of the driving gear, or, in other words, for each revolution of the pen barrel, six barrels are completed, the time required being six minutes.

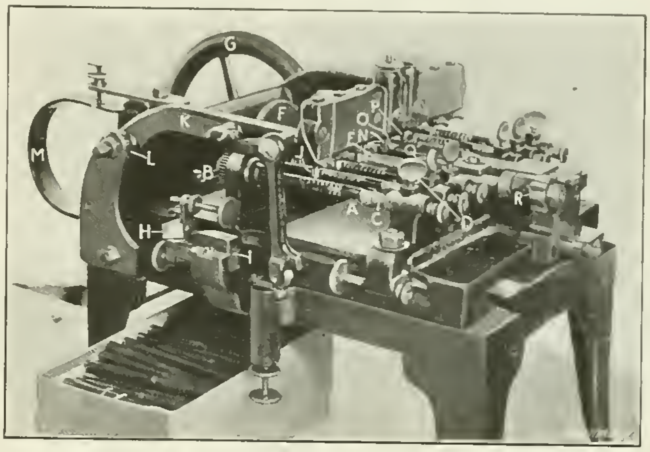

Fig. 16. Special Automatic Machine for Chasing the Rubber Barrel and Cap

The chasing on the barrel, as previously mentioned, does not continue entirely around its circumference. This is accomplished by a sleeve held on the central screw *E*, which lifts up the head *K*, by means of the roller *O*, when it rests on the full portion of the sleeve. Here the machine cuts "air" until the arbor has turned around sufficiently to allow the roller to drop off the sleeve, when the chasing again commences. The machine is stopped automatically by means of a finger attached to the ratchet plate *F*, which comes in contact with a spring-actuated slide, normally kept in contact with an arm, which, in turn, is fastened to the tooth clutch. As soon as this finger touches the slide, it depresses a spring, and at the same time pulls the former from the cam on the lever, thus allowing the latter to be acted upon by another spring, which disconnects the clutch, thus stopping the machine.

Putting on the Clip-cap

The clip-cap, which is used for holding the pen in the pocket, is held to the cap by means of a twin rivet. The holes for the twin rivet are drilled in an ordinary drill press, after which the rivet is placed in a slotted arbor, the latter being inserted in the cap, then pushed up forcing the two prongs of the rivet through the holes. The cap is then taken to the foot-press shown in Fig. 14, where the operator places it on an arbor. Here the cap *A* with the arbor in it is laid in a groove cut in a lead block *B*, the latter being held in a cast-iron shoe *C*. The riveting is done with a small punch *D*, provided with a circular depression in its lower end, the operator simply pressing the foot-treadle, bringing the punch down on the top of the twin riveting prongs, and thus setting them.

* * *

If some men applied themselves to their work with only half the energy which they display in trying to find something to fuss about, they would not have to work half as hard as they do.

CONDITIONS IN THE FAR WEST

By CARROLL ASHLEY[*]

In the following article the writer intends to give some of his opinions of the difference between working in the shops on the Pacific coast and in those in the East. The reason for doing this is that many mechanics come to the Pacific coast uninformed of the real conditions there, and hence frequently meet with difficulties or disappointments. Few people in the East are well informed on the exact conditions in California, because advertisements mis-state and over-state the advantages gained by living in the West. In referring to the conditions on the Pacific coast, the writer will refer particularly to those in Los Angeles. All factors involved, however, cannot be considered without bringing in some details which are not strictly of things mechanical, such as climate, temperature, etc. A short visit to the Pacific coast will not give to most people a clear idea of the conditions. Although these conditions may not be in all respects such as expected, it is true that if one has lived here a year, one usually gives up the idea of going back East—to stay.

Toolmakers working in tool- and die-rooms, doing fine and complicated work, and having steady employment, should not think of leaving it for a similar job in Los Angeles. There are exceedingly few shops in or near this city where there are opportunities or facilities for doing "close" work. In this city of 350,000 inhabitants, those who have good positions are keeping them with hopes of resigning only in favor of the coming generation. A first-class mechanic used to the fine toolmaking of the East has no chance here unless he is able to adapt himself to the methods of doing work here. The writer has seen many ex-foremen, chief draftsmen, and first-class tool- and die-makers who have left the East and expected upon their arrival here to "land" good jobs, but who have had to be satisfied with work in garages and numerous small job shops, where work is done very cheaply, and the mechanic is so "hustled" that it soon drives him to start a chicken ranch.

There are a large number of small jobbing shops around the city, the greater number of which are poorly equipped for doing all the kinds of work that they undertake. The work in these shops will vary from turning automobile crankshafts to the milling of all kinds of gears, including those of metric pitch. An extensive business is done in experimental work, generally in inventors' ideas, which must be gotten out cheaply "to see if it works." The writer once had an experience of making a fountain ruling pen for draftsmen, which was promised in thirty hours. In that time it was hardly possible to make the cutters and end mills for the hinge part, to say nothing of the internal (I almost said infernal, which they nearly were) parts. As a matter of fact, it took over three weeks to complete the work.

The largest shops in or around the city are either oil-well tool builders or structural iron concerns. It is with these that steady employment can be obtained, but if one never has made oil-well tools before, it takes some time to get acquainted with the work. One-sixty-fourth or one-thirty-second inch is amply close enough on this line of work, but nevertheless these are the shops to be employed in out here. The one with which the writer is employed gives its men (about 400) each a turkey at Christmas and a picnic in August. Smoking is permitted in the shop and visitors are allowed. There is a cordial feeling between the owner of the shop and the men, and there is a standing invitation to call on the general manager and talk over with him any dissatisfaction that may arise. It is gratifying to note that the carpet on the floor in the general manager's office is not worn threadbare on this account. The shop is equipped with the best class of machinery imported from the East. The planers stand up well under the heavy cuts taken, but the lathes, of the strongest make known to the writer, are not very satisfactory for oil-tool work, involving the rapid machining of nickel and other similar steels.

The railroad shops have not been mentioned because the the average toolmaker knows practically nothing of locomotive work. Therefore, the mechanic coming from the East must choose between three different branches of machine shop work, besides the railroad shops, *viz*: Garages and job shops, the structural iron works, and the oil-well tool shop. The last named branch includes shops for mining machinery, gas and donkey engines and oil-well supplies.

If a man gets a job in an oil-tool shop and has never worked in this kind of a shop before, it may bother him at first to swing the work on 45-degree centers and to put in the center-hole with a prick punch. Flat drills are used almost universally except in the drill press. The "joint-turner" is a specialist here and is paid $4.50 for nine hours. The average wage of a good mechanic is 40 cents per hour, but by going to the oil fields, a good oil-tool man can get $6.00 per day with house rent, gas and water free. Nevertheless, it is difficult to keep good men in the oil fields even at that price. Good machine blacksmiths on oil-tool work receive from $5.00 to $7.00 per day, tool dressers from $4.00 to $5.00, and helpers in the shop where the writer is employed get $2.50 for nine hours, with time-and-a-half for over-time and double time for Sundays and holidays.

Los Angeles is an open shop town and efforts to unionize it have thus far failed. The strike inaugurated more than a year ago has practically been unsuccessful, although there are men "out" who still have hopes. The railroad shops appear to be holding their own although it was alleged that there was a complete "walk-out" at the time of the beginning of the strike. Unless the railroad machinists, however, are aided by the engineers and trainmen, it would seem that the chances are against a complete victory for the strikers.

Besides the work here, however, we must consider the climate; although hardly any two seasons are alike, we have no severe weather changes. It is much more comfortable here than in the East, and the only snow we see is on the mountains. There are a great many places to go to for recreation, both on the mountains and at the seashore. The thermometer registers as low as 40 degrees F., and as high as 100 degrees. Los Angeles is no place for consumptives or for those having bronchial troubles. We have fogs at different times of the year, but they furnish moisture for our fruit growers and tone down the temperature of the hot days. There are a great many old people here who expect to, and do, live longer than in the East. The cost of living, in the writer's opinion, is as low as in the East.

* * *

GERMAN VIEW OF TRADE SECRETS

A remarkable decision relating to trade secrets was recently handed down by the highest German court. Several men who had been employed in a factory started a competing works and utilized, in the new undertaking, their knowledge of various decorative designs of the former employer. The latter brought suit on the basis of the German law against unfair competition and the lower courts decided in his favor, but the highest court reversed this decision and stated that the members of the new company acted within their lawful rights. According to the opinion of the court, trade secrets which are confided to an employe, or which become known to him in a legitimate manner in the course of his employment, may not be disclosed by him to outside parties while he remains in that employ; but the prohibition ends with the period of employ, and the acquired knowledge may be used thereafter in any way.

* * *

DECISION IN KRUPP PATENT SUIT

For several years the Krupp Co., of Germany, has been in litigation with the Midvale Steel Co., of Philadelphia over certain armor plate patents. Four suits were brought to restrain the Midvale Steel Co. from manufacturing armor plates, it being alleged that the processes used infringed the Krupp patents. The United States Circuit Court of Appeals handed down a decision October 11 dismissing the suits. The decision given by Judge Joseph Buffington stated that the evidence was not sufficiently satisfactory either in quality or amount to establish an infringement. It was declared by the court that two of the claims of the Krupp patents are invalid and that there could be no infringement of them even if the same process was employed by the defendant.

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MAKING DIES FOR HAMMERING MACHINES

By CHESTER L. LUCAS[*]

Machine hammering, a process akin to swaging, plays an important part in the manufacturing processes in the jewelry and allied trades. A greater variety of work may be hammered than it is possible to swage, and for this reason the process is adapted to the forming of ornamental shapes, such as beaded work and jewelry parts, either from solid stock or tubing. The advantage of the process over screw machine production is threefold; less material is required for the work, the resulting product is stronger on account of the compression of the metal, and the surface of the stock is not removed, thus making it possible to work rolled gold-plated wire and tubing. The hammering machine is not a competitor of the screw machine, although many classes of work can be done better by the hammering machine.

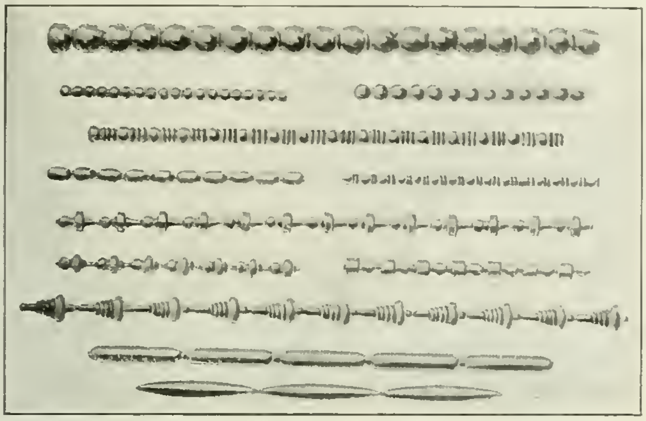
Fig. 1. Samples of Products of the Hammering Machine

Fig. 1 conveys an idea of the range of work that may be done on this machine. This illustration particularly shows the value of the hammering machine in the optical and kindred trades. The Langelier Mfg. Co., Providence, R. I., makes a great many dies for these machines, and as the die-making operations, as well as the hammering process itself, are a little out of the ordinary, a description of the work may be of interest.

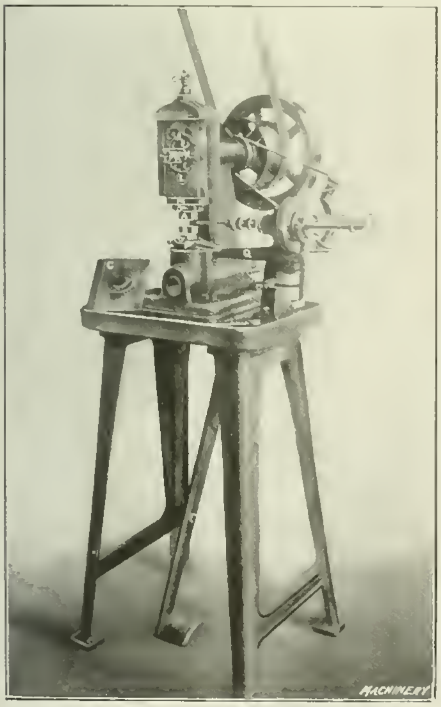
Fig. 3. Hammering Machine with Front Plate removed to show Operating Mechanism

Fig. 4. Finishing the Hob for Making Hammering Dies

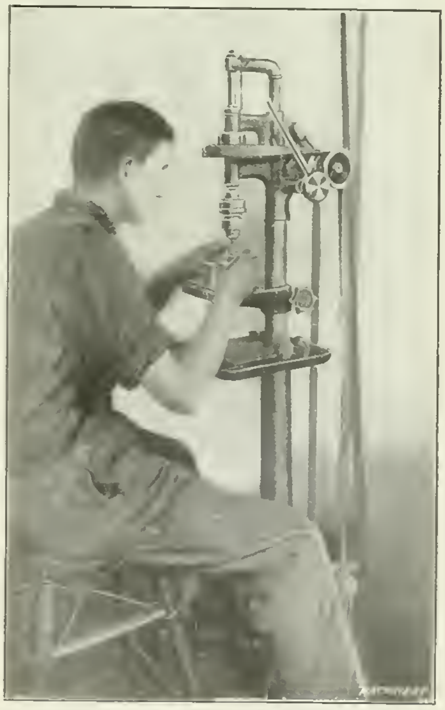
Fig. 5. Reaming the Impressions in the Dies by the Use of the Hob

The "Baby" Hammering Machine

Fig. 3 shows the smallest size of the Langelier hammering machines with the front plate removed to show the construction of the operating mechanism. This machine will operate on work of brass or composition wire up to 1/8 inch in diameter, and tubing, the walls of which are not over 0.024 inch thick, up to 1/4 inch in diameter. The fact that tubing may be worked by this method makes it possible to manufacture hollow beads from gold-plated tubing.

In the illustration of the hammering machine, Fig. 3, the dies are shown at *A* and *B*, with a piece of work in process of being hammered into shape. The lower die *B* is adjustable in height, being raised or lowered by a foot lever that carries a pinion at its upper end, which in conjunction with rack *D* operates a cross-slide. As the top side of this slide is wedge-shaped, and the lower face of the anvil-block is also wedge-shaped, the anvil-block that carries the lower die may be raised or lowered at will by the foot lever.

While being hammered, the stock is held in a small chuck *F*, at the end of the rotating spindle *G*. This rotating spindle may be turned by the handwheel *H*. By throwing in the friction clutch, the spindle and work will be automatically rotated. The spindle is driven by a tongue extending throughout its length, but it may be moved laterally by hand when feeding the work. By means of trip *P*, attached to the anvil-block, the clutch is automatically thrown in as soon as the die is raised to the work. As soon as the die is lowered, trip *P* comes into contact with arm *Q*, throwing out the clutch and stopping the rotation of the spindle.

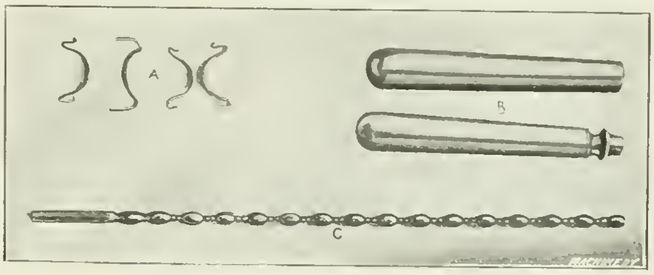

Fig. 2. A, Nose-pieces used in Optical Work; B, Hammered Knife Handle and Blank for Same; C, Hammered Work produced by the Machine shown in Fig. 8

The force of the blow is regulated by a set-screw *O* at the top of the machine. The operating mechanism consists of six rollers *J* which actuate the slide *M* that carries the upper die. These rollers are carried in the roller cage *K* which is integral with the driving shaft. While the rollers are held in this roller cage, they project through its outer edge, so as to extend slightly beyond it. Then, as the shaft revolves, these rollers successively strike roller *L* which is similarly encaged in slide *M*. This slide is kept normally raised by a spring, not shown, so that it returns to its normal position after each downward impulse produced by the revolving rollers *J* striking against roller *L*. As six blows are struck during each revolution of the shaft, the action takes the form of a continuous vibration. On some classes of work, the upper die strikes 3600 blows per minute.

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[*] Associate Editor of MACHINERY.

Making the Hob for a Die

The important factor in turning out a pair of dies for the hammering machine is the hob, or reamer, by means of which the impressions are cut in the die blanks. Fig. 9 shows at *A* a number of hobs that have been made and used on past jobs. Needless to say, these hobs are very carefully kept, in case the dies should require renewal. In making a hob, the first step is to lay out and file a sheet metal templet, covering five or six units of the design, to shape. The hob is then roughed out in a lathe, using the templet as a guide. The die-maker interviewed, used the tool-holder and tools shown at *B* and *C* in Fig. 9 for this operation. After the hob has been roughed out, a forming tool like that shown at *D* is made to fit one section of the hob, and one section of the hob at a time is brought to shape.

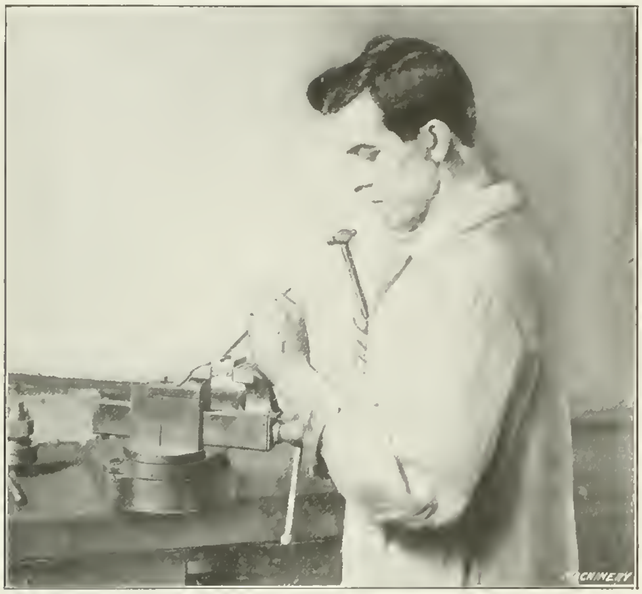
Fig. 6. Chipping the Clearance in a Pair of Dies

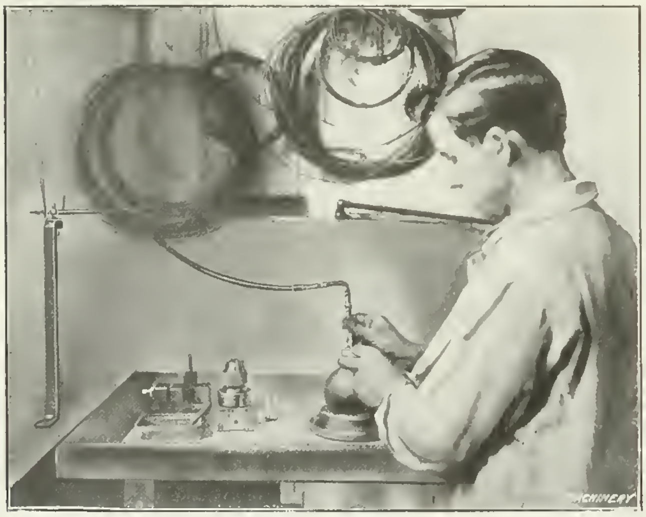
Fig. 7. Polishing a Die by means of a Flexible Shaft, Boxwood Tips and Carborundum

The hob is cleaned up and finish filed in a speed lathe, as shown in Fig. 4. Hand tools are used exclusively in putting on the finishing touches, the die-maker trying the templet often to make sure that it fits correctly. As soon as one or two units of the hob have been finished, the stock is drawn farther out of the chuck and the new section worked upon. After the hob has been finished to fit the templet, it is ready for fluting. The fluting operation is a simple one, being done with a very acute-angled cutter like that shown at *E* in Fig. 9. The hobs are relieved by hand filing, hardened, and drawn to a straw color.

Reaming the Impressions in the Dies

The die blanks themselves are made of tool steel, turned up with shanks three-quarter inch in diameter. For most work, the faces of the dies used in this size of hammering machine are made one inch wide and two inches long. In Fig. 9, *F* shows the face view of a pair of dies, and *G* shows the end view. In cutting, or as it is called "reaming" the shape into the die blanks, the bulk of the steel is first removed from the blanks in a shaper. Not only does this facilitate the work of quickly removing the metal, but the shaped recess serves to guide the hob when starting to ream the dies. The clamp shown on the bench in Fig. 7 is employed for holding the dies while being reamed. The hob is held in a drill press, in the same manner as a reamer, and the dies are held in contact with it by the special clamp in the manner illustrated in Fig. 5. At first the dies are but lightly clamped against the hob or reamer so that they will not catch. Gradually the dies are clamped tighter upon the hob, until finally the faces of the dies meet, thus indicating that the hob has been sunk to its full depth. The impressions must be cleaned out occasionally during the reaming, and plenty of good lard oil must be applied to obtain smooth surfaces.

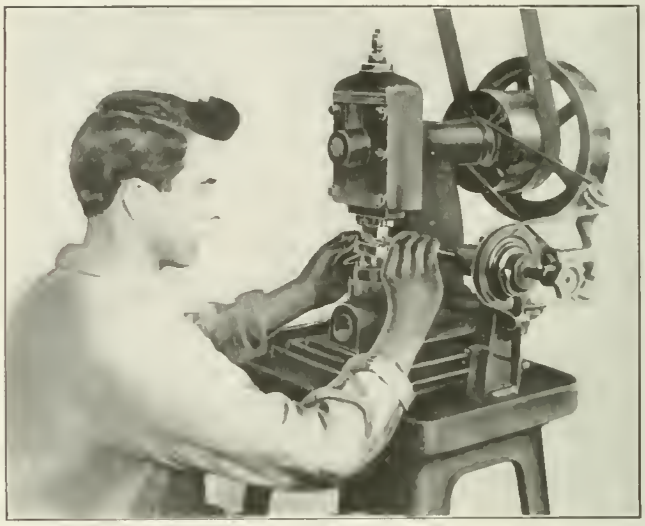
Fig. 8. Method of using the Hammering Machine

Finishing the Dies

Fig. 6 illustrates the die-maker chipping the clearance at the edges of a die impression. The edges of the impressions are very sharp, and of perfect form after reaming, but in this condition they would mar the surface of the stock being hammered. After the edges have been slightly chamfered by chipping, they are smoothed up with file and emery cloth; then the dies are ready for hardening. The die on which the work-

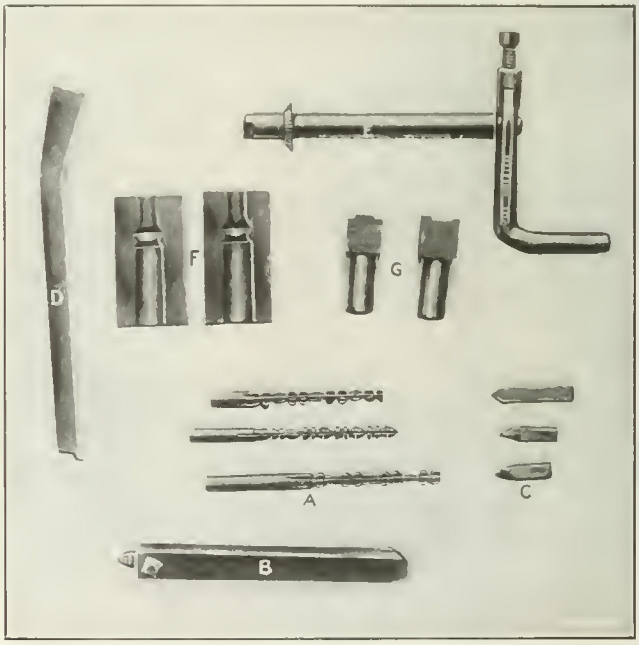

Fig. 9. A Few of the Special Tools, Hobs and Dies

man is chipping the clearance in Fig. 6 is one of the pair shown at *F* in Fig. 9, and the work that these dies do is well illustrated at *B* in Fig. 2. The upper piece is the steel blank for a hollow knife handle, and the lower piece shows how it appears after the hammering operation. From the photograph it will be seen that the hammering has increased the length perceptibly. The making of the hollow handle blank itself is an interesting operation—but that is another story.

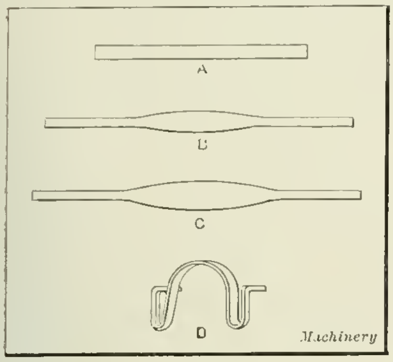

Fig. 10. Eye-glass Nose-piece and its Development

Not the least interesting part of the die-making is the polishing operation that follows the hardening. The dies must be well polished before being put into use, and this is accomplished by the use of a flexible shaft that terminates in a small chuck, as shown in Fig. 7. The die is held in a ball-vise, and is polished with boxwood sticks that are held and revolved by the chuck. Fine carborundum and oil are applied, so that the boxwood points really become laps. Power is supplied by a string belt from an overhead shaft.

In making dies for work that is to be separated, like small ornaments or beads, the dies are left with a cut-off at one end, so that as the work is moved forward in the dies, one section will be completed and cut off at each forward movement of the stock. In all hammering dies, each succeeding pair of units of the design is slightly smaller than the previous pair nearer the end where the stock enters, so that each set of sections of the dies closes the metal down a little more until it is finished by the last set. In changing the position of the work, the foot lever is released, allowing the lower die to drop enough to shift the tube or rod forward one section.

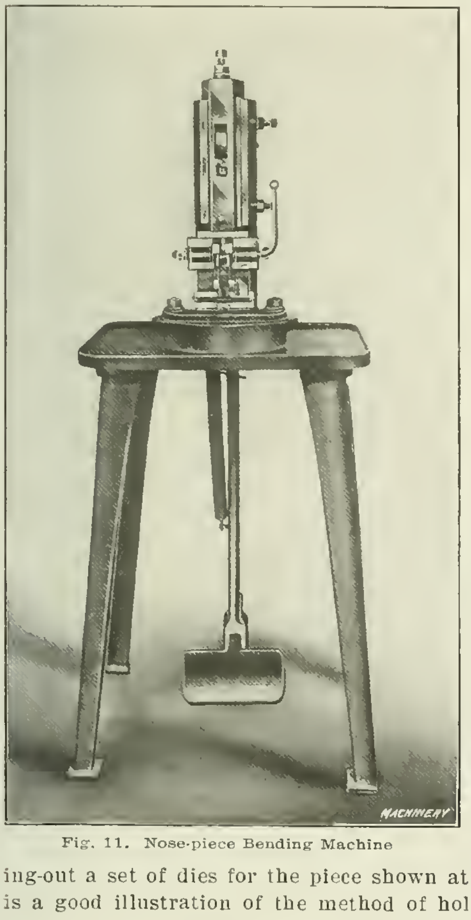

Fig. 11. Nose-piece Bending Machine

Fig. 8 shows the die-maker trying-out a set of dies for the piece shown at *C* in Fig. 2. This is a good illustration of the method of holding the work and the operation of the hammering machine.

Nose-piece Bending Machine

Although a little apart from the subject of this article, it may be well worth mentioning an extremely interesting piece of wire forming which Mr. J. B. Palizza, engineer for the Langelier Mfg. Co., showed the writer. The work consisted of nose-pieces used in manufacturing eye-glasses. Some of the different styles of these nose-pieces are illustrated at *A* in Fig. 2. The wire from which these are usually made is gold-filled, and a great deal of it is made in the manner described in an article entitled "The Making of Seamless Gold Wire," published in MACHINERY, March, 1911, engineering edition.

The wire is first cut to length as shown at *A*, Fig. 10, after which each end is swaged down as shown at *B* in the same illustration. The saving in stock effected by the use of the swaging operation is very apparent, and as has been mentioned before, the swaging operation does not injure the gold covering of the work. The blanks are now annealed so as to make them soft enough for the two succeeding operations. The third step, shown at *C*, Fig. 10, consists in flattening the swaged blank throughout its length, and the result of the final operation of bending the nose-piece to shape is shown at *D*.

Fig. 11 shows the machine used for bending the nose-piece to shape. By its use, various shapes and sizes of nose-pieces may be bent by substituting different formers in the dies. The dies themselves, as well as the foot press in which they are used, are the work of the Langelier Mfg. Co.

The construction and operation of the machine may be followed by referring to the view in Fig. 12. The lower half of the dies consists of a bolster *A*, bolted to the bed of the press. Upon this bolster, the two halves of the lower die are mounted on slides *C*, and kept normally together by spiral spring *D*; *E* is an adjustable gage used for locating the blanks in the dies. At *F* is shown the shoe that holds the blank firmly in place until the main former *G* comes down to make the principal bend. The lower die sections support the wire, while the upper die sections *H* are bending the ends, and former *G* is bending the nose section. Hand lever *I* operates shaft *J*, which carries the two punches *L*, the function of which it is to offset the ends of the nose-piece.

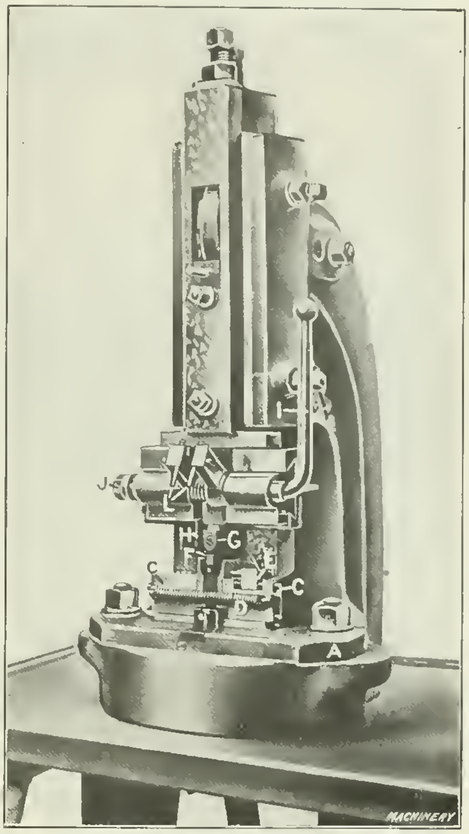

Fig. 12. Mechanism of Nose-piece Bending Machine

In operation, the blank is laid across the lower die sections and against gage *E*. Foot pressure upon the treadle brings down the ram of the press, causing the upper die sections *H* to bend down the outside ends, while former *G* is making the main bend. At the end of the stroke, pressure is still retained upon the treadle while the operator brings forward lever *I* to offset the ends of the nose-piece by means of punches *L*, as mentioned. The whole bending operation requires but a few seconds, and is easily carried out by an unskilled operator.

Credit is due to Mr. A. T. Langelier, treasurer of the Langelier Mfg. Co., and Mr. A. J. Langelier, manager of the factory and designer of the machines illustrated, for courtesy shown the writer in the preparation of this article.

* * *

Paint which indicates changes of temperature by a change in color can be made, according to the *Mechanical World*, by a mixture of 7 parts of saturated solution of potassium iodide and 134 parts of saturated solution of mercuric chloride with 1 part of pulverized copper sulphate and the necessary oils and driers. The paint changes its color between 115 and 130 degrees F., and can be applied to any surface of which it is desirable to determine the temperature. The range of temperature at which the color-changes take place may be slightly varied by altering the proportions of the ingredients.

RE-CUTTING MILLING CUTTERS WITHOUT ANNEALING

By F. B. JACOBS*

In everyday shop practice it is customary to sharpen ordinary milling cutters on the periphery only. There are two reasons for this: One is that the side teeth seldom become dull after they have been backed off, and the other that it is often impractical to re-sharpen the side teeth as a given size has to be maintained. The result is that as soon as the peripheral teeth have been nearly ground away by repeated sharpenings, the cutter finds its way to the "tool steel scrap," to be sold for a very small percentage of its actual value. Experience teaches us that to anneal and re-cut milling cutters in the regular way is not practical, although it is sometimes done, to keep a toolmaker busy or to give the apprentice boy experience. It is not practical because the size of the hole is always "lost" in annealing, and generally twenty-five per cent of the cutters are lost in rehardening, owing to fire cracks.

It is common practice in some shops to re-cut small or thin cutters, milling saws for instance, by hand. The method generally employed is to lay them on a wide rest and feed the teeth, one after another, toward the center of a grinding wheel, the face of which is trued to the proper angle. This method is not practical on large or wide cutters as the circumference of the wheel leaves the teeth hollow, and the accurate spacing of the teeth is invariably lost. Again, the ordinary wheel, as used for cutter sharpening, will not hold its shape long enough to do more than three or four teeth without re-dressing, which of course wears away the wheel very rapidly.

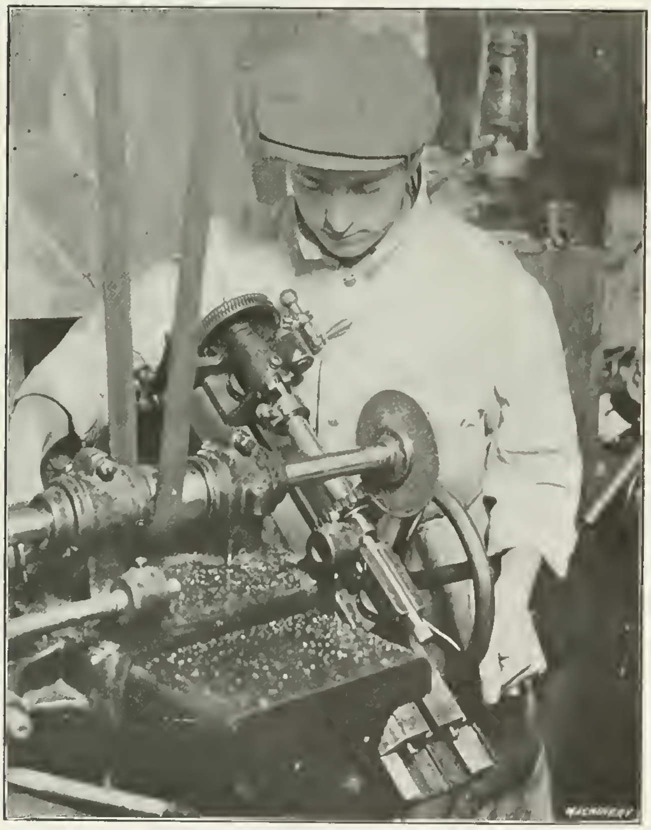

Fig. 1. Re-cutting Milling Cutters in Brown & Sharpe No. 3 Cutter Grinder

However, if the following practical method is employed, no machinist will experience any difficulty in reclaiming many cutters that are now peacefully reposing in the scrap box, awaiting the call of the junk man. An ordinary automatic surface grinder can be used, provided it is equipped with dividing centers. As the writer's experiments in this line were conducted with a No. 3 Brown and Sharpe cutter grinder equipped with a form-cutter grinding attachment, the method used in that case will be described.

The cutter, shown in Fig. 2, was held on an arbor between the centers of the cutter grinder, as shown in Fig. 1, and the teeth were gashed out one after another. (See Fig. 3.) For this purpose, an aloxite vulcanite wheel 7 inches in diameter, ⅛-inch face, 1¼-inch hole, 39 grit, V-K-9 bond was used. This wheel was run at a speed of 4370 R. P. M. A higher speed would be practicable, as a vulcanite wheel must be run at a very high speed to show high efficiency. Contrary to the general rule, wheels with vulcanite bond do not burn the work when run at high speeds. With the cutters in question, the gashing was made ⅛ inch deep. One tooth was done at a time, with three cuts, one after another, so that each cut was approximately 0.042 inch deep. With this cut no evidence of burning was noticeable. The direction of the wheel and feed should be the same, or in other words, the same as a gear and rack run together. When fed in the opposite direction, which on first thought appeared to be the more practical way, it was found that the wheel had a tendency to burn, in breaking through. After the first tooth was gashed to the required depth, the graduations on the cross-slide screw were relied on to determine the proper depth for the remainder of the teeth. On each tooth, the cutter was set to bring what was left of the original face to within a few thousandths of the wheel. The old teeth were relied on wholly for the proper spacing. The object of this gashing was to preserve the corner of the wheel used for the second operation, which consisted of grinding away the superfluous stock between the bottom of the gashes and the points of the teeth.

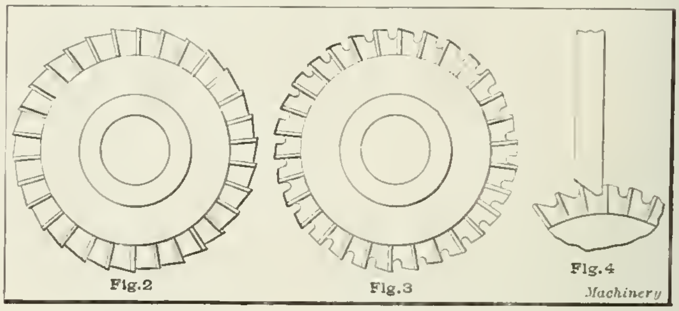

Fig. 2. Cutter to be re-cut Fig. 3. Cutter after First Grinding Cut Fig. 4. Effect of Final Grinding Cut

In this operation, the cutter was held as before and the teeth were ground out one at a time by being fed under a wheel having its face trued to the proper angle. (See Fig 4.) An aloxite wheel 5 inches in diameter, ⅜-inch face, 1¼-inch hole, 50 grit, 0 grade, D496 bond was used, the speed being 3500 R. P. M. The wheel was set central, and in re-cutting, the face of each tooth was brought to within a few thousandths inch of the back or flat side of the wheel. The cutter was then fed back and forth under the wheel taking a chip of approximately 0.002 inch at a time, until the land of the tooth was of the proper dimension, or about 1/32 inch wide. The cutter was then turned just enough to bring what was left of the original face of the tooth to bear on the back side of the wheel. This removed the small amount of stock not taken out by the first operation, and matched up the side and face teeth.

It is somewhat difficult to give exact figures regarding the time it should take to re-cut cutters of different dimensions, as the human element has to be taken into consideration. The writer's time for gashing, re-cutting and backing off two "Novo" steel cutters 3 5/16 inch in diameter, 1/2-inch face, having thirty teeth, was two and one-half hours. As this work was wholly of an experimental nature it is reasonable to assume that any machinist could, with a little practice, do the same work in much shorter time. For an illustration, assume that a machinist of ordinary ability, at 30 cents per hour, takes two and one-half hours to re-cut the cutters mentioned. Two and one-half hours at 30 cents per hour equals seventy-five cents. As the cutters in question, when re-cut, are practically as good as new, it does not take an expert on production costs to see that it is worth while to reclaim the worn-out cutters by the method described.

* * *

The factory full of contented men when cold weather comes is the one properly equipped with heating apparatus which is kept in good order and working.—*The Wood-worker.*

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* Address: Care of The Carborundum Co., Niagara Falls, N. Y.

THE ROSS RIFLE AND ITS MANUFACTURE—3

THE PROCESSES EMPLOYED IN THE MANUFACTURE OF A MILITARY RIFLE OF UNIQUE DESIGN

By DOUGLAS T. HAMILTON*

While extremely simple in operation, the Ross rifle is far from being an easy manufacturing proposition. It requires about 1142 separate and distinct operations to make the complete rifle. The receiver, bolt sleeve and bolt are the most difficult parts to produce, with the exception of the barrel, as far as the machining operations are concerned, and it is the manufacture of these and other minor parts, which will be dealt with in the following article.

The receiver, shown in Fig. 29, requires some forty different operations, and is one of the most important parts of the Ross rifle. After being drop-forged, the front and rear ends are drilled in an upright drill press of special design, shown in Fig. 34. The front end *A* is then recessed and faced in a hand screw machine, after which the bottom face *B*, terminating at the point *C*, is milled in a Lincoln milling machine, using a straight milling cutter; this operation is completed in one pass of the cutter.

The receiver is next taken to the Lincoln milling machine, shown in Fig. 30, where the circular cut *D* on the front end is made. This operation is performed more quickly and the work is given a better finish in the Lincoln miller than would be possible in the lathe. The receiver *A* is held on two plugs fitting in the drilled holes in each end and is clamped to a revolving fixture which is rotated through 180 degrees by means of a worm and worm-wheel enclosed in the cast-iron box *B*. The worm is driven by a bevel gear *E*, which is operated from the rear of the machine through spur gearing. The worm-wheel is directly connected to the work-holder *F*, and the rotation of the latter is stopped at the desired point by the indexing holes in the worm coming in contact with a finger, which throws out the feed. The cutter *C* finishes the circular part, and the cutter *D* chamfers the end.

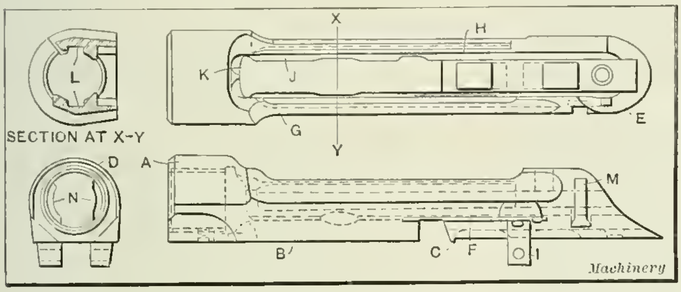

Fig. 29. Plan, Elevation and Sectional Views of the Receiver

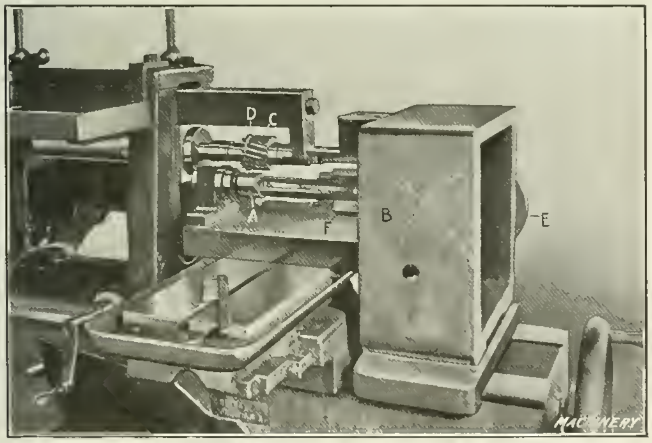

Fig. 30. Milling Circular Portion of the Receiver in a Lincoln Miller

The circular part *E* on the rear end of the receiver (see Fig. 29) is then finished in the Lincoln milling machine in a similar manner to that just described for the front end. A saw slot *F* for the cut-off which ejects the empty shell is next cut in the Lincoln miller, after which the left- and right-side top angles *G* and *H* are profiled in a Pratt & Whitney machine. During these operations the receiver is held on studs fitting in both ends, which are used for locating it during all the subsequent operations. The opening between the lugs *I* is now profiled, after which the top angle *J* on the right side is finished. The inside face of the receiver is next profiled for the bolt sleeve clearance, and the opening for the magazine is made. The part around the ejector slot is then profiled, after which the cartridge opening *K* is finished in a similar manner.

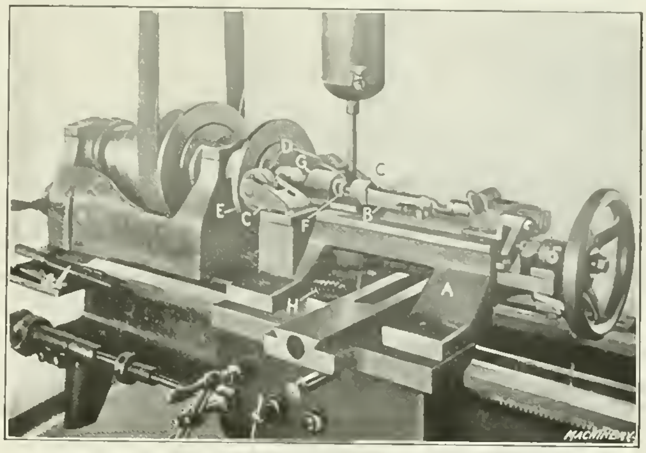

Fig. 31. Cutting the Cam-faced Lugs in the Receiver

The next operation is to cut the guide slots *L* in the receiver for the tongues on the bolt sleeve. The slot *M* for the bolt stop is then cut in two operations. In the first operation the straight slot is cut, and in the second operation the T-shaped portion at the bottom is cut, forming a seat for the bolt stop.

Cutting the Cam-faced Lugs in the Receiver

The receiver is now ready to have the cam-faced lugs cut, behind which the lugs on the bolt are locked. This is done in a lathe especially fitted up for this purpose, which is shown in Fig. 31. A cast-iron fixture *A* straddles the ways and is fastened to the carriage. This forms a base on which there is a slide, carrying a fixture provided with a center and clamping device, which holds the receiver *B*. Two brackets *C* attached to the base *A* are furnished with rollers *D*, which rotate on a face cam *E*, the latter being screwed onto the nose of the spindle in a similar manner to an ordinary faceplate. An arbor *F*, fitting in the nose of the spindle and supported in the bracket *G*, carries a small cutter (not shown) which is used for cutting these cam-faced lugs. The 3-inch rollers *D* are held in contact with the face cam *E* by coil springs *H*.

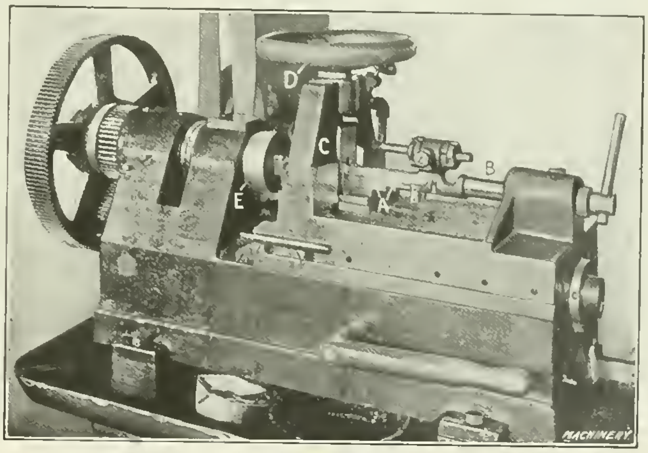

Fig. 32. Tapping the Threads in the Receiver, used in fastening it to the Barrel

In operation, the face cam *E* transmits a reciprocating motion through the rollers *D* to the carriage, which is disconnected from the regular feed-screw, thus allowing it to be moved back and forth. Cam *E* is only provided with one projection, which comes in contact with first one and then the other roller, thus taking a cut off both cam-faced lugs for each revolution of the spindle. The feeding of the work to the cutter is accomplished by the back-and-forth movement of the carriage holding the work, which, through a cam and roller, operates a finger, the latter rotating a ratchet disk connected to the feed-screw attached to the top slide.

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* Associate Editor of MACHINERY.

Cutting the Thread in the Receiver

The front end *A* of the receiver, Fig. 29, is furnished with a buttress thread of 1/20 pitch, by means of which it is attached to the barrel. This thread is first roughed out by a small cutter of the desired shape. The machine in which it is accomplished consists essentially of a head, provided with a thread of the correct pitch and furnished with a clamping member in which the receiver is held. The forward travel of the work is guided by this master thread, and the internal cutter cuts the thread. The cutter is started in a certain relation to the receiver, so that it will match up properly when assembled on the barrel.

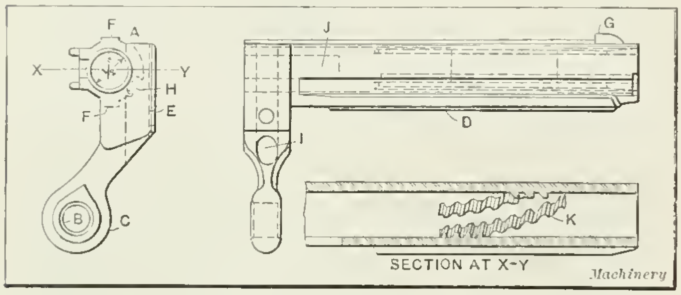

Fig. 33. The Bolt Sleeve—Section showing the Threaded Ribs

The thread is only roughed out in this operation, and is finished with a tap. The receiver *A* is held on the rear center *B* of the machine shown in Fig. 32, and is clamped in a fixture in the head *C* by means of the handwheel *D*. A tap held in the head *E* has a slot cut in it acting as a locating point. The carriage carrying the receiver is fed forward by a lead-screw having the same pitch as the tap. The machine is driven by friction pulleys at the rear through the gearing as shown, and the spindle is reversed by shifting the belt from one pulley to the other.

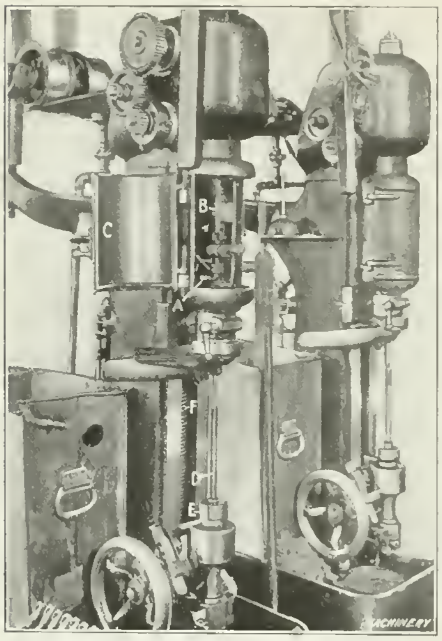

Fig. 34. Drilling the 1/2-inch Hole in the Bolt Sleeve

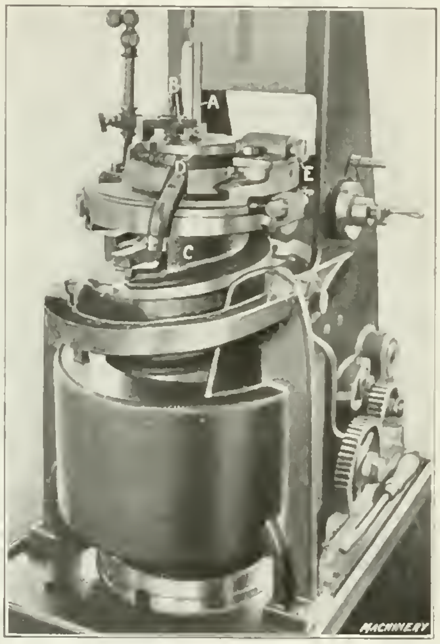

Fig. 35. Cutting the Spiral Grooves in the Bolt Sleeve

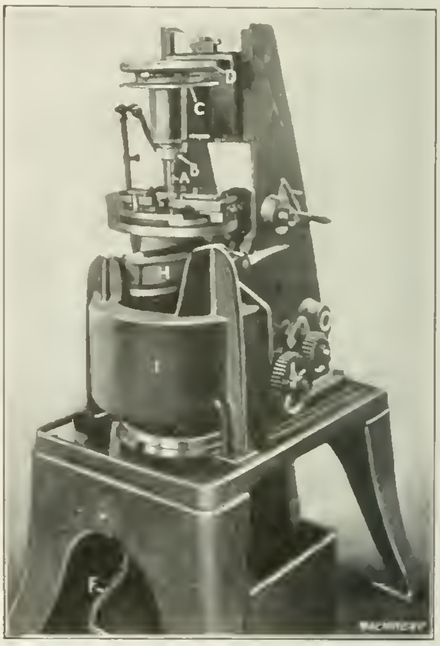

Fig. 36. Cutting the Spiral Ribs on the "Straight-pull" Bolt

Three holes are now drilled in the front end of the receiver, two of which are tapped out for the screws that hold the trigger guard, while the third hole is tapped out to fit a screw acting as a cam for starting the rotation of the bolt. After this the bolt sleeve clearance is profiled, and the name rolled in the side, when the receiver is ready for polishing and hardening in oil.

Machining Operations on the Bolt Sleeve

The bolt sleeve shown in Fig. 33 is made from a drop-forging, for which two dies are used, one for breaking down and the other for finishing. The drop-forging is milled to length, after which the hole *A* is drilled in the upright drilling machine shown in Fig. 34. The bolt sleeve *A* is held in a jig *B* in the revolving head of the machine, and when it has been set, the cover *C*, shown thrown back, is closed, thus preventing the oil from flying around. The hole is drilled with a C-drill *D*, which is of the same type as that used for drilling the hole in the barrel. This drill is not revolved; it is held in the head *E*, which is fed up automatically by the feed-screw *F*, the head being returned to the "down" position when the hole is completed by means of a trip, which, through gearing, reverses the direction of rotation of the feed-screw.

The ends of the sleeve are now faced in a lathe, after which the hole *B* (see Fig. 33) is drilled and counterbored. This hole *B* and the hole through the receiver are used as locating points in the subsequent operations. The handle *C* is then circular milled in a milling machine, the bottom face *D* is milled in a Lincoln miller, the top face *E* is finished, and the sides of the ribs *F* are milled, after which the under side is finished. The back face of the lug *G* is then milled and the sides of the ribs are profiled.

The next operation is to place the sleeve in a profiling machine and profile the extractor slot *H*. This requires three cuts; the square part of the slot is milled with a circular cutter and a T-shaped cutter mills out the beveled sides which retain the shell extractor. The top of the sleeve is milled with a circular form cutter in the milling machine and the hole *I* for the bolt lock is drilled in a jig. The hole *A* is ½ inch in diameter, which is the root diameter of the thread in the bolt sleeve. The bolt sleeve is now counterbored on each end to the outside diameter of the thread in an upright drilling machine, after which it is reamed on both ends. The slot *J* for the cocking piece is then milled, leaving the bolt sleeve ready to have the spiral grooves cut.

Cutting the Spiral Grooves in the Bolt Sleeve

The spiral grooves having a pitch of 4.86 inches are cut in the machine shown in Fig. 35, where the bolt sleeve *A* is held by a clamp *B* to the top face of the "spiral" head. A bar, similar in shape to a boring-bar, is inserted in the sleeve, and is provided with a small cutter. This bar is held to the spiral head *C*, which is provided with a master screw of the same pitch as the grooves to be cut in the bolt sleeve. That

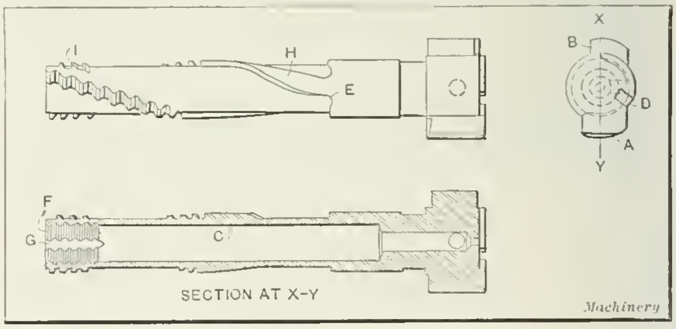

Fig. 37. Three Views of the "Straight-pull" Bolt

part of the machine holding the sleeve remains stationary, the head *C* alone rotating and thus traveling up and down, while the tool cuts the spiral grooves. The cutter is fed in to the required depth automatically by a feeding arrangement similar to that used on the profiling machine, while the indexing is accomplished by hand. The plate *D* is provided with four notches in which a spring plunger *E* fits. As soon as one groove is cut to the required depth, this spring plunger is drawn back and the head is indexed.

The buttress thread *K*, Fig. 33, is now cut in the bolt sleeve; this operation is performed with a tap in a machine similar to that shown in Fig. 32. The grooves cut in the machine, Fig. 35, were only 3/16 inch wide and have to be increased in width, so the bolt sleeve is taken to another machine, similar to that shown in Fig. 35 but equipped with a wider cutter. This operation is called "shaving between the false working spirals." The bolt sleeve is now finished, except for carbonizing, polishing, hardening and inspecting.

Machining Operations on the Bolt

The bolt, shown in Fig. 37, is made from tool steel in an Acme automatic screw machine. The sides of the lugs *A* and *B* are straddle-milled in a Lincoln milling machine, after which the hole *C* is drilled in the barrel drilling machine shown in Fig. 18 in the November installment. This hole is then reamed to 0.375 inch, the ejector slot *D* is profiled, and the "vent" holes *E* for the starting of the spirals are drilled. The buttress thread *F* for the firing pin and spring retainer is then tapped in a hand screw machine, and the slot *G* broached in a punch press.

Forming the Spiral Ribs on the Bolt

The grooves forming the long spirals *H* and the short spirals *I* are cut in the spiraling machine, Fig. 36, after which two of the ribs are partly removed in a machine of a similar type, leaving the short spirals as shown in Fig. 37. The construction of the machine shown in Fig. 36 is similar to that shown in Fig. 35 as far as the working of the spiral head is concerned, but the work is held in a different manner and is operated upon differently. In the machine shown in Fig. 35, the bolt sleeve is rotated around the cutter, while in the machine shown in Fig. 36 the cutters are rotated around the bolt, the latter remaining stationary in the chuck *B*.

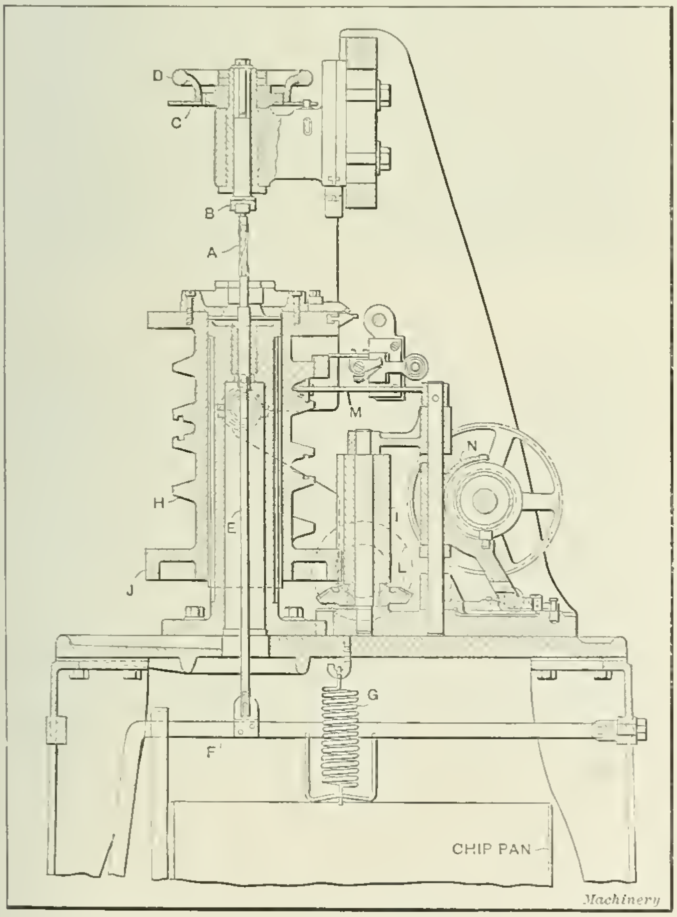

Fig. 38. Sectional View of Spiraling Machine used in Cutting Spiral Ribs on the Bolt

While the two illustrations Figs. 35 and 36 give a fair idea of the construction of these spiraling machines, a better understanding of their operation can be obtained by referring to the illustration Fig. 38, which is a sectional view of the machine shown in Fig. 36. The bolt *A* is here shown in position in the chuck *B*. but the four cutters are not shown. When this machine was first designed, the cutter head contained only one cutter, so that it was necessary to index the work for each groove, the plate *C* and handwheel *D* being used for this purpose. Lately this machine has been redesigned and has been fitted with four cutters, which eliminates the necessity of indexing the work. The chuck *B* is cut out to fit the lugs on the bolt *A*, preventing the latter from turning. The bolt is held up in the chuck by a rod *E*, fitting in the hole in the forward end, and is forced upward by means of the lever *F*, which is shown protruding from the machine in Fig. 36, and spiral spring *G*. The work is removed from the chuck by simply depressing the lever *F*.

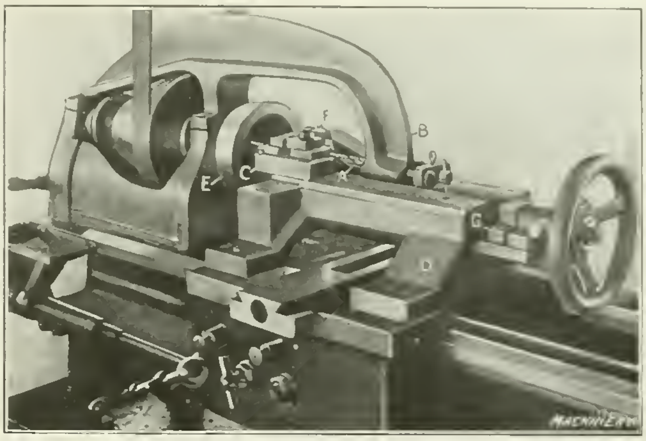

Fig. 39. Cutting Cam-faced Lugs on the Bolt

The driving power for the master worm *H*, which has the same pitch as that required on the bolt—4.86 inches—is obtained through a belt from the overhead works and is transmitted through spur and bevel gearing to the pinion *I* which meshes with the spur gear *J* cast integral with the master worm. The pinion *I* is driven by bevel gears *L* and is reversed to move the head up and down by means of a link *M* operating in the master worm and connected to a clutch *N*, which is disengaged from one train of gears to move the master worm up, and engaged with another train rotating in the opposite direction to bring it down. The worm is guided by lugs cast integral with the outer casing *I* of the base, Fig 36.

Shaving the Extractor and Locking Cams on the Bolt

The two lugs *A* and *B*, Fig. 37, are provided with cam faces, which lock behind corresponding cam-faced lugs in the receiver. These lugs are faced in a lathe provided with a special attachment, as shown in Fig. 39. The bolt *A* is held rigidly on centers. one of which is in the head, and the other in the arm *B*, while a cutter, held on the slide *C*, faces the rear faces of the lugs. The fixture *D* straddles the ways and is fastened to the lathe carriage, the latter being disconnected from the feed-screw. A face cam *E*, screwed onto the nose of the machine spindle, gives a reciprocating motion through a roller *F* to the carriage. The top slide *G*, carrying the cutter, is fed in by a ratchet device somewhat similar in design to that shown on the machine in Fig. 31. The front cam face on the lug *B* is cut in a similar machine.

The buttress thread on the spiral ribs *H* and *I* is cut in a machine somewhat similar in design to that used for cutting the thread on the breech end of the barrel. The space between the spiral ribs is relieved in a spiral machine of the type shown in Fig. 36. After a few minor operations, such as profiling the extractor slot *D*, the bolt is fitted to the receiver gage, hardened in oil, and ground in a Brown & Sharpe grinding machine. The lug *B* is ground slightly eccentric on its periphery and acts as a cam. After grinding, the bolt is inspected.

Practically all of the principal operations on the Ross rifle have now been described in detail, but mention might be made of a few additional operations which incorporate certain interesting features. A number of the parts are made from machine and tool steel and are drop-forged. A representative group of drop-forging and trimming dies is shown in Fig. 40. Here *A* and *B* are the roughing and finishing drop-forging dies for the trigger guard; *C*, the dies for the trigger; *D*, the dies for the pawl; *E* and *F*, roughing and finishing dies for the bayonet; *G*, dies for the butt-plate; and *H*, the trimming punch and die for the butt-plate.

As a large number of the parts are made from drop-forgings, they require finishing, and as most of the work is circular milling or milling of irregular form, the majority of the parts are machined in the profiler. An example of profiling is shown in Fig. 41, which shows the profiling of the rounded portion on the trigger guard. Most mechanics are familiar with the operation of the profiler, and it therefore needs no description.

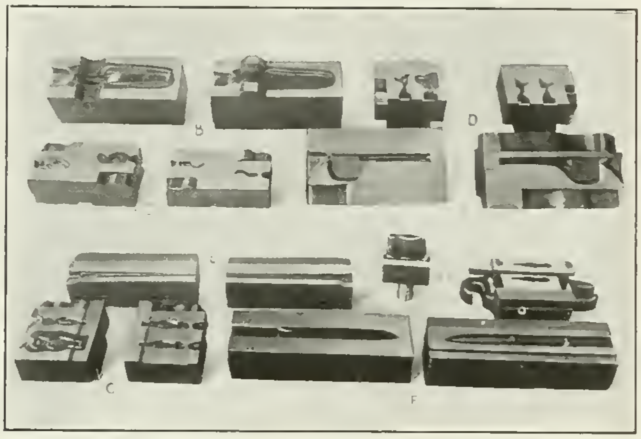

Fig. 40. Drop-forging Dies for Trigger Guard, Trigger, Butt Plate, and Bayonet

Fig. 42 shows the stages in the various operations on the front and rear bands for holding the stock to the barrel, the butt-plate (which is placed on the end of the wooden stock), the trigger guard, trigger, sear, pawl, etc. The samples shown on these boards give a fair idea of the number of operations required on each of the parts. The bands are drawn up from sheet steel, in the powerful geared press shown in Fig. 43. One cupping and five redrawing operations, with annealing in between, are necessary to complete the drawing of these bands. This punch press, as well as the other punch presses throughout the works, is supplied with a C. J. Root counter, shown at *A*, which counts the number of pieces drawn through the press.

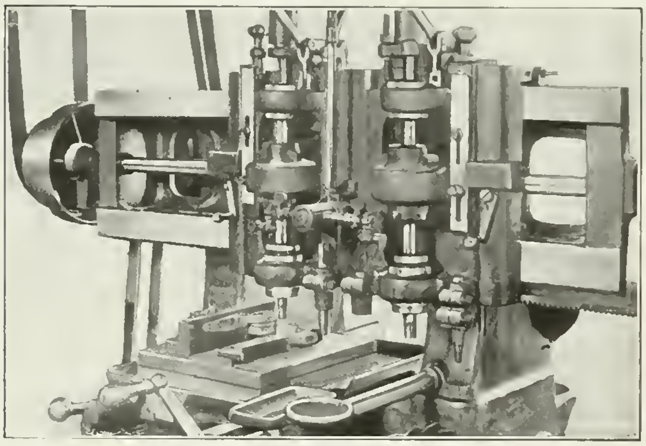

Fig. 41. Profiling the Trigger Guard

Aligning the Front and Rear Sight Bases

After the barrel has been inspected and the sight bases have been finished, it is taken to the assembling department where the rear and front sight bases are assembled. The rear sight base is put in a block jig *B*, as shown in Fig. 44, and this is slipped over the barrel *A* and placed in the fixture. The receiver has been assembled to the barrel, so that the latter is held in position by a clamp *C*, holding down the receiver. The sight base is held in the correct position by a wedge, and is forced onto the barrel to the desired distance by means of the lever *D*. The hole for the pin is then drilled, and the dowel fastening the sight base to the barrel is put in before the latter is removed from the fixture.

The base for the fore sight is now put in a jig *E* which is placed up against a stop on the fixture. Here the jig is so clamped as to hold the sight base in alignment with the rear sight base, and the sight base is pressed back to the point where it is to be fastened. The barrel is now removed from this fixture, a cross hole through the front sight band is drilled, and a pin is driven in.

Setting the Sight and Testing the Accuracy of the Military Rifle

Upon the completion and assembling of all the parts of the 0.303 Ross military rifle, it is taken to the government inspection department where the sights are set and the accuracy of the rifle is tested. The rifle is held in a mechanical rest, as shown in Fig. 45, which is so designed that the rifle will be held approximately in the same manner as when fired under ordinary conditions—in the hands of a soldier—as regards points of support, recoil, etc. The rifle *A* is elevated by means of the handwheel *B*, and is shifted laterally by means of the handwheel *C*. The fore part of the stock is supported against rollers to facilitate the lateral movement of the butt end. A target, similar to that snown at *D*, is placed 100 feet away from the muzzle of the rifle. The white space *E* or the target outline forms a rectangle 1 inch wide by 1½ inch high. Of course this target is placed in an enclosed shed, so that the wind cannot affect the flight of the bullet.

In testing the rifle, trial shots are fired to ascertain if the fore sight is in the correct position. After the inspector has set the fore sight directly in the center of the rectangle *E*, by operating the handwheels *B* and *C*, and has discharged the cartridge, he looks through the telescope *F* to see where the bullet has hit. If he should find that the shot has gone ½ inch to the left, or is centering on the boundary line of the target, Fig. 45, he shifts the rifle laterally by means of the handwheel *C*, so that the sight is located ½ inch to the right of the center of the 1½- by 1-inch rectangle (Fig. 45). He now adjusts the fore sight laterally on the barrel so that it will be in line with the center of the rectangle or target. When the fore sight has been set and the rifle elevated to the proper distance, five shots are fired in rapid succession. All these shots must hit within the 1-by 1½-inch rectangle, and if they fail to do so the rifle is not accepted. The accuracy of this rifle is worth mentioning. While the writer was getting the information for this article, five shots were fired in rapid succession and each bullet practically passed through the same hole.

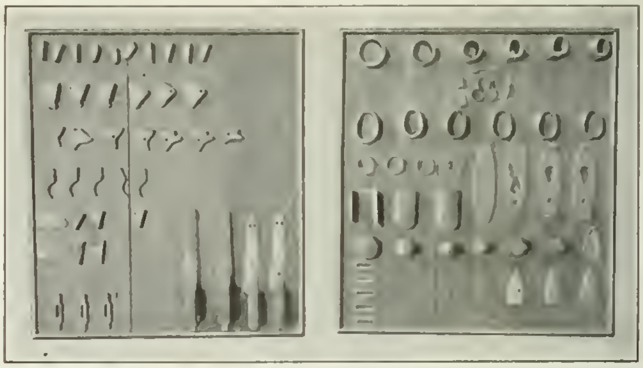

Fig. 42. Samples showing Operations on the Bands, Butt Plate, Trigger Guard, Trigger, etc.

Before the rifles are put in the store, ten per cent of the number called for on the order are taken to another testing shed, where they are held in a mechanical rest, as before described, and are sighted at a target placed at a distance of 600 yards. Ten shots are fired at this target, and nine out of the group must lie within a two-foot circle or else the rifle is not accepted.

Obtaining the Muzzle Velocity and Maximum Pressure

To determine the muzzle velocity and the pressure developed by the explosion of a cartridge in the chamber of a rifle, a barrel *A* is screwed into a bushing held in the fixture *B*, shown in Fig. 46, by a knurled nut *C*. A telescopic sight

D is located in U-shaped supports, which are held in blocks *E* fastened on the barrel by wing nuts; this sight is used to locate the barrel in the proper relation to the target, which is placed at a distance of 180 feet from the muzzle of the barrel. The type of target used is shown at *G* and consists of two sheets of paper pasted together, a copper wire being first placed between the sheets, stretched back and forth and connected to two terminals.

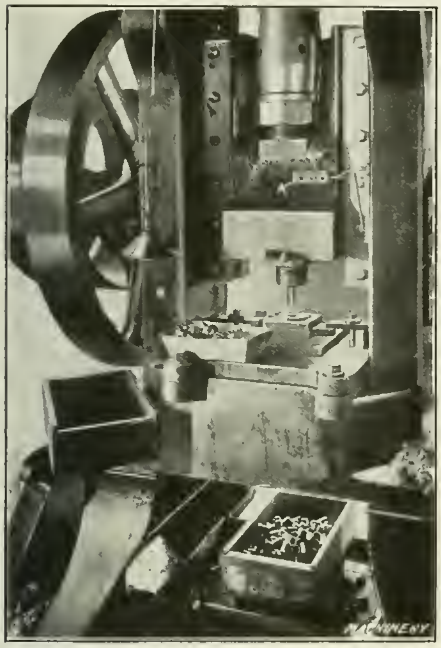

Fig. 43. Drawing the Bands in a Heavy Geared Drawing Press

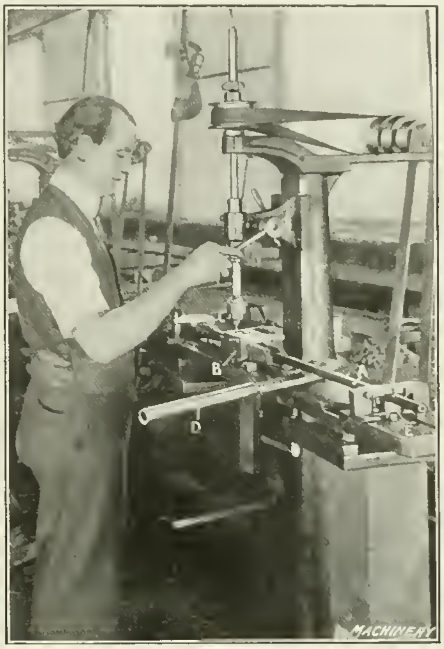

Fig. 44. Aligning and Assembling the Front and Rear Sight Bases

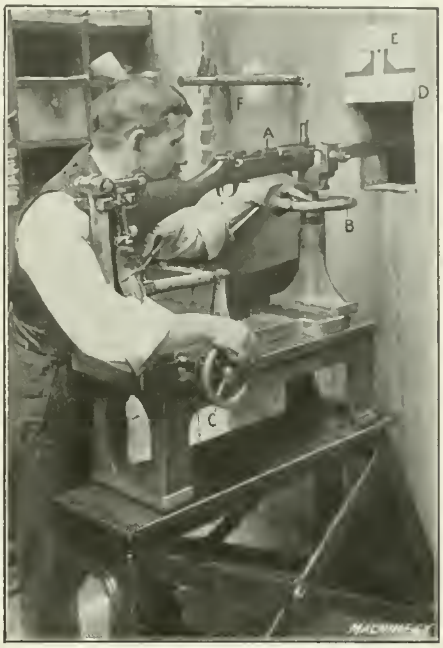

Fig. 45. Setting the Sights and Testing the Accuracy of the Military Rifle

When the rifle has been sighted, the cartridge is dipped up to the neck in Rangoon oil, and placed in the chamber of the barrel. A block *F* holding a cup in which is inserted a copper disk or "pressure block," as it is called, is then put in place, after which the block *F* is placed in the fixture, being held up tightly against the breech end of the barrel by a flat wedge not shown. The cartridge is discharged by a firing pin passing through the block *F* and the copper block, and is operated by turning the striker *H*, which is forced forward by a spring. As the striker is turned, a pin driven into it is brought in line with a hole in the nut *I*, allowing the spring to operate the striker carrying the firing pin.

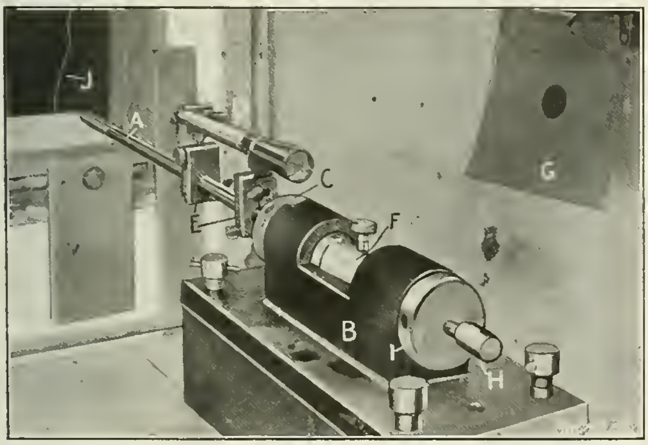

Fig. 46. Obtaining Muzzle Velocity and Breech Pressure

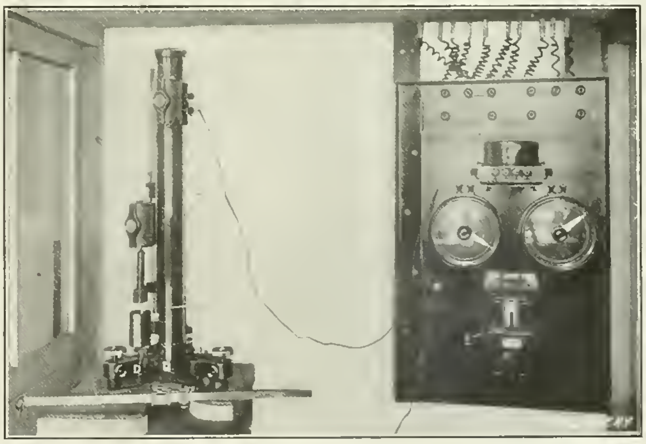

Fig. 47. "Chronograph," the Instrument used in Obtaining Muzzle Velocity

Upon the discharge and recoil of the cartridge, the copper block is compressed. As this copper block is measured before being inserted, and as the pressure required to compress it a certain amount is known, it is an easy matter to measure the block again and determine the maximum pressure in pounds per square inch.

The muzzle velocity of the bullet, more properly termed the "initial velocity," is obtained by means of an instrument called a "chronograph," which is shown in Fig. 47. The chronograph consists essentially of two electro-magnets supported on a vertical stem or upright *A*, which, when magnetized by a current, are capable of holding brass rods tipped with iron. The longer of these rods *B* is called the "chronometer rod," while the shorter one *C* is called the "register rod."

The operation of this instrument is as follows: A copper wire *J*, Fig. 46, is placed directly in front of the muzzle of the rifle, and is connected to the magnet in the instrument, Fig. 47, holding the rod *B*. At a distance of 180 feet from the muzzle of the rifle, is placed the target *G*, Fig. 46. This target through its terminals is also electrically connected to the instrument by two wires running from the target to the electro-magnet, which holds the register rod *C*.

Now upon the discharge of the cartridge, the bullet, leaving the muzzle of the rifle, cuts the wire *J*, breaking the circuit and allowing the chronometer rod *B* to drop. Then when the bullet cuts one of the copper wires passing through the target, it breaks the second circuit and allows the register rod *C* to drop, which in dropping, falls upon a trigger plate *D*, releasing a spring attached to a knife-blade. The spring, when released, causes the knife-blade to fly forward and make a nick in the chronometer rod *B* as the latter falls. The two circuits connecting with the electro-magnets holding the chronometer and register rods can be broken simultaneously by means of an instrument *E*, called a "disjunctor," which forms a part of the chronograph. Now the distance between the nicks made by the knife-blade when both rods *B* and *C* are made to fall by the disjunctor *E*, and when they are operated by means of the bullet cutting the wires, is the time required for the bullet to travel from the muzzle of the rifle to the target. By means of a suitably graduated vernier scale *F*, the distance between the two nicks can be read in feet per second. The reading thus obtained is the average velocity, and is approximately the actual velocity at half the distance—90 feet.

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EFFICIENCY IN MEN AND MACHINES

Judging by the success of the manufacturers of high-class machinery, the average machinery user realizes that it is good business policy—that is, a good investment—to equip his plant with nothing but the highest grade of machines and accesories. It is well known that although the first cost of such equipment is greater, it is found to be cheaper eventually, producing a greater output, requiring fewer repairs, and not being out of commission, due to break-downs, as often as inferior machinery.

If this is true of machinery, why is it not also true of men? In a great many cases we find well-equipped shops manned with cheap and comparatively unskilled labor. Some manufacturers do not believe there is the same economy in employing the best class of men that there is in using the best class of machines; but is it not reasonable to assume that the same rule that applies to the equipment also applies to the human element? A more intelligent man, a more highly skilled man, a higher priced man, is likely to be so much more efficient than an inferior workman that he really is the cheaper man in the end. It is not the price paid per hour that entirely determines the cost; the efficiency of the men in proportion to their pay is an important factor.

If it is good policy to employ a better class of men because they are more efficient, it is also good policy to pay a wage which is a little higher than the lowest wage for which the man can be hired. This does not seem to be the policy of some manufacturers, but it is a proposition which no one with any knowledge of human nature would attempt to contradict. The man who knows that he is paid only the lowest rate he can get elsewhere is likely to be an inefficient workman; he has no particular incentive to "hold on to" his job, except in dull times when work is scarce. The man who is paid a rate slightly higher than he might expect elsewhere is the most efficient man to employ, other things being equal. He usually does all in his power to make good, so that his efforts will enhance his value as a producer; and through the stimulus thus given him to exert his latent powers, his efficiency is increased, and a feeling of cooperation is established between him and his employer. There should be no feud between capital and labor when a business is so conducted that it works in the interest of all the parties involved.

* * *

ARBITRATION BY TECHNICAL JUDGES

Judge Learned Hand of the United States District Court, in the Southern District of New York, recently rendered an opinion in the case of Parke, Davis & Co., versus the Mulford Co. involving infringement of patents used in the manufacture of chemicals, in which he said:

> "I cannot stop without calling attention to the extraordinary condition of the law which makes it possible for a man without any knowledge of even the rudiments of chemistry, to pass upon such questions as these. In Germany where the natural spirit eagerly seeks for all the assistance it can get from the whole range of human knowledge, they do quite differently. There the Courts summon technical judges to whom technical questions are submitted and who can independently pass upon the issues without blindly groping among testimony wholly out of their ken. How long we shall continue to blunder along without the aid of unpartisan and authoritative scientific assistance in the administration of justice, no one knows; but all fair persons not conventionalized by provincial legal habits of mind ought, I should think, to unite to effect some such advances."

In making this comment upon the present condition of the law in the United States, Judge Hand was merely expressing the thought underlying the plan of the New York Chamber of Commerce for the adjustment of commercial disputes by arbitrators selected from an official list. This plan provides, in a most practical way, for the disposition of technical questions arising in business by men peculiarly qualified by reason of their experience to deal with such questions. As the list covers men in all lines of business and industry, there is no longer any necessity for submitting such questions to untrained jurors, or judges unprepared for such technical questions.

* * *

THE HORSEPOWER AND THE KILOWATT

About the time of the Philadelphia electrical exhibition in 1884, an effort was made in scientific and engineering circles to substitute the kilowatt for the indefinite horsepower as the unit measurement of power; but the time was not ripe for such a radical change in engineering measurements. It is possible, however, that the agitation for this change that has recently been revived by the Committee on Units and Notation, representing various associations of German electrical engineers, will be more successful, as there is now a better appreciation of the value of using the kilowatt as a unit rather than the horsepower.

It must be admitted that the kilowatt is just as good a mechanical unit as an electrical one, and it has the advantage of being a logical rating, expressing a definite relation to the absolute system of measurements in general use for scientific purposes. It has been said that the kilowatt is the point of contact between the electrical and mechanical systems of measurement, and this statement is very much to the point. Why then continue to use the horsepower, which is a purely arbitrary unit, and which has no direct relation to anything mechanical, when we have in the kilowatt a much more natural unit of power measurement?

One of the advantages of the kilowatt is that it is an absolute international unit. A kilowatt in Germany, France and in the United States is the same, while that is not true of the horsepower. The latter, in countries using the metric system, is calculated as the equivalent of 75 kilogram-meters per second, which equals 542.5 foot-pounds per second, or 32,550 foot-pounds per minute—an appreciable amount less than the 33,000 foot-pounds constituting the British and American horsepower. The adoption of the kilowatt as a unit of power would avoid having dynamos rated in kilowatts while their driving machinery and electric motors are rated in horsepower.

No standards of measurement would be changed by the adoption of the kilowatt as the standard unit of power, because it is just as easy to express the equivalent of a kilowatt in foot-pounds per second or minute as it is to express the equivalent of a horsepower in those units.

GOOD JUDGMENT AS A BUSINESS ASSET

One of the most valuable qualities in a man having charge of an industrial undertaking—or of any business for that matter—is a keen perception of the relative importance of the various details of the business. This qualification has frequently been called a "sense of values." In some cases a manager will pay so much attention to minor details that serious losses occur in other parts of the business, to which he attaches less importance. A case illustrating this is mentioned in one of our contemporaries: In a certain drafting-room the men were instructed by the chief to draw all details so as to make it possible to use the simplest and quickest methods in the shop. Accordingly the men were required to see that the rivet-spacing on all flange angles should be so arranged that one templet could be used in the shop for both "legs." This rule frequently made possible a saving of fifty cents in the shop at an expense of several dollars in the drafting-room, to say nothing of the awkward and inefficient way in which the rivets sometimes had to be arranged.

That was a case where the man in charge had no conception of the relative importance of the work under his supervision. He strained at a gnat and swallowed a camel. And it is not only the men in charge of the industrial undertakings and those at the heads of departments who are afflicted with this shortcoming; it is frequently found in the shop. We see men finishing work within a thousandth inch where a thirty-second would be close enough. We see draftsmen making an elaborate drawing for a temporary job, where a simple pencil sketch would be sufficient. We see red-tape systems followed in cases where considerable economies might result if exceptions were made.

Errors of judgment in this respect are of course most costly when they are made by a man in charge of other men, because they are usually multiplied in the work of each of the men under him. Every man, and especially the man in authority over others, should carefully weigh in his mind the relative importance of the questions he must decide. The efficient management of an industrial undertaking or a department requires constant compromises between conflicting conditions; and the best manager, the best foreman, the best workman is the man who combines with other necessary qualities a highly developed sense of values.

* * *

GEAR-CUTTING PRACTICE

A great change in the gear-cutting business has developed during the past few years. The automobile manufacturers, who have become the largest customers of the gear-cutting shops, are no longer willing to accept spur and bevel gears of "commercial accuracy." They now demand gears of much greater refinement of accuracy and finish than were considered necessary for almost any machinery five years ago. While the automobile manufacturers may seem arbitrary in their demands, they are simply passing along the imperative demands for quiet running gears in transmission and rear axles made by their customers. They must meet these demands or fail to sell their cars.

Owners of cars—even the cheaper ones—will no longer tolerate the noisy rattletraps that were the rule rather than the exception in the early days of automobile production. As automobile manufacture has advanced, more and more attention has been given to the elimination of noise. Valve mechanisms have been enclosed to reduce to a minimum the rattle of cams and valve lifters. The advent of the so-called "silent engine" in which poppet valves and cams have been eliminated has still more accentuated the difficulties of the gear-cutting business. The gears remain as the last resort of the noise imp, from which he can be routed only by the use of improved gear-cutting machinery, careful work and inspection, and better methods all around.

The demand for hardened gears by the builders of high-priced motor cars is difficult to meet because of the inevitable distortion of the teeth due to heating the gear and cooling it in a bath. The ultimate solution of the problem of manufacturing high-grade hardened gears probably will be finishing by grinding on some form of generator grinder.

SELLING METHODS IN THE MACHINE TOOL TRADE

Editor MACHINERY:

I am not a knocker by nature, but once in a while I feel like getting out my ball pein hammer. The present occasion for the resurrection of the hammer is the way in which the majority of manufacturers attempt to sell machinery. I am not knocking them because I want to hurt them, but because some of them need to wake up.

I have charge of a small shop in which metal and wood working machinery is used. Once in a while we purchase new tools, and my experience at such times convinces me that the machine tool trade is sadly in need of instruction, both in methods of selling and of advertising. Usually my experience runs something like this: I wish to buy, let us say, a 16-inch engine lathe. I turn to the classified list of advertisers in MACHINERY, make out a list of those who make tools of the kind I want, and then send each maker a letter giving the size and full description of the machine that I wish to purchase. In case there is anything about the machine that I wish to know, I ask about it, and finally, of course, I ask for the lowest price on the machine that I want. In addition to the price, I ask for such description of the machine as will enable me to judge of its value.

Now, I have learned to divide machine tool builders into two classes: those who manage the selling end themselves, and those who delegate the management of sales to their "local representatives." About two-thirds of our firms belong to the latter class. In my case the local representatives are New England representatives, usually having offices in Boston. The New England representatives may be classified in several ways. We may divide them into those who understand all about machine tools, and those who do not know anything about machine tools. We may also divide them into those who have authority to make concessions, and those who cannot make concessions without consulting the manufacturers. A third method of division is to divide them into those who do business by correspondence, and those who prefer to send along a salesman. Bearing these divisions in mind, let us see what happens to my correspondence. In the course of the next week or two, I receive letters from about one-fourth of the manufacturers who quote me prices and discounts. Sometimes they send the specifications of their lathe and sometimes they do not. If I am particularly interested in a machine for which the specifications are not sent, I write for them. A few manufacturers, perhaps fifteen or twenty per cent. ignoring the fact that I have already described the machine which I wish to purchase, write and ask what equipment I wish with the lathe. Most of them write me that my inquiry has been referred to their "New England representatives" Messrs. Blank and Dash. Sometimes I receive a catalogue with the letter, but usually I do not. In a few cases, the manufacturers do not answer my letter, but refer it to their New England representatives.

After a few days more, the New England representatives begin to get busy, and I receive a courteous letter from Messrs. Blank and Dash requesting information as to the equipment I desire. After furnishing the desired information, I receive a quotation, and sometimes I receive the specifications of the tool. Usually, however, I do not receive these specifications until I write a letter requesting them. In about one third of the cases Messrs. Blank and Dash have received full information of my wants from the manufacturers, and I get all the information I desire immediately. Sometimes the New England representatives want to get into "personal touch" with me. They send a young man to see me who carries a grip full of catalogues and a large fund of assurance. Usually he also has two ten-cent cigars. He arrives about ten o'clock in the morning on my busy day, and sits down to talk it over.

Now, if this young man is an engineer, and knows his business, and has authority to make terms, I can settle the matter one way or another in ten minutes. Usually, however, he does not know much about the line of goods he is trying to sell, and tries to disguise his ignorance by a superfluity of oratory. If I ask him about the details of the machine he is selling, he explains that it is the greatest machine on the market; that it is very rigid; that special pains have been taken in its design; that the manufacturer had a great deal of experience in the manufacture of that tool; that it is the best all-around machine that can be found; that it is all "made with jigs," etc. Once, when I asked one of these young gentlemen if it was all jig work and if they didn't do some planer work on the tool, he assured me that they did not, and that every part of it was constructed by means of jigs. I am going to visit that wonderful shop the first chance I get. Usually, however, when I ask the salesman about such points as these, he frankly admits that he doesn't know, that he is not an engineer, and that he cannot give definite information as to the principal dimensions of his machine.

Now I would like to know why a man of that kind should be sent out to sell machinery. When a man is sent out to sell a typewriter he is carefully trained to present the good points of his machine and to fully explain the details of its mechanism. He knows that when he tries to sell the typewriter, he will have to sell it to a man who knows all about typewriters, or who will seek advice from some one that does. Buyers of machine tools usually know more about what they are going to buy than do any other class of customers. Men who sell machine tools ought to be experts who know how to intelligently present their case, and who can devise methods of work and make estimates of time required. It will probably cost more to employ such salesmen, but, in my opinion, it is waste of money to employ any other kind. When I am considering which of two lathes of nearly the same price is the better, I do not care to be told by the salesmen of each of the two manufacturers that their machine is the best on the market; that it will pull the heaviest cut; that it will do more work than any other machine; that it is the heaviest machine of its capacity built, etc. What I want to know is whether the size of the spindle bearing is 2 by 3 or 3 by 4 inches. I want to know the size of the belt and cones, and the ratio of the back-gearing; I want to see the details of the apron, and to know what materials go into the different parts. Then I can form an intelligent idea as to the relative value of the two machines. Mr. Manufacturer, when I try to buy a lathe, I know just as much about using it as you do about making it. Why don't you try to get together with me on that basis?

Why should a man who wants a machine and knows what he wants, have to wait six weeks and write four letters before he can get quotations? Why does he have to write another letter before he finds out how much discount he is going to get on the quotation? When a man wants to buy a carload of 2-inch pipe he can find out in three days what the best prices will be. He is not referred to a local representative, he is not asked whether he wants black pipe or galvanized. He gets the full information, and if the manufacturer has any doubt as to whether he wants black or galvanized pipe, he quotes on both.

I must admit that when I buy goods I am prejudiced in favor of the man who shows a little common sense in the way he tries to sell me machinery. If he knows how to sell tools, it is pretty good evidence, to my mind, that he knows how to make tools, and I am apt to think that his machinery is just a little bit better than anyone else's. Because he has presented his case fully and completely in the first place, his machine becomes a standard by which I judge the others. If they fall short of it in any particular, I am apt to think that they are inferior, even when they may be better in some points. Perhaps there is an advantage in having a local representative, but I fail to see it. It is sometimes an advantage for a firm to have someone to look after their interests in a particular locality, but why should the customer be prohibited from doing business with the firm itself?

In some respects the best example of modern selling methods is the up-to-date department store. The department store is not usually a manufacturer, but no department store would think of anything else than dealing directly with the manufacturer and selling directly to the customer. In other words, the department store is organized for the purpose of eliminating the jobber and the local representative. In the long run that manufacturer who gives his customers the greatest value for the least money will do the most business. So long as a manufacturer tries to do business through a middleman, so long will he increase to his customers the price of goods of a given quality, by the profits and expenses of the middleman. It is not a mistake for the average manufacturer to attempt to do business in this way? My own experience is that those manufacturers who do not employ local representatives, either sell the same quality of machinery for a lower price, or sell a better quality for the same price.

We hear a good deal of scientific management in these days, but we hear very little about the scientific management of the sales department. Our manufacturers try in every possible way to reduce the expenses of manufacturing, and to devise new and more efficient methods; but we never hear of an attempt to reduce the expenses of salesmanship or to buy the greatest selling power for a given amount of money. Our manufacturers never give serious consideration to anything relating to salesmanship except the medium in which they advertise and the form of their advertisement. If the claims of the advocates of scientific management are correct, and we can reduce manufacturing expenses by twenty to fifty per cent, is there not also a possibility that the average manufacturer can reduce his selling expenses by the same amount?

The question of what to advertise and how to advertise it is a matter that ought to receive more attention than it does. We must remember that the men who buy machine tools know something about them. Consequently, the thing which they are interested in is the actual construction of the tools. Descriptive illustrations are the most powerful and telling arguments with most of us. A section through the headstock of a lathe showing the method of adjusting the parts, the size of the bearings, etc., helps to sell such a tool. A view of the interior of the apron will convince a skeptic, if the machine is a good one. A series of good articles pointing out the several features of some particular machine and calling attention to other machines in which the same points are embodied, appeal to the man who knows his business. The kind of advertising that we are interested in is the kind that instructs us. A great many advertisements will attract our attention, but unless they teach us something, they are of no value in selling goods.

An advertisement which has a price attached teaches us something; one which invites us to write for prices and discounts teaches us nothing. Very few people will write for prices and discounts unless they are actively interested in the particular machine advertised. Advertising his prices does not put a manufacturer to any disadvantage, for if his price is low (and he can afford to make it low if he advertises it), the fact that he advertises it will attract trade if he at the same time convinces his readers that his article is a good one. If his price is higher than that of his competitor, the reader naturally looks to see if the article is not a better one, and if it is enough better than the one he has contemplated purchasing, he will give his order to the manufacturer who advertises his price. Of course the argument may be made that if a manufacturer advertises his price, his competitor is able to shade his price, and take the business away. In order to do so, without maintaining an expensive selling organization, he must advertise his own price. The manufacturer will answer, of course, that this will result in a price war. If the manufacturer's shop is properly organized, if he is willing to manufacture for a reasonable profit, and if he handles his business economically, he has nothing to fear from such a war. If, on the other hand, his shop is not properly organized, his business is not on a sound basis, or he wishes to obtain exorbitant profits, such a war will naturally be distasteful.

The present system of doing business has arisen not because it is the best system, but because a large number of estimable gentlemen desire to make their living by their wits and not by their hands. They prefer smoking ten-cent cigars with the purchasing agent to running a machine in the shop. Hence we have an army of "salesmen," "local representatives," "district agents," "sales managers," etc., all of whom foregather around the saucer of profits and greedily lap up the cream.

I have written at considerable length on these matters, because they have been in my mind for some time, and because I feel that they are of importance to the well-being of the machinery trade. Anything which will reduce the prices of machinery without reducing the reasonable profits of the manufacturer or the wages of the working man is certainly to be welcomed. Anything which will make it easier for the prospective purchaser of machinery to obtain what he wishes is desirable. Our present system of doing business is organized for the benefit of the middleman, who is usually a man who knows a great deal more about "business" than he does about machinery. What we need to do is to bring the manufacturer and the purchaser into direct contact, and the best way to do it is by the methods that have been developed by our modern department stores.

Durham, N. H. FORREST E. CARDULLO

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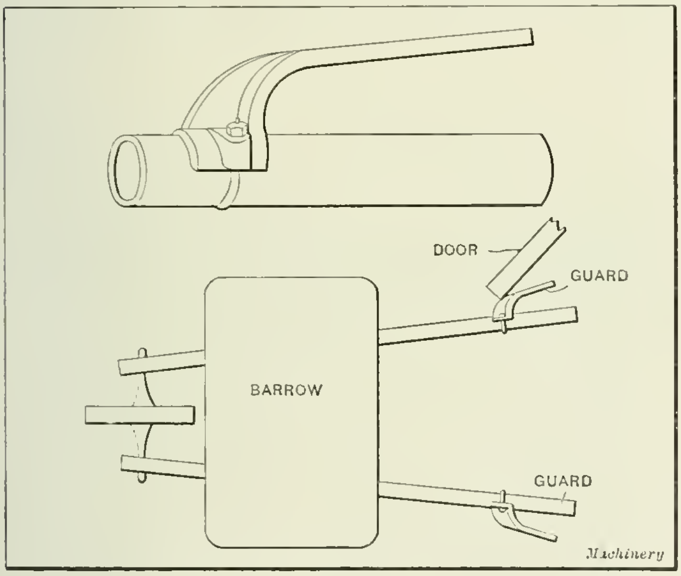
FINGER GUARD FOR WHEEL-BARROW HANDLES

The accompanying illustration, reproduced from the *Journal of Industrial Safety*, shows a guard which is particularly useful when pushing wheel-barrows through a doorway, especially when the door is kept closed by means of a spring or weight. Anyone who has ever scraped his knuckles on some solid object while pushing a wheel-barrow will appreciate the merits of this simple device. It consists of a steel or malleable-iron casting, as shown, attached to the wheel-barrow handles at the place where the hands usually rest, by U-bolts about ⅜ inch in diameter. The castings should be made about 6 inches long, and 2 inches wide at the base, and may taper to about 1¼ inch at the point, being about ½ inch thick. The guards are curved so that they stand out about 2 inches or somewhat more from the handle. Guards of this type will save the knuckles a good many unpleasant experiences.



Finger Guard for Wheel-barrow Handles

* * *

The research laboratory of the General Electric Co. has developed during the past year, a method for producing ductile tungsten and molybdenum which will be of the utmost importance in the further development of the tungsten filament lamp. The ductile tungsten now produced would almost seem to be a new substance, tungsten having always been considered to be hard and brittle and not ductile, either at ordinary temperatures or when heated. The ductile tungsten is a bright steel-colored metal, capable of being drawn into the finest wire, the tensile strength increasing with the drawing. A wire 5 mills in diameter has a tensile strength of 490,000 pounds per square inch, while one of a diameter of only 1.2 mill has a tensile strength of 610,000 pounds per square inch.

A NEW GEAR CHART*

By C. F. HETHERINGTON†

The accompanying gear chart was devised to serve as a rapid means of solving the gear problems that are encountered in machine design work. The engineer engaged in the preliminary design of a new machine may not care to spend a great deal of time on calculations for the strength of the minor details; at the same time, if he is a careful engineer, he will not care to base the lay-out purely on guesswork; when he has completed his first general design, he should feel confident of the later satisfactory development of the details.

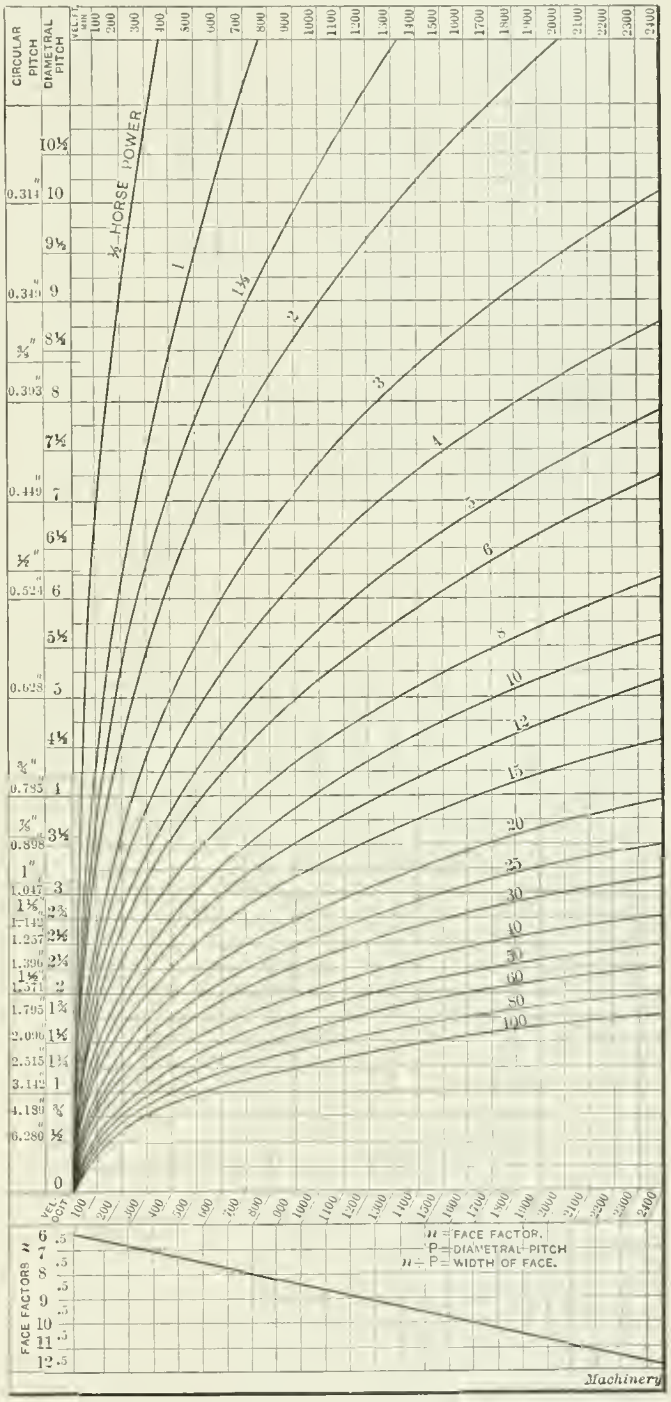


Fig. 1. Chart for Cast-iron Gears with Molded Teeth

The writer had been in the habit of consulting the catalogues of various gear manufacturers in making his selection of gears, but it often happened that discrepancies were discovered by subsequent calculations or by comparison with other catalogues, when the details of the design were taken up. As a result, various authorities were consulted from time to time, and from the theories of the different authorities the writer selected such elements as appeared to be rational and practicable, and combined them in the formula given in the following. From this formula the gear chart, Fig. 1, was plotted by assigning different values to the horsepower and velocity factors in the formula.

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* For additional information on this and kindred subjects, see the following articles previously published in MACHINERY: "The Strength of Helical Gearing," October, 1908, engineering edition; "The Variation of the Strength of Gear Teeth with the Velocity," January, 1908, engineering edition; "Strength of Gears," December, 1906, engineering edition; "The Strength of Gear Teeth," October, 1906, engineering edition; "Use of Diagrams and Tables for the Solution of Problems in Gearing," March, 1904, engineering edition. See also MACHINERY'S Reference Series No. 15, "Spur Gearing," and No. 37, "Bevel Gearing," and MACHINERY'S Data Sheet Series No. 5, "Spur Gearing," and No. 6, "Bevel, Spiral and Worm Gearing."

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The Lewis formula, as first proposed by Mr. Wilfred Lewis in a paper published in the proceedings of the Engineers' Club of Philadelphia, January, 1893 (see MACHINERY's Reference Series No. 15, "Spur Gearing," second edition), has been recognized as authoritative for a number of years. It is, however, not in such a form as to lend itself to rapid solution of problems, and furthermore the writer does not think that it can be properly applied to problems involving ordinary cast-iron gears with cast rather than cut teeth. The method of derivation of the Lewis formula was given in the How and Why columns of MACHINERY in the September, 1911, number, and it is not necessary to deal with it here. The method used, however, seems to the writer more refined than is justified when cast gear teeth are considered, especially when an allowance for backlash has been made in the design of the gear; but for nicely cut teeth there seems to be no better standard than the Lewis formula, and the writer uses it without hesitation for this class of gearing.

The formula from which the gear chart for cast-iron gears with cast teeth was plotted is as follows:

$$P = \sqrt{\frac{(2900 + V) \times V}{11.3 \times \text{H.P.} \times (1100 + V)}}$$

in which

P = diametral pitch,

V = pitch-line velocity in feet per minute,

H. P. = horsepower to be transmitted.

In the development of the formula, the load is considered as borne by one tooth at its extremity, as indicated in Fig. 2, and the tooth is regarded as a cantilever. The ordinary proportions for the standard 15-degree involute tooth are used.

Let

P = diametral pitch,

p = circular pitch,

$L = 0.7\,p = 0.7\,\pi \div P$,

$t^* = 0.5\,p = 0.5\,\pi \div P$,

F = width of face,

W = load on tooth,

S = section modulus of tooth section at root,

R = safe fiber stress,

B = bending movement.

Then

$$B = L\,W = \frac{R\,F\,t^2}{6}$$

Substituting,

$$\frac{0.7\,\pi\,W}{P} = \frac{R\,F\,(0.5\,\pi)^2}{6\,P^2}$$

To determine the safe stress R, the following formula was adopted as giving fair average values:

$$R = \frac{7{,}200{,}000}{V + 1100}$$

It will be seen that the safe stress as found by the above formula begins with a static stress of 6500 pounds per square inch, and decreases as the velocity increases. This formula is similar in form to that used by the International Correspondence Schools.

It is considered good practice to make the ratio of the width of face to pitch increase with the velocity, and the writer adopted as his rule for this variation the formula:

$$F = \frac{(2900 + V) \times \pi}{1450 \times P}$$

Hence,

$$W = \frac{\dfrac{7{,}200{,}000}{V + 1100} \times \dfrac{(2900 + V) \times \pi}{1450 \times P}}{5.35\,P}$$

$$W = \frac{2910 \times (2900 + V)}{P^2\,(V + 1100)}$$

$$\text{H. P.} = \frac{W\,V}{33\,000} = \frac{2910\,(2900 + V)\,V}{33{,}000\,P^2\,(V + 1100)}$$

Hence,

$$P = \sqrt{\frac{(2900 + V)\,V}{11.3 \times \text{H. P.} \times (V + 1100)}}$$

It will be observed from the derivation of the formula that the values of horsepower or pitch which are obtained from the chart are all dependent upon a certain face width, and in order to facilitate the determination of this face width, the lower diagram is provided. For instance, suppose that a diametral pitch of $2\frac{1}{2}$ has been determined by the upper chart as necessary to transmit 30 horsepower at a velocity of 1150 feet per minute; then the proper face width will be found by following the velocity ordinate for a speed of 1150 to its intersection with the oblique line in the lower chart. Horizontally opposite this point, at the left, will be estimated the factor 8.75; the face width will then be $\frac{8.75}{2.5} = 3.5$ inches.

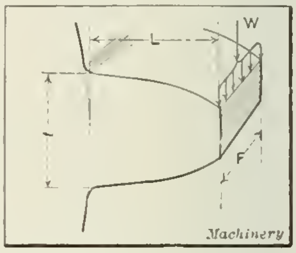

Fig. 2. Assumed Condition of Loading Gear Tooth used in Deriving the Chart, Fig. 1

The chart may also be used for gears made of steel casting by using a factor representing the ratio between the strength of cast iron and steel. Thus, if we take 6000 pounds per square inch as the safe stress for cast iron at 100 feet per minute velocity, and 19,500 pounds per square inch as the safe stress of steel castings at the same velocity, we establish a ratio of 1 to 3.25 between cast iron and steel castings, and the formula should be written:

$$P = \sqrt{\frac{(2900 + V)\,V \times 3.25}{11.3\,\text{H. P.} \times (V + 1100)}}$$

$$= \sqrt{\frac{(2900 + V)\,V}{3.5 \times \text{H. P.} \times (V + 1100)}} \text{ for steel castings}$$

Hence, the diametral pitch for steel $= \sqrt{3.25} = 1.8$ times the pitch for cast iron, or the horsepower transmitted by a steel gear will be $3\frac{1}{4}$ times that of a cast-iron gear of the same pitch and velocity.

The chart is plotted for velocities up to 2400 feet per minute, but for cast-iron gears with cast teeth the writer does not recommend velocities exceeding 1500 feet per minute. The higher values may be used in calculations for steel gears.

Example of the Use of the Gear Chart

What pitch is required for the teeth of a gear which is to transmit 20 horsepower, the pitch line velocity being 400 feet per minute?

In the chart, Fig. 1, the 20-horsepower curve intersects the ordinate for 400 feet pitch-line velocity very nearly on the abscissa for 2 diametral pitch. To find the width of the face, find the face factor n, in the lower part of the chart, for a velocity of 400 feet per minute. This factor is about 7. Hence, the face width, $n \div P$, in this case equals $7 \div 2 = 3\frac{1}{2}$ inches, P being the diametral pitch.

* * *

According to the *Daily Consular and Trade Reports*, a new radiator intended for the motor of an airship has been designed. The motor develops 300 horsepower, and the radiator for it is made entirely of aluminum. The radiator is 4 feet 7 inches high, 4 feet 7 inches wide, and 8 inches deep. The hourly capacity of the radiator is 6868 gallons; its weight is 145 pounds when empty, and 209 pounds when full of water.

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* For pinions with a small number of teeth, the value of t as given is somewhat too large, as here the undercutting at the root of the gear teeth causes the width at the root to be less than at the pitch line.—EDITOR.

MAKING COLLAPSIBLE TUBES BY THE EXTRUSION PROCESS*

By CHESTER L. LUCAS†

The extrusion process is extensively used for making collapsible tubes of tin and lead, for containing dentifrice, artists' colors and other preparations. Through the courtesy of Mr. L. T. Sheffield, president and treasurer, and Mr. W. K. Sheffield, secretary of the New England Collapsible Tube Co., of New London, Conn., the writer is enabled to present to the readers of MACHINERY an account of the operations employed in the work of making these collapsible tubes. The business of the company was originally established by the late Dr. Sheffield, in 1850, as a dentifrice manufacturing business. He made at that time only the tubes he required in putting out his preparations. Later, however, the demand for good collapsible tin tubes became so strong that the company commenced to make them for outside concerns, and now the tube department has grown to be far larger than the dentifrice department.

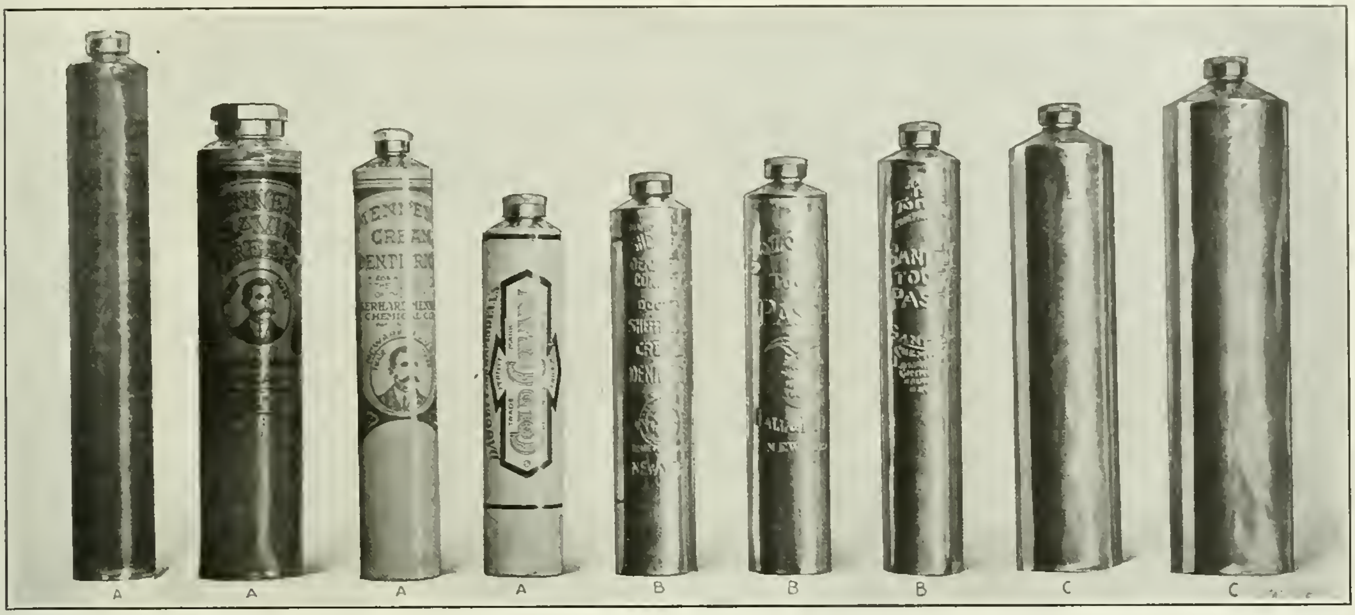

Fig. 1. Collapsible Tin Tubes made by Extrusion

The best collapsible tubes are made from pure tin. Lead is often used for tubes for paste, glue, and ink; but for toilet preparations, like dentifrice, only the purest tin is employed, and this article will treat entirely of the making of collapsible tin tubes. Tin ore is found in Germany, Spain, Russia, Malacca, Australia, Mexico and the United States. The amount of tin ore mined in the United States, however, is very small, and not nearly sufficient to meet the demands of this country. The very best tin is obtained from the Straits of Malacca, as this tin is particularly free from impurities. This is a very important requisite in tin for the extrusion of collapsible tubes for dentifrice, because foreign matter would not only cause the tubes to be poor, but the

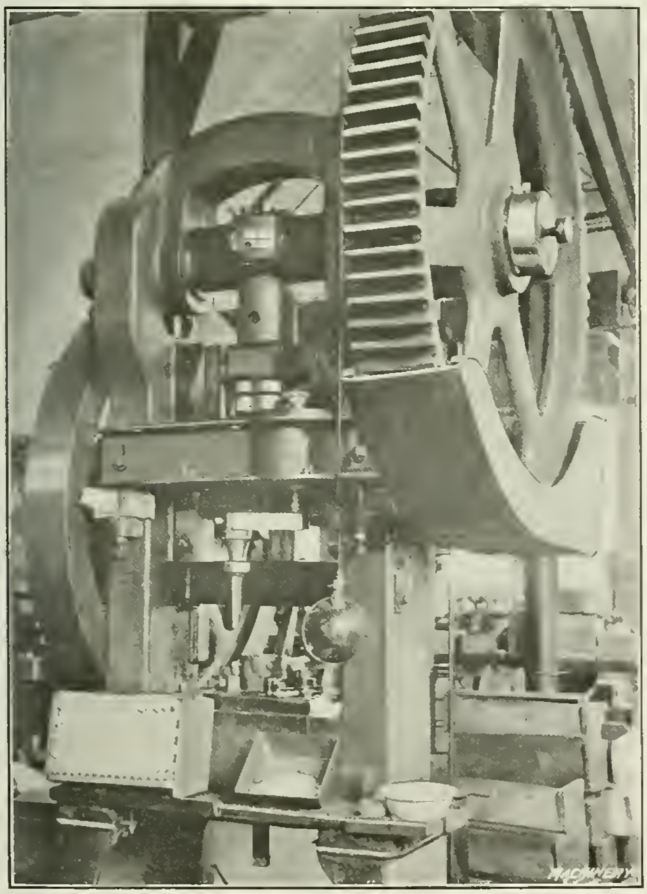

Fig. 2. Extrusion Press made by the E. W. Bliss Co., Brooklyn, N. Y.

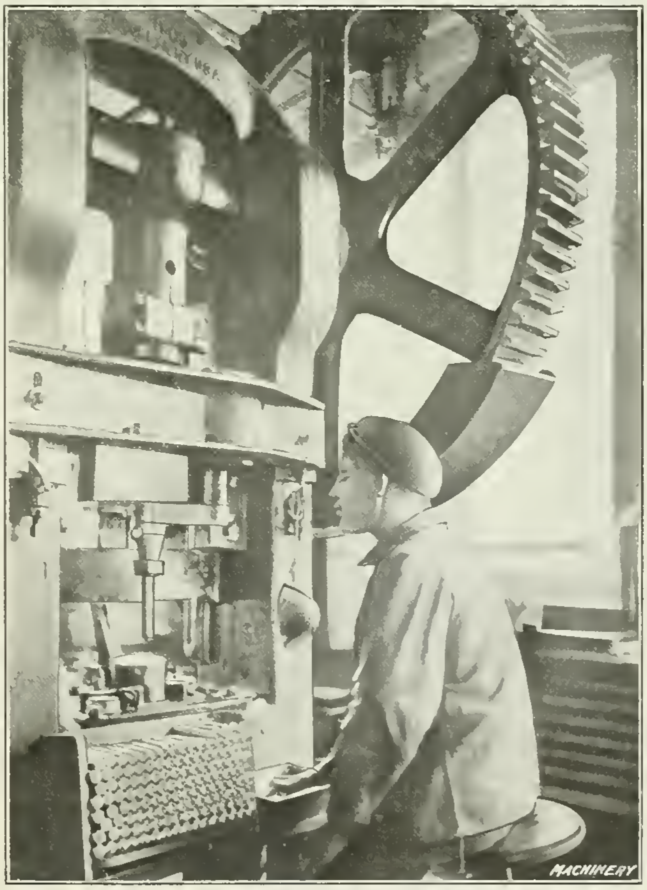

Fig. 3. Making Collapsible Tubes at the Rate of 600 per Hour

quality of the dentifrice would be affected, and moreover there would be constant trouble from injury to the dies.

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* See MACHINERY, October, 1911, engineering edition, "The Extrusion Process"; November, 1911, "The Extrusion of Shells and Tubes."

† Associate Editor of MACHINERY.

Fig. 1 illustrates a few finished collapsible tubes and their caps. Those marked *A* have been decorated by lithographing; those marked *B* have been embossed; while those marked *C* are plain tubes onto which labels may be pasted. Collapsible tubes may be made as large as 2½ inches in diameter, and of any length up to 9 inches. The thickness of the walls of the tubes ranges from 0.005 inch to 0.010 inch, varying with the size of the tube. If desired, raised lettering may be produced upon the shoulder of the tube. The opening in the top of the tube may be of any size, either round or oblong in shape.

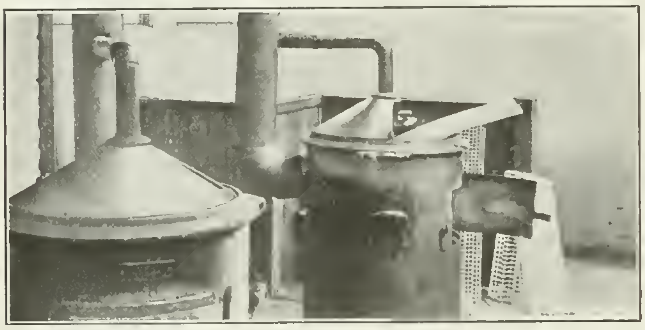

Fig. 4. Melting Furnaces where the Tin Ingots are cast into Nine-pound Slabs

The cold extrusion of collapsible tin tubes is totally different from the hot extrusion process for solid shapes described in the October number of MACHINERY, and it is just the reverse of the cold tubular process described in the November number. The extrusion of tin, however, is much more easily accomplished than the extrusion of copper and brass. Briefly stated, collapsible tin tubes are made by placing a round blank of tin in a die-cavity shaped like the head of the tube, and of the same internal diameter as the external diameter of the tube to be made. Then a punch, whose greatest diameter is the same as the inside diameter of the tube, comes down on the blank. It forces the metal into the bottom of the die, and squeezes the excess metal upward through the narrow annular opening between the outside of the punch and the inside of the die-cavity. The tin literally "crawls" up the punch as it is extruded. When the punch ascends, it automatically swings outward to allow the operator to remove the completed tube, otherwise there would not be room to withdraw the tube from the punch. The threading of the head is done in another operation in this factory, although some companies make the die in halves, with half of the threaded section in each, necessitating the opening of the die after each stroke of the press.

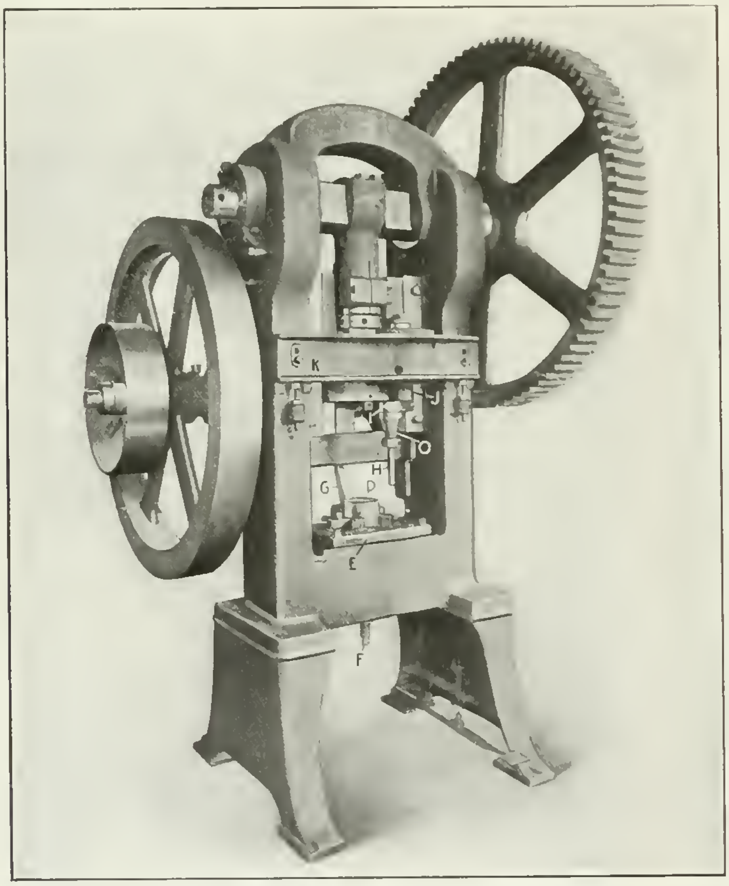

Fig. 6. Details of Arrangement of Extrusion Press

The general method of making collapsible tubes is illustrated in Fig. 2, where the blanks are shown in the square pan, and the extruded tubes in the rack at the left. Fig. 3 shows the operator just completing a gross of 5-inch tubes, representing about fifteen minutes' work. This illustration also gives a good idea of the size of the press.

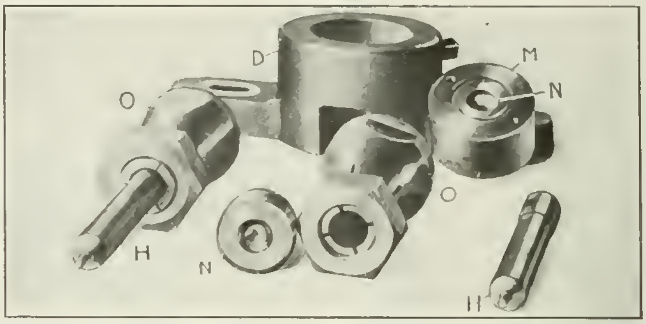

Fig. 5. The Press Tools used in Collapsible Tube Making

Preparing the Stock

The particular grade of tin used by this company for collapsible tube making comes from the Straits of Malacca and is known as Penang tin. It reaches the factory in the form of 130-pound pigs, and is then re-melted in the furnaces shown in Fig. 4 and cast in slabs weighing nine pounds each. These slabs are about six inches wide, fifteen inches long and one-half inch thick.

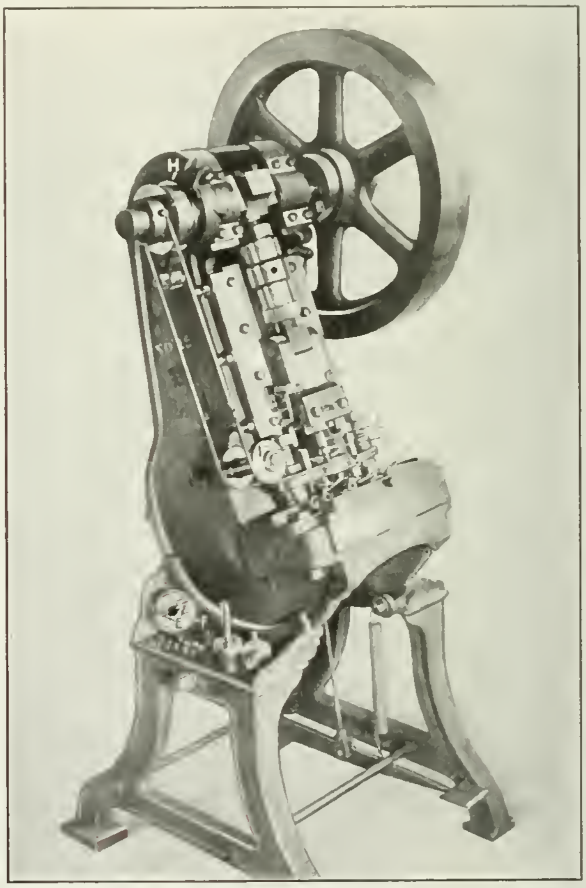

Fig. 7. Blias Cap-forming Press with Unscrewing Attachment

The slabs are taken to a pair of rolls and reduced to a thickness ranging from 0.110 to 0.220 inch, varying with the length of tube that is to be made. For a five-inch tube, the metal is rolled to 0.190 inch. The next operation consists in blanking the disks for the tubes. These disks, three of which appear at *P*, Fig. 8, are cut to the same diameter as the diameter of the tube that is to be made, and in blanking, they are slightly "crowned" to conform to the inclined shoulder of the tube. This crowning is accomplished by merely chamfering the end of the blanking punch to the proper bevel; the die is perfectly flat. The blanking press is equipped with a roll-feed, and the rolls are knurled, so as to grip the sheets firmly. In Fig. 4 may be seen some of the sheets from which blanks have been cut, and which are sent back to the melting room for re-casting into slabs.

The Extrusion Presses

The operation of extruding collapsible tubes and the presses used are without doubt the most interesting features of the work. Two of these presses are shown in Figs. 2 and 3; and in Fig. 6 the details of the press and dies are well illustrated. For the large tubes, one-inch diameter and over, the E. W. Bliss Co.'s No. 63 press is used, and Figs. 6 and 7 show representative Bliss presses for making collapsible tubes and their caps. The No. 63 press is rated as a five-ton press, and its chief point of distinction, aside from its powerful construction, is its peculiar punch action, which will be described later. Referring to Fig. 6, *D* shows the die-shoe held to the bolster *E*, which latter is bolted to the bed of the press; *F* shows the end of the knock-out rod operated by lever *G*. The punch *H* is held in the arm *I*, which turns upon shaft *J*. Front plate *K* is adjustable, and its inner side is recessed for the cam that swings the punch-arm and punch away from the die. As the ram descends, this arm slowly swings so as to bring the punch in alignment with the die. It reaches the point of alignment just before the end of the stroke, so that at the time the end of the punch strikes the blank, the punch descends vertically. In Fig. 3 the arm has just started to swing outward on the upward stroke; in Fig. 2 it is half-way out; and in Fig. 6 the arm is shown at the end of its outward swing, giving the operator ample room to withdraw the tube from the punch. Knock-out rod *F* frees the end of the tube from the die, allowing the tube to remain on the punch as it ascends.

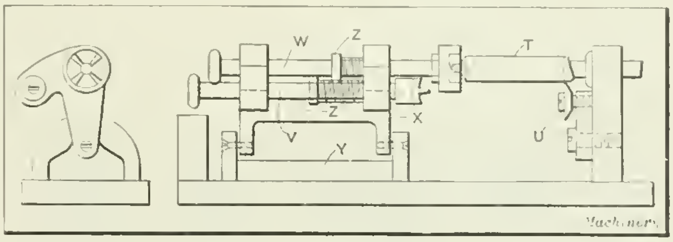

Fig. 12. Principal Parts of Tube Trimming Machine, as seen from the Rear

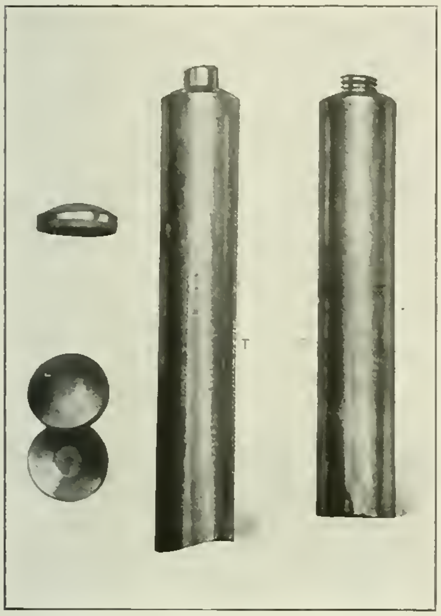

Fig. 8. The Three Operations in Making a Collapsible Tube

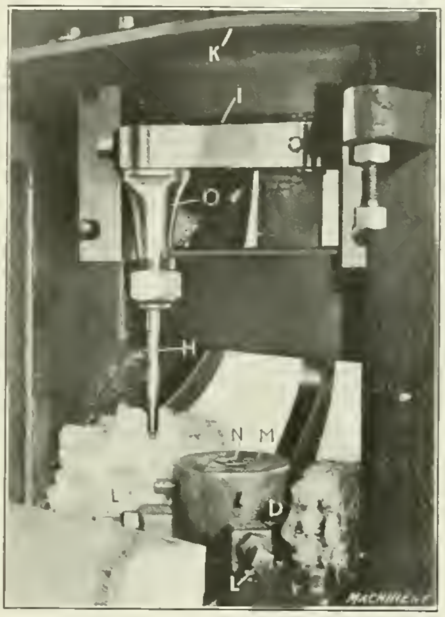

Fig. 9. Die and Punch in Position in Press

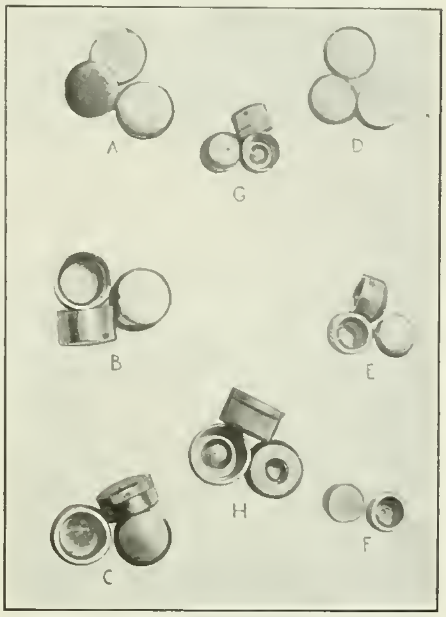

Fig. 10. Caps of Different Sizes and Styles in Various Stages of Completion

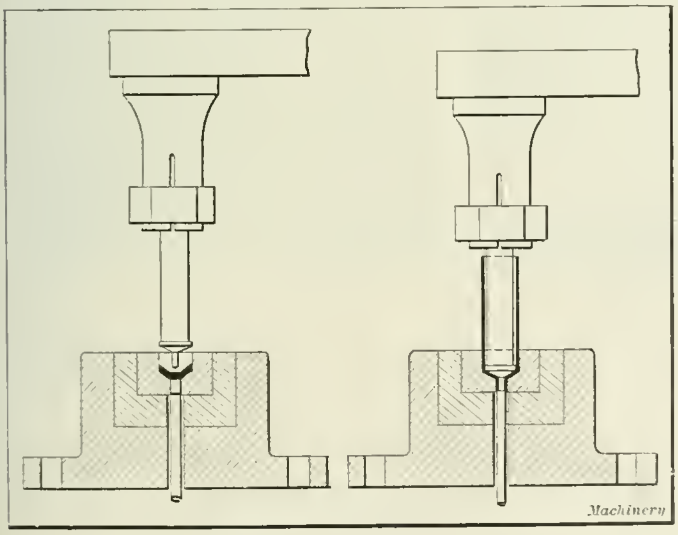

Fig. 11. Principle of Making a Collapsible Tube

In operating an extrusion press of this character, the operator places the blanks in the die with his right hand and removes the tubes from the punch with his left hand. The speed with which the metal "crawls" up the punch is surprising, but it must be remembered that the extrusion of a five-inch tube must take place while the punch is descending the last one-eighth inch. The operator is obliged to wear a glove upon his left hand on account of the heat imparted to the tube by the extrusion. A skilled operator is able to "catch" nearly every stroke of the press. When making these 1-inch by 5-inch tubes he will turn out 600 tubes per hour, and on the smaller tubes, ½-inch by 2½-inch, using a smaller press of the same type, the average production is 1500 tubes per hour.

The Dies for Extruding Collapsible Tubes

Figs. 5 and 9 illustrate the parts of the dies and punches. Fig. 9 shows a close view of the tools in the press and Fig. 5 shows the tools as they appear out of the press. At *D* is shown the die-shoe, held to the press by the two ears shown in Fig. 5, and adjusted laterally by the four screws *L* indicated in Fig. 9. Within this die-shoe rests the die-ring *M*, made of tool steel and carefully hardened and tempered. This ring acts as a support to strengthen the die *N* shown within the ring; this die is also separately shown at the front of Fig. 5.

The die *N* is made of the best tool steel and its cavity is made just the size and shape of the outside of the head of the tube, except that the hole that sizes the nose extends clear through this die to admit the knock-out. Thus the knock-out is employed to form the bottom of the die as well as to eject the finished tube. If the shoulders of the tubes require lettering, a hob is made with the lettering raised. By placing this hob in the die-cavity, the letters are all stamped into the die at the same time. A collapsible tube die must be very smooth and highly polished in order that the metal will flow easily and take on a bright finish. This polishing is started with fine emery and oil and the final high polish is obtained with crocus and oil. The final polishing must be done after the die has been hardened and tempered to a faint straw color.

The punch used in extruding collapsible tubes has several distinctive features that are peculiar to this line of work. Two of these punches are shown at *H* in Fig. 5. The working part of the punch is made about one inch longer than the tube that is to be produced, and two inches additional length is left for the shank. The shank of the punch is held in the punch-holder *O* by tightening the nut upon the tapered sleeve. The part of the punch that does the actual work is the tip end, having the largest diameter. To illustrate this more clearly, Fig. 11 shows two collapsible tube punches and dies; in one case the blank is shown in position in the dies, and in the other the result of the operation is indicated. From these it will be seen that the long pilot forms the hole at the shoulder and outlet. As the pressure upon the blank is increased, the recess in the die becomes filled with metal and the excess metal is squeezed up past the end of the rib on the punch. As the pressure is continued, the shoulder of the tube constantly becomes thinner; the displaced metal is forced into the walls of the tube, thus increasing its length. It is obvious that after the metal has been squeezed past the ribbed end of the punch, its path is clear, for the upper part of the punch is considerably smaller in diameter than the inside of the tube. For a one-inch tube, the die-cavity is exactly one inch; the ribbed end of the punch would measure about 0.985 inch; and the body of the punch would be approximately 15/32 inch in diameter. The punches are made of Jessops steel, hardened, and the temper drawn to a light straw color, except in the slender pilot, which is drawn very much lower. The punch-holder *O* is threaded into the swinging arm *I* shown in Fig. 6.

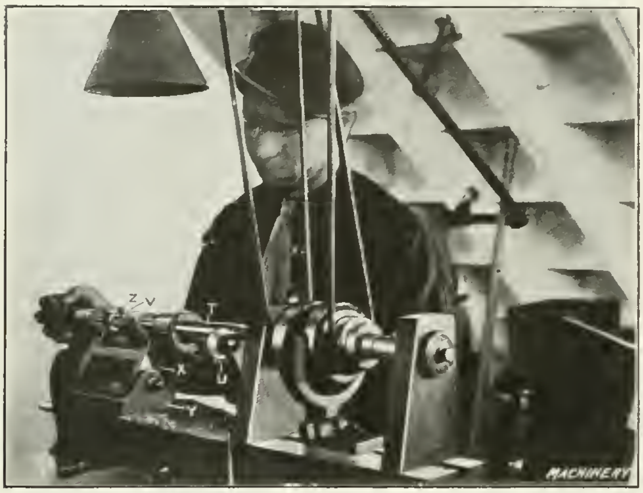

Fig. 13. Trimming Large Tubes

Trimming the Tubes

When the tubes come from the extrusion presses they appear as shown at *T* in Fig. 8. As will be noticed, the opening in the head is not cut through, nor is the head threaded. Better results are obtained by cutting the thread at the time the tube is trimmed. Figs. 12 and 13 show one of the tube trimming and threading machines of a type designed especially for the work and patented by this company. As will be noticed in the illustrations, the machine is similar in construction to a bench lathe. The tube is slipped over an arbor, and a rotary trimming wheel *U* which the operator swings into contact with a cutting edge on the arbor, thus trimming the tube to standard length, is pivoted upon the front of the headstock. The sizing and threading of the head of the tube is done with tools operated from the tailstock. This tailstock is of novel construction, having two operating spindles *V* and *W*, located at a fixed distance apart in a solid casting *X*. This casting is hinged upon a block *Y* bolted to the bed of the lathe, so that either of the spindles may be brought into line with the tube arbor at will, by throwing the tailstock casting either forward or backward. Stops are provided to insure the proper alignment of the two spindles in either position, and at the front there is a locking lever to hold the tailstock firmly in the desired position while the spindle is at work. Provision is also made for throwing the tailstock back far enough to have both spindles out of the way, permitting the tube to be withdrawn from the arbor.

When the tailstock is thrown toward the operator, the rear spindle *V* is in line. This spindle carries a combined counterbore and drill that clears out the hole in the head of the tube and faces off the end so that the cap will go on for a proper distance. If the tubes have oblong openings, so that the paste will "come out like a ribbon," a counterbore alone is used, merely facing off the top until the opening is clear. Next, the tailstock is thrown backward, bringing the threading die on spindle *W* into line. The head of the tube is threaded, and by pressure upon a foot treadle, the rotation of the tube arbor is reversed, thus unscrewing the tube from the die. The reversing clutch, as well as the straight-belted and cross-belted pulleys may be seen in Fig. 13. The travel of the counterboring and threading spindles is limited by stop-collars *Z*. In operation, the spindles are simply pushed forward, and spiral springs return them to their normal positions. In Fig. 8, at *P*, *T* and *R*, are shown the three steps in making the tubes.

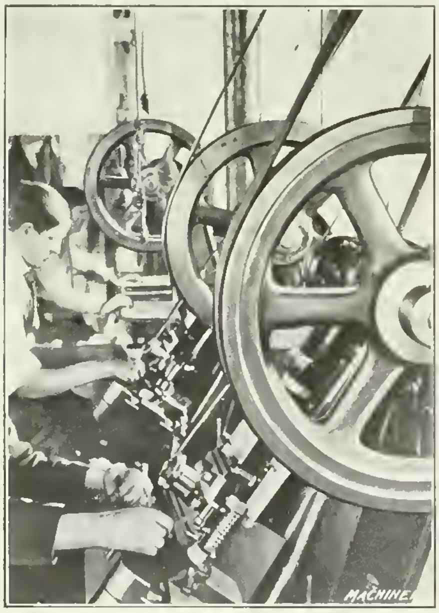

Fig. 14 Cap Blanking and Cap Making Presses

Fig. 15. Trimming the Large Caps

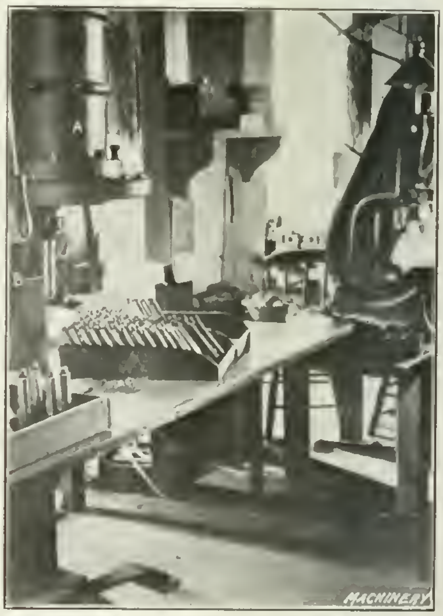

Fig. 16. Filling the Tubes

Cap Making

The caps for collapsible tubes are made in an entirely different manner from the tubes, although the blanking and finishing operations are very much the same as those employed in the tube making. The metal for the caps for 5-inch tubes is rolled to a thickness of 0.140 inch; the blanks are cut ½ inch in diameter, and the punchings are not crowned as were the tube blanks. In the background of Fig. 14 may be seen a cap blanking press, while in the foreground are shown the working parts of two cap forming presses.

Forming the Caps

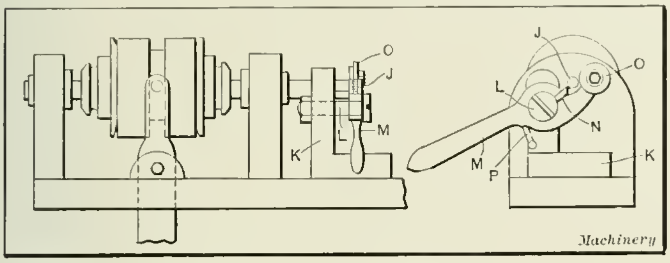

Fig. 17. Details of Cap Trimming Machine

The operation of forming the caps is an interesting piece of press-work, and the principles should be applicable to other lines of manufacturing. By referring to Fig. 7, the operation of the tools may be clearly followed. The die is shown at *A*, and upon its top surface there is a slide *B* that facilitates the feeding of the blanks to the working part of the die, without danger to the operator's fingers. The punch *C* has its tip end threaded with the same size thread as that on the tube that the cap is to be used with. The die-cavity is of the same diameter as the outside of the cap to be formed. Thus, when the punch strikes the blank, the tin is "crowded" around the sides of the punch, being confined on the outside by the limits of the die-cavity. This operation wedges the blank tightly into the die-cavity, but as the metal is just as tightly pressed into the threads upon the punch, the cap is readily withdrawn when the punch ascends.

The manner in which the cap is removed from the threaded punch is of interest. As the punch rises from the die, a beveled shoulder *D*. on the upper part of the punch body, comes into contact with the ends of three set-screws, located at the upper ends of the gripping fingers *E*. As these fingers are centrally hinged, the effect of this contact of the beveled-edged shoulder against the set-screws on the upper ends of the gripping fingers is to throw the tips of the fingers together, causing them to grip the cap as it rises on the punch. These gripping fingers are pivoted in a circular plate that is fitted to a bearing in stripping plate *G*. One of these circular plates, of the two-finger style, is shown at *F* at the side of the press. By means of a pulley *H* on the driving shaft, run independently from above, so as to make possible a higher speed, the gripping finger plate is kept constantly revolving. Thus, as soon as the cap is gripped by the fingers, it is rapidly unscrewed from the punch. During this operation, the punch is rising, and in order that the cap will not be pulled away from the gripping fingers, the stripping plate *G* that supports this mechanism is arranged to slide upward upon pins *I*, thus keeping pace with the ascending punch. When the cap has been unscrewed, the punch continues to rise until the set-screws slide off the shoulder at the bottom, thus releasing the fingers and allowing the cap to slide into a box at the rear of the press. Some caps have a monogram embossed upon the top; this part of the work is easily included in the forming operation by engraving the design in the bottom of the die.

Trimming the Caps

Machines for trimming and knurling the caps are shown in Figs. 15 and 18, and in detail in Fig. 17. The trimming machine in Fig. 15 is used on the large caps, and the machines in Fig 18 take care of the smaller sizes. These machines all work upon the same principle; therefore, the reference letters in Figs. 15 and 17 will apply to each machine. The end of arbor *J* is threaded to fit the inside of the cap. A bracket *K* bolted to the lathe bed, has a slot in which stud *L* is adjustable. Upon this stud is mounted lever *M* which holds the trimming blade *N* and the knurling wheel *O*. In operation, the cap is screwed onto the arbor and the lever *M* moved down until it strikes the stop *P*, this one operation sizing the cap, chamfering the end, truing up the sides and knurling the grip. These machines also are fitted with reversing clutches.

Fig. 10 illustrates the stages that the blanks pass through when being made into caps. At *A* are shown the blanks for the large caps; at *B*, the cupped blanks; and at *C*, the finished caps; *D*, *E*, and *F* show the steps in making the small caps, and at *G* and *H* are illustrated small and large finished caps of another style.

Decorating, Embossing and Filling the Tubes

If the tubes are to be decorated like those shown at *A*, Fig. 1, they are sent to the decorating department, where attractive designs are lithographed in one, two or three colors. A decorated tube has a superior appearance compared with a tube with a paper label pasted upon it, and in addition, the lettering will be plain and easily legible long after a paper label has been washed from a tube.

Some manufacturers prefer to use a tube without labels or ink-printing of any kind, and they use the embossed tubes shown at *B*, Fig. 1. While these tubes, perhaps, are not quite as attractive as lithographed ones, they are considerably cheaper, and there is no question as to their being sanitary The embossing is done by rolling the lettering into the tube under embossing rolls.

Fig. 16 illustrates the machines for filling and closing the tubes in the filling department. The dental cream is contained in the large cylinder *A* that extends to the floor above. Pressure upon the foot treadle opens the valve in nozzle *B*. The operator slips a tube over the nozzle and withdraws it as it is quickly filled with the dentifrice, replacing it immediately with another empty tube. Another operator then takes the tubes and closes the ends, by folding in the press at the right in Fig. 16, and the completed tubes, filled with dentifrice, are ready for packing.

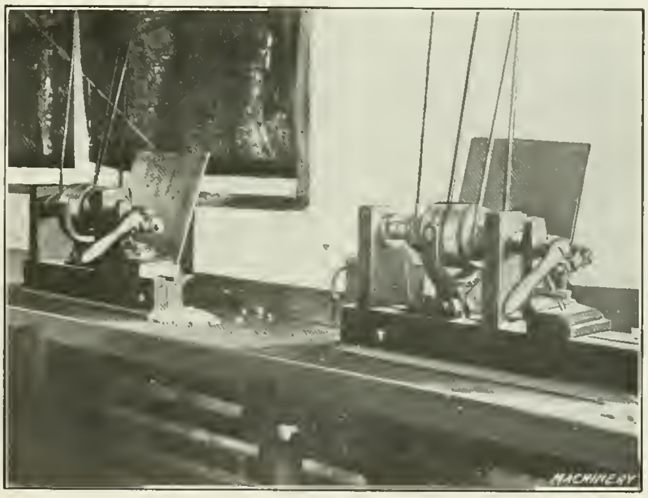

Fig. 18. Two of the Machines for Trimming Small Caps

* * *

The influence which machinery has had on the development of agriculture is well indicated by the news of a remarkable record in plowing made on October 14 at Lafayette, Ind. Official tests were made by the Purdue University and the Indiana Agricultural College with a multiple plow consisting of fifty individual plows pulled by three traction engines. The plows were designed and made by the Oliver Plow Works, of South Bend, Ind., while the traction engines were made by the M. Rumely Co., of La Porte, Ind. By this equipment it was found possible to turn over an acre of ground in four minutes, fifteen seconds, or at the rate of about fourteen acres an hour. Feats of this kind indicate that, while agriculture is, and always must remain, the fundamental or basic human activity, the mechanical trades have made agriculture what it is today. The machine designer and the mechanic are as necessary to the farmer who uses modern methods as the latter is to them.

MILLING RADIAL TEETH IN CUTTER BLANKS—2*

By GEORGE W. BURLEY†

In the previous installment of this article, a formula was deduced for finding the depth of cut required when milling radial teeth, such as the teeth on the side of side milling cutters and the end teeth of end-mills. This formula was as follows:

$$d = R\left(1 - \frac{0.025}{\sin\phi}\right)\cos\theta \qquad (4)$$

in which the symbols denote quantities as indicated in Figs. 1 and 2, which illustrations are here reproduced from the previous installment.

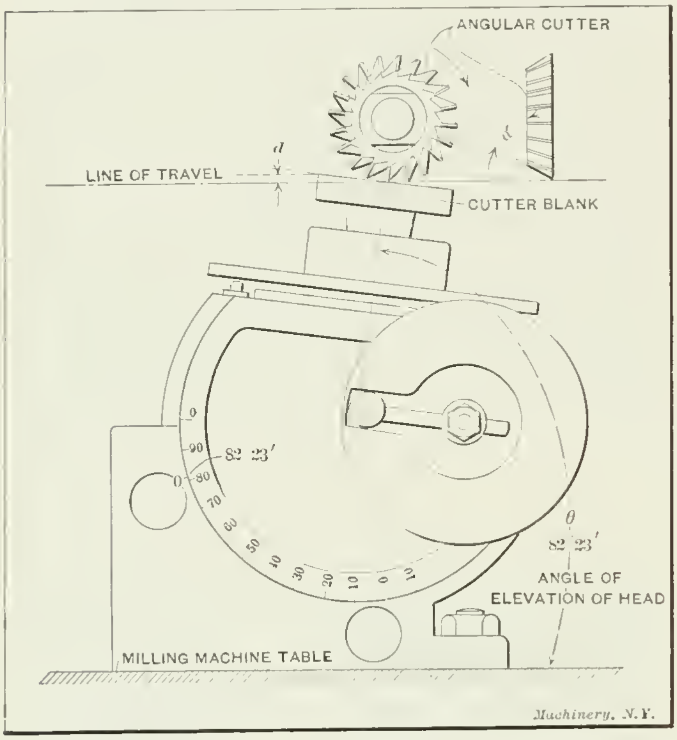

Fig. 1. Diagram for Calculating Angle of Elevation of Index-head

It is common practice, however, to leave the blanks of the cutters slightly larger than the finished cutters, in which case Formula (4) will have to be modified to take this difference in dimensions into account. The modified and exact formula is:

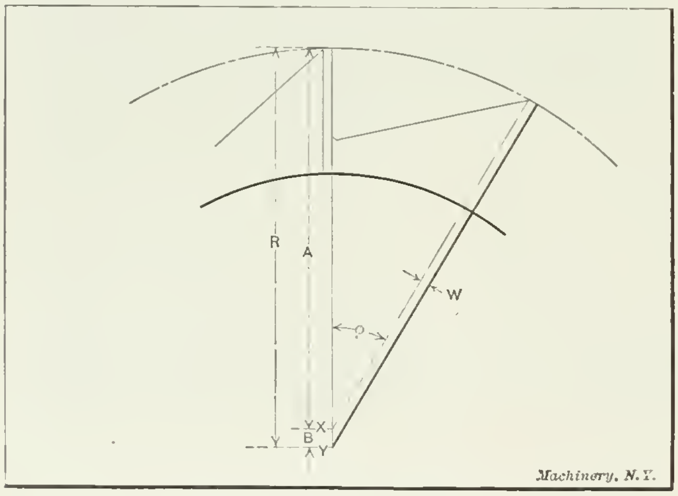

Fig. 2. Part Plan of a Side Milling Cutter, illustrating Method of Determining Width of Land, etc.

$$d = R_1\left(1 - \frac{0.025}{\sin\phi}\right)\cos\theta + x\sin\theta \qquad (5)$$

in which R_1 = the actual radius of the cutter blank, and x = one-half of the difference between the thickness of the blank and that of the finished cutter.

To illustrate the use of this expression, let us suppose that $R = 4$ inches; $N = 36$ (number of teeth); and $a = 75$ degrees.

Then $\phi = \frac{360}{36} = 10$ degrees, $\tan\phi = 0.1763$, and $\cot a = 0.2679$.

Therefore $\cos\theta = 0.1763 \times 0.2679 = 0.04723$.

Further, $\sin\phi = 0.1736$; so that $\frac{0.025}{\sin\phi} = \frac{0.025}{0.1736} = 0.144$.

Neglecting oversize, and employing Formula (4),

$$d = 4\ (1 - 0.144)\ 0.04723$$
$$= 0.1617 \text{ inch.}$$

Now let $R_1 = 4.005$ inches and $x = 0.005$ inch, these dimensions allowing for 0.010 inch oversize on the blank both in regard to the diameter and to the width. Then $\sin\theta = \sqrt{1 - \cos^2\theta} = \sqrt{1 - 0.04723^2} = 0.9988$. Hence

$$d = 4.005\ (1 - 0.144)\ 0.04723 + (0.005 \times 0.9988)$$
$$= 0.1619 + 0.004994$$
$$= 0.166894$$
$$= 0.1669 \text{ inch aproximately.}$$

It will be noticed that, in the case chosen, $\sin\theta$ is almost equal to unity. This is true for practically every case, so that instead of Formula (5) we can use, with sufficient accuracy for all practical purposes, the following formula:

$$d = R_1\left(1 - \frac{0.025}{\sin\phi}\right)\cos\theta + x \qquad (6)$$

* * *

THE SELECTION OF DIRECT-CURRENT MOTORS FOR FACTORY USE*

The prospective purchaser should ascertain accurately the desired speed or speeds of the machine to be driven, and the maximum horsepower as well as the average horsepower required to do the work. The speed or speeds of the driven machine may be ascertained by tests conducted with an experimental motor, or from data furnished by the builder of the machine, where such information is available. Often the motor drive is to replace a steam drive, or individual motor drives are to replace an existing motor-driven group drive, in which cases the speeds are easily determined.

Horsepower Required

The horsepower required to do the work should be determined as accurately as possible. The purchaser may rent an experimental motor and ascertain the power required, which is probably the most satisfactory way to solve the problem. The group drive generally requires that this testing be done, as the amount of power required under actual conditions for a group of machines of different kinds and sizes is problematical, and the information cannot be obtained from the machine manufacturers as can often be done in the case of an individually driven machine. It should be remembered in this connection that from the input to the test motor as measured with a wattmeter, or with a voltmeter and ammeter, should be subtracted the test-motor losses, as the motor to be purchased is rated on horsepower output or brake-horsepower. Money spent in the accurate determination of the amount of power required is wisely expended—a fact often overlooked by the factory manager.

Machine-tool builders, motor manufacturers, and central stations are often called upon to supply the information as to how large a motor should be. Without accurate data, the machine-tool builder often overestimates the horsepower required for driving his tools, in order to be on the safe side, with the result that the motors run at one-quarter to one-half load day in and day out, at greatly reduced efficiency. The electrical losses, together with interest and depreciation on the unnecessary extra investment may amount to a considerable sum in a large installation. It certainly behooves the machine-tool builder to have on hand (and, of course, many of them do) accurate data required from carefully conducted tests, covering the performance of his motor-driven machines under all conditions of load and speed.

The motor manufacturer often has in his own establishment individual machine-tool drives and group drives similar to those of the prospective purchaser, in which event he can supply the necessary information as to the size of the motor. Many up-to-date central stations also have a vast amount of data on power required for different motor drives, derived from actual tests under working conditions, which are always available to a prospective power consumer.

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* With Data Sheet Supplement.

† Address: University of Sheffield, Sheffield, England.

* Abstract of an article by Earle D. Jackson in the *Engineering Magazine*, September, 1911.

The piece-worker requires a relatively larger motor for the same tool than does the operator working by the day. In the former case, heavy cuts at the higher speeds will be the rule, together with quicker starting and more continuous running of the motor, as the piece-worker crowds his machine to the limit, and must be provided with ample motor capacity. Nothing is more discouraging to a workman than to find out that the motor will not perform all the work he requires of it, or is continually giving trouble.

Having determined the speeds of the driven machines and the horsepower required to do the work under all conditions, a knowledge of the various types of direct-current motors is the next essential in order that the motor may be selected which will fulfill the conditions required of it in the most acceptable manner.

Types of Motors for Different Requirements

The general classification of direct-current motors now included in the standard product of nearly all motor manufacturers is as follows:

Approximately constant speed, no load to full load........	Shunt motor. Shunt-commutating pole motor.
Semi-constant speed, no load to full load	Compound motor.
Adjustable speed, remaining approximately constant for one adjustment, no load to full load	Shunt motor, with adjustable field resistance. Shunt-commutating pole motor with adjustable field resistance.
Adjustable speed, semi-constant for one adjustment, no load to full load	Compound motor, with adjustable shunt field resistance.
Varying speed, varying with the load	Series motor. Series-commutating pole motor.

Open or Enclosed Motors

The question whether to employ the open or enclosed motor often arises. The metal covers of closed motors reduce the efficiency and capacity of the motor by preventing free circulation of air around the active elements of the motor. Working conditions will usually decide whether it is possible to use the open motor, which is, of course, the desirable practice, or whether the presence of excessive dust makes it necessary to enclose the moving parts of the motor partially or completely. The partially or semi-enclosed motor should not be placed in a concealed position for the reason that it is then certain to be neglected in an ordinary factory. The perforated covers and wire screens will close up by dust and dirt, and as the result the semi-enclosed motor becomes virtually a totally enclosed motor with a semi-enclosed rating and consequent trouble.

General Considerations

Vertical motors are made in the various sizes and are only to be recommended when the nature of the drive makes it apparent that they possess great advantages over the standard or horizontal type, as vertical motors are troublesome to keep in running order and require greater attention. They are not generally kept in stock by local dealers, and the motor, as well as repair parts, must be replaced from the factory stock at the risk of the usual delay in shipment.

Manufacturers' standard sizes and speeds of motors should be chosen wherever possible, in preference to motors of special sizes and speeds, as prices, time of delivery, and general performance of the former will be found to be more favorable than those of special design. In many cases, it will be found impossible to select from the standard sizes and speeds of a single motor manufacturer only, all the motors which are required, and in this case there is no valid reason why the order should not be divided up and the motors purchased of the builders whose standard product meets the required conditions.

The direct-current voltage now practically standardized for factory use is 220 volts. This voltage is both economically and operatively superior for direct-current motor systems to that of 110 volts sometimes employed.

Types of Drives

Having determined the horsepower and selected the type or types of direct-current motors desired, the best means to employ in driving the machines is the next problem that is confronted. In considering a belt drive, a greater pulley reduction than 5 to 1 is not to be recommended. Idlers to increase the arc of contact, or countershafts between the motor and the driven machine to reduce the initial speed of the driver, are doubtful expedients, unless the amount of power used is very small. It is an easy matter to design a belt drive of this kind in which 20 to 30 per cent of the power of the motor is wasted between the motor and the driven machine.

Direct-connected drives, gear drives, and silent chains constitute a list of positive drives from which it should be possible to select a satisfactory method of driving a machine from a motor, in which safety, reliablity, and economy of operation are all present. The direct-connected drive is the ideal drive, as it eliminates all intermediate power-absorbing apparatus. In a great many cases, however, the use of the direct-connected drive necessitates the employment of a special motor. It is unfortunate, in this respect, that machine-tool builders and motor manufacturers often disregard each other when it comes to the selection of standard speeds for their respective machines, although they are collaborating more than they did formerly. The silent chain as a means of driving a machine is coming into wider use. The early types of silent chains were expensive, rapidly depreciated, and in many installations were far from being "silent." In point of efficiency, the silent-chain drive stands next to the direct-connected drive. The main objection to the gear drive is its excessive noise, but this may be overcome to a large degree by the use of a rawhide pinion.

Specifications

Specifications should be drawn which state in detail the number of motors required, the horsepower of each motor, the desired motor speed or speeds, together with the speed or speeds of the corresponding driven machine, and the name or description of the machine, giving the number of hours of its probable use per day; whether the motor is to be of the open, semi-enclosed, or enclosed type; the line voltage; details of the motor drive, including pulleys, gears, chains and sprockets, of both driver and driven machine; and whether the motor foundations are to be included in the contract price. Specifications should be submitted to at least three reputable motor manufacturers for quotations, giving cost complete in the case of each separate motor, weights and mechanical sizes of motors offered, efficiencies at one-quarter, one-half, three-quarters, and full loads, for all ranges of speed called for, speed regulation from no load to full load, commutation at all loads and speeds, temperature rise, overload capacity, times of delivery, and description of all starting and field or other rheostats to be furnished, as well as complete description of each motor. Each one of the foregoing items should be known, if intelligent comparison and selection are to be made. The specifications may also call for a test of each motor purchased, to be made by the purchaser or his engineer after the motors are in place and before final acceptance, to demonstrate whether or not all of the required conditions have been fulfilled.

The investment in a set of inexpensive but reliable electrical measuring instruments is to be highly recommended in connection with a motor drive. For a small installation, the set should include a portable voltmeter, ammeter, and wattmeter. For a large installation, a considerable investment is sometimes warranted. Thus on important machines, graphic wattmeters can be installed, showing at any time of day the amount of power used. These instruments, moreover, can be moved from place to place, until every motor in the shop has been included, thus acquiring valuable data for shop records. This is especially valuable immediately after a drive is installed as a means of ascertaining whether or not the motor of proper size and characteristics has been selected.

DESIGNING A HYDRAULIC ACCUMULATOR

By W. E. MOREY*

When designing a hydraulic accumulator intended to serve a given number of presses, the factors given in the following must be taken into account. Some of them, as will be shown later, may be disregarded in most cases, because they are of small importance. The factors are:

1. Normal requirements of all presses, measured in gallons of water per minute.
2. Pressure to be maintained in pipe lines.
3. Capacity of pumping plant in gallons per minute.
4. Friction losses in pipe lines.
5. Friction losses in moving parts.
6. Available space for the erection of the accumulator.
7. Inertia of moving parts.
8. Strength of materials used.
9. Required excess capacity, to provide for possible expansion in business.

The last factor depends on whether the possible expansion is likely to take place in the near future, and whether the increase would not be better taken care of by building another accumulator when required. In the present case we will assume that we are to build the accumulator large enough for present needs, and will let the future take care of itself.

It will be necessary to assume certain of the factors mentioned, and work out the design accordingly. Assume a working pressure of 1500 pounds per square inch for all the presses. The presses to be served are as follows: One press of 600 tons capacity, 24-inch stroke, making two strokes per minute; one press of 300 tons capacity, 36-inch stroke, making three strokes per minute; two presses of 100 tons capacity each, 15-inch stroke, making four strokes per minute; three presses of 50 tons capacity each, 12-inch stroke, making four strokes per minute.

By assuming the capacity of the presses, and basing the calculations on this assumption, the internal friction losses may be neglected, because it is not necessary that the presses should be of the exact capacity assumed.

The amount of water required by the presses, in gallons per minute, is calculated by the following formulas:

$$A=\frac{C\times 2000}{P}\qquad(1)$$

in which A = area of ram in square inches,

C = capacity of press in tons,

P = pressure of water in pounds per square inch.

$$G=\frac{N\times n\times A\times S}{231}\qquad(2)$$

in which G = gallons of water per minute,

N = number of presses of any given size,

n = number of strokes per minute,

S = length of stroke in inches,

A = area of ram in square inches.

Substituting Equation (1) in (2):

$$G=\frac{N\times n\times C\times 2000\times S}{P\times 231}\qquad(3)$$

Substituting the numerical values in Equation (3), we have, for the 600-ton press,

$$G=\frac{1\times 2\times 600\times 2000\times 24}{1500\times 231}=166.2 \text{ gallons per minute.}$$

For the 300-ton press we require 187.0 gallons per minute, for the 100-ton presses, 69.3 gallons per minute, and for the 50-ton presses, 41.5 gallons per minute. The total amount of water required thus is 464 gallons per minute, or say, in round numbers, 465 gallons.

In many hydraulic plants, if not in all, two lines of pipes are used, one for low-pressure, say 300 pounds per square inch, and one for high-pressure, say 1500 pounds per square inch, with such an arrangement of valves at the presses as will permit the rams to be moved as far as possible with the low-pressure or "cheap" water, the heavy pressure being thrown in only to complete the stroke. As in the present instance the design of the accumulator only is considered, we will assume only one set of pipes.

The capacity of the pumps is assumed to be 350 gallons per minute. We have found, however, that the normal capacity of all the presses is 465 gallons per minute. Owing to the fact that the presses are very rarely all in operation at the same time, and also on account of the fact that it is customary to shorten the strokes whenever the work permits it, it is safe to design the accumulator with a capacity of 115 gallons per minute, as this will provide a sufficient margin for all conditions.

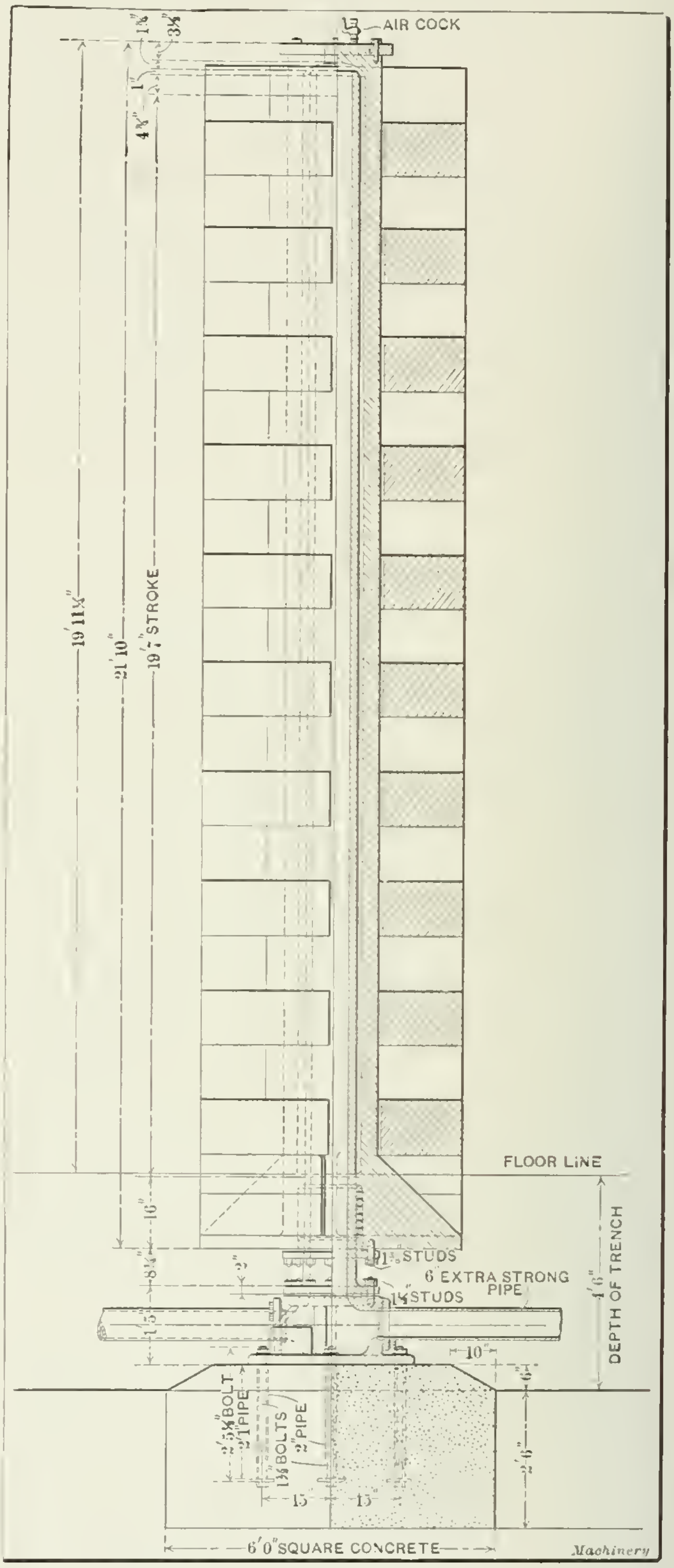

Fig. 1. General View of Hydraulic Accumulator

Having determined the capacity of the accumulator in gallons, we must now ascertain the available head room where the accumulator is to be located. In this way we can determine the stroke and the resultant diameter. It is better to use as long a stroke as possible, with a ram of small diameter, rather than a short stroke and large diameter, because the weight on the accumulator necessary to produce a given pressure varies as the square of the ram diameter. In the present case it is not desirable to build a tower above the roof to accommodate the accumulator, and we find that from the top of the foundation to the top of the accumulator at the extreme stroke, the distance is 44 feet. An allowance of 5 feet is made between the top of the weights and the roof, to make it possible for workmen to go up on the top without danger, when the accumulator is in operation. The top of the foundation is placed 4 feet below the power-house floor. This brings the pipes low enough to be safe from frost when running directly from the pumps through the accumulator to the main.

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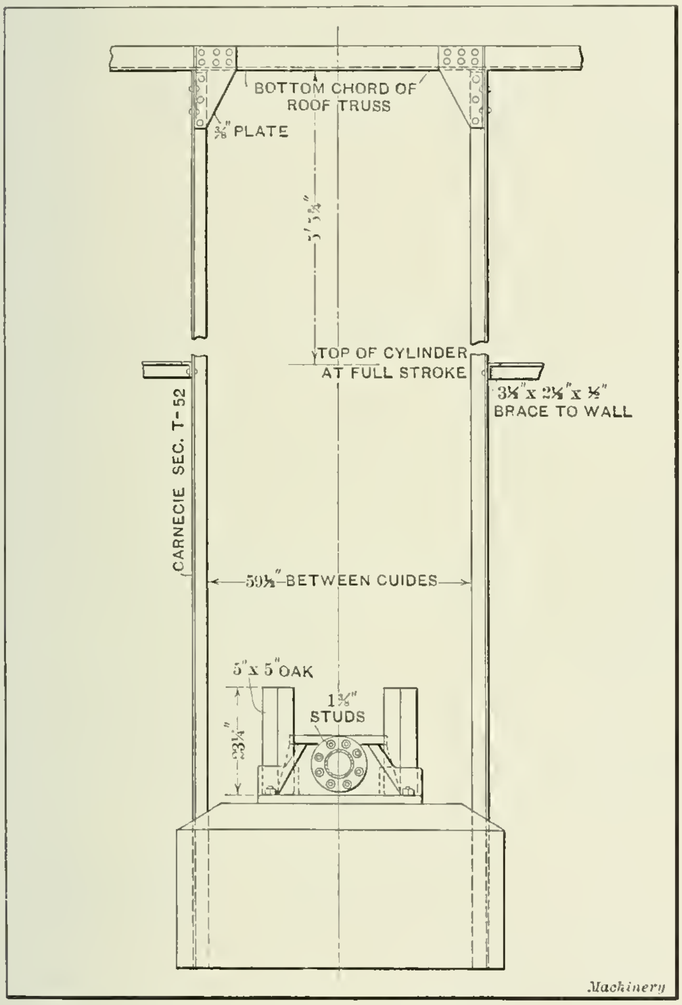
BOTTOM CHORD OF ROOF TRUSS
⅜" PLATE
5' 5¾"
TOP OF CYLINDER AT FULL STROKE
3½" x 2½" x ⅜" BRACE TO WALL
CARNECIE SEC. T-52
59⅛" BETWEEN CUIDES
5" x 5" OAK
1⅜" STUDS
23¼"
Machinery

Fig. 2. Guiding Frame of Accumulator

The depth of the base casting is determined largely by the diameter of the pipe flanges which secure the inlet and outlet pipes to it. These pipes are 6-inch extra-strong steel pipes, with an outside diameter of 6⅝ inches and an inside diameter of 5¾ inches. The studs through the pipe flanges must be strong enough to resist a pressure of 1500 pounds per square inch on the inner cross-sectional area of the pipe. Owing to the stresses brought to bear upon the studs by tightening up the nuts, it is not advisable to figure on an allowable stress in the studs of more than 5000 pounds per square inch at the root of the thread. By the formula,

$$a = \frac{d^2 \times \pi \times P}{4 \times T} \qquad (4)$$

we find the total stud area required. In the formula given:

d = inside diameter of pipe = 5¾ inches,

P = pressure of water = 1500 pounds per square inch,

T = allowable stress in studs = 5000 pounds per square inch,

a = total area of studs at root of thread.

Hence,

$$\frac{5.75^2 \times 3.14 \times 1500}{4 \times 5000} = 7.79 \text{ square inches.}$$

If we assume that we use eight studs, we will find that the nearest stud diameter will be 1⅜ inch with an area of 1.06 square inch at the root of the thread. The stud circle must be 9¼ inches in diameter in order to permit ample room on the outside of the 6-inch pipe to turn the hexagon nuts. The outside diameter of the flange we may make 12 inches. The base portion of the casting should have a thickness of, say, 2 inches; ½ inch is allowed at top and bottom of the flange, making the total height 15 inches. Approximately three feet should be allowed for the gland, the clearance under the gland, and the clearance at the top of the cylinder. Hence, 4 feet 3 inches should be subtracted from the total available space of 44 feet. This leaves us 39 feet 9 inches, which will be approximately twice the stroke of the accumulator, the stroke thus being assumed, for preliminary purposes, to be 19 feet 11 inches. As there are 231 cubic inches in one gallon, and the stroke is 239 inches, the diameter of the ram for an accumulator of 115 gallons capacity is found as follows:

$$d^2 = \frac{115 \times 231}{239 \times 0.7854} = 141.5, \text{ and } d = 11.9 \text{ inches}$$

The diameter, then, will be assumed to be 12 inches, and the stroke will be made to suit this diameter.

The next step is to determine the inside diameter of the ram which is calculated from the following formula:

$$P \times (12 - 2t) = S \times 2t$$

in which P = pressure in pounds per square inch, as before,

t = thickness of wall in inches,

S = allowable working stress of cast iron = 3000 pounds per square inch.

Thus we have:

$$1500 \times (12 - 2t) = 3000 \times 2t$$

$$t = 2 \text{ inches.}$$

The ram must be bolted to the base casting strongly enough to resist an upward pressure of 1500 pounds per square inch on the area of an 8-inch circle. To find the bolts required, Formula 4 is used:

$$a = \frac{d^2 \times \pi \times P}{4 \times T}$$

in which d = inside diameter of ram, the notation otherwise being as before.

Hence,

$$a = \frac{64 \times 3.14 \times 1500}{4 \times 5000} = 15.1 \text{ square inches.}$$

It will be found that twelve studs, 1½ inch in diameter, will be required, as the area at the root of the thread of a 1½-inch stud is 1.295 square inch. In order to be able to use a good-sized fillet at the flange, the stud circle is made 17 inches in diameter, and the outside diameter of the flange 21 inches. The thickness of the flange will be made 2 inches in order to be uniform with the flange on the base casting.

From the data so far obtained we can now complete the drawing of the base casting, being careful to nicely round the core so as to offer the least possible resistance to the passage of the water. Care is also taken to make the casting of uniform section, as far as possible, so that the shrinkage will be as uniform as possible, and cracking from internal strains avoided. The joint between the ram and the base is made by cutting a circular groove in the base casting and partly filling it with lead, well peened in and faced. An annular projection on the bottom of the ram bears on this lead ring. In addition, a sheet rubber gasket is used inside of the lead joint, extending to the 8-inch bore. The pipe joints on the sides are indicated in Fig. 3, where the pipe flanges are also shown.

The next step is to design the gland and the lower end of the cylinder. We must first determine the lowest position of the cylinder, by allowing room for packing it when the gland is resting on the ram studs. A space of 8¼ inches between the bottom of the cylinder and the top of the ram flange, with a gland as shown in detail in Fig. 3, will allow about 2 inches space for putting in the packing. The cylinder is supported in this position by four oak blocks, 5 by 5 inches, which fit into pockets in the casting as indicated in Fig. 2. The gland studs are of such length that the nuts can be started when the gland is entered ½ inch into the cylinder. The packing is to be 1-inch square braided flax, soaked in tallow, and the length of the packing chamber, when the gland is up to within ½ inch of the cylinder flange, is to be about equal to the diameter of the ram, or 12 inches.

The size and number of gland studs are calculated by the following formula:

$$a = \frac{(d_1^2 - d_2^2)\pi \times P}{4 \times T}$$

in which d_1 = outer diameter of gland = 14 inches,

d_2 = inner diameter of gland = 12 inches,

P = pressure of water = 1500 pounds per square inch,

a = total stud area at root of threads,

T = allowable stress in studs = 5000 pounds per square inch.

Hence,

$$a = \frac{(196 - 144)3.14 \times 1500}{4 \times 5000} = 12.25 \text{ square inches.}$$

Assuming that twelve studs will be used, we find that studs of 1⅜-inch diameter, having an area at the root of the thread of 1.06 square inch, will be required. The stud circle is made 18 inches in diameter, in order to get ample room to turn the nuts. The flange is made 21 inches in diameter.

The inner diameter of the cylinder will be made 14 inches, as it is not to be bored and it is necessary that it be large enough to insure its not coming into contact with the ram. The thickness of the metal is calculated from the following formula:

$$t = \frac{P \times D}{2S}$$

in which t = thickness of cylinder,

P = pressure of water, as before,

D = internal diameter of cylinder = 14 inches,

S = allowable stress in metal = 3000 pounds per square inch.

Hence,

$$t = \frac{1500 \times 14}{2 \times 3000} = 3\tfrac{1}{2} \text{ inches.}$$

The length of the ram and the length of the cylinder must now be definitely determined. In order to have a capacity of 115 gallons, we find, as indicated below, that the cylinder must move 19 feet 7 inches.

d = diameter of ram = 12 inches.

$$\frac{115 \times 231}{d^2 \times 0.7854 \times 12} = \text{stroke in feet} = 19.58 \text{ feet.}$$

It is, of course, necessary to allow a margin of safety in the length of the ram, so that the bored portion of the cylinder above the packing will not pass the end of the ram. In Fig. 1 it will be noted that at the extreme stroke, or rather at a normal stroke of 19 feet 7 inches, this portion comes within 4¾ inches of the end of the straight part of the ram. This gives 22 feet 3 inches for the length of the ram including a 60-degree chamfer at the top, 1 inch in length, for facilitating assembling, but not including the annular projection at the bottom.

An automatic throttling arrangement, connected by cable to a butterfly valve in the steam pipe of the pump, is located at such a point that it becomes operative when the cylinder reaches this point. As a further protection, two ¼-inch holes are drilled through the ram just above the lower line of the packing when the cylinder is at the extreme stroke. These holes are 1 inch apart vertically. By this means instant and audible, as well as forcible, notice is given to any one in the engine room if the accumulator exceeds its proper stroke.

The length of the cylinder may now be determined. A clearance of 1¾ inch is allowed between the top of the ram and the inside of the cylinder head. In order that the stresses in the metal at the top may be uniform with those in the sides, the inner radius is made equal to the inside diameter of the cylindrical portion, or 14 inches. The curved head is then joined to the sides by a fillet of 2-inch radius. The thickness of the head is the same as that of the sides, or 3½ inches, thus making the total length of the cylinder 21 feet 10 inches, as shown in Fig. 3.

It is now possible to calculate approximately the weight of the cylinder and find how much additional weight is necessary to produce a pressure of 1500 pounds per square inch of ram area. The total weight required, neglecting the friction of the packing, is found as follows:

$$W = \frac{P \times d^2 \times \pi}{4}$$

in which W = total weight required for the accumulator,

P = pressure of water, as before,

d = diameter of ram = 12 inches.

Hence,

$W = 1500 \times 144 \times 0.7854 = 169{,}600$ pounds, approximately.

The weight of the cylinder, as shown in Fig. 3, without the lower flange and ribs, is calculated to be 13,200 pounds, which leaves a balance of 156,400 pounds to be provided for by means of weights of cast iron, made in the form of segments, each of

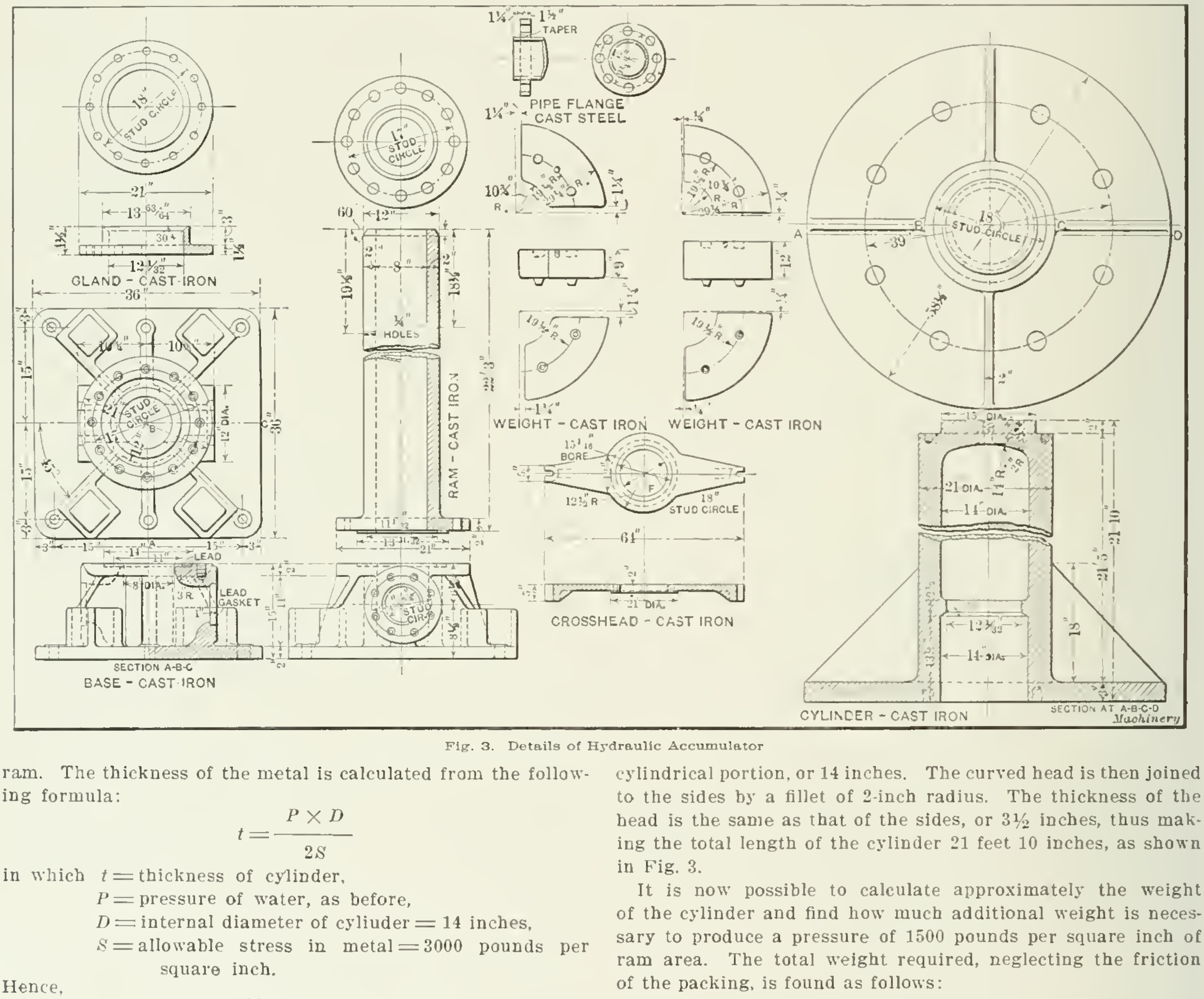

Fig. 3. Details of Hydraulic Accumulator

which is one-quarter of a ring. The inner diameter of these segments is made ½ inch larger than the outside diameter of the cylinder, or 21½ inches. Assuming that the total height of the weights, including the 3-inch flange at the bottom of the cylinder, may be 21 feet 6 inches, we find the outside diameter of the weights and the cylinder flange by the following formula:

$$W = (D^2 - d^2)\ 0.7854 \times 0.26 \times H$$

in which D = outside diameter of weights in inches,
d = inside diameter of weights = 21.5 inches,
H = height of weights = 258 inches.

The factor 0.26 is the weight in pounds of one cubic inch of cast iron. Hence,

$156{,}400 = (D^2 - 21.5^2)\ \ 0.7854 \times 0.26 \times 258$, and $D = 58.5$ inches.

In order to strengthen the lower flange of the cylinder, the casting is made with four ribs 2 inches thick and extending 18 inches up the sides. This makes it necessary to make the two lower rows of weights of such size that they will fit between the ribs. It will be seen in Fig. 3 that the cylinder flange has a series of holes spaced equally on a 39-inch diameter circle. Into these holes, lugs on the bottom side of the lower weights fit. The tops of the weights have similar holes so that the whole mass is securely locked together. The segments "break joints" after the first two rows are laid, as indicated in Fig. 1. Each weight is tapped for a 1-inch eye-bolt, which is to be located above its center of gravity for handling purposes.

To guide the accumulator, a crosshead of such length that the guides will clear the weights is bolted to the top of the cylinder. The guides are formed of Carnegie steel T-sections, T-52, which are connected by gussets to the lower chord of the roof truss and securely braced to an adjacent brick wall. The lower ends are imbedded in the concrete foundation, as shown in Fig. 2.

In the center of the cylinder head is a hole which is left in the casting as a support for the core. The hole is afterwards tapped for a 2-inch pipe plug. By using an eye-bolt with pipe threads, this can be used for raising the cylinder into position. To let out the air when necessary, a valve is provided in the cylinder head.

In designing the foundation we must take into account the bearing value of the concrete and the bearing value of the soil. The total weight to be supported is approximately ninety tons, and as concrete composed of one part of Portland cement, two parts of sand, and five parts of broken stone, can carry from twelve to fifteen tons per square foot, an area of 9 square feet under the base casting is more than sufficient. The soil upon which the foundation is to rest, we will assume, consists of sand well cemented and able to carry a pressure of from four to six tons per square foot. It might, therefore, be allowable to use a base 5 feet square, but as the accumulator is so high that it would readily be thrown out of plumb by a slight settling, the base should preferably be made 6 feet square. The bolts are set in pipes to allow for slight variations.

No account has been taken of the inertia of the falling accumulator with regard to its effect on the strength of the parts. The reason for this is that the pipe lines are provided with shock valves at various points. These valves consist of plungers which are moved in stuffing boxes to relieve any excess of pressure. They are controlled by springs whose strength is proportioned with reference to the normal pressure in the lines.

* * *

The world's speed record for a long-distance train is said to be the 82 hours 15 minute record made by a special train from Seattle to New York City, a distance of 3178 miles. This record was recently made by a train laden with two million dollars' worth of silk, over the Great Northern, the Chicago, Burlington & Quincy, and the New York Central lines. This is an average speed of more than 38.5 miles per hour for the entire distance across the continent. Considering the fact that two great mountain ranges were crossed, and that frequent changes of engines and train crew were necessary, the time made is remarkable. The best previous record by rail between the Atlantic and Pacific coasts was 97 hours 40 minutes.

TASK WORK—THE BASIS OF PROPER MANAGEMENT[*][†]

About fifteen years ago, the financiers of this country realized that in many cases, at least, the larger factories were making a greater percentage of profit than the smaller ones, and they conceived the idea of uniting the smaller ones under one system of management. By this move the small factories were placed on a better financial standing, and the financial or business expense was reduced. In this way they also reduced competition and decreased the cost of selling. Business prospered rapidly, and the illustrated magazines were filled with pictures of the "captains of industry" who had engineered these combinations; it was freely predicted that the economies obtained were so great that it would only be a question of time before Europe would be flooded with American goods.

The formation of "trusts" in manufacturing, and of great "systems" in railroading went on at a rapid rate for some years. The economies produced by these methods, and the elimination of competition, enabled many combinations to pay dividends on stock that represented little or no value. While the internal trade grew at an astounding rate, the American invasion of Europe did not materialize, and it was not long before complaints were heard of the "increasing inefficiency of labor." Wages began to rise, but the output of the workmen did not rise correspondingly. The financier had undoubtedly effected economies in the portions of the business directly under his control, but he had not succeeded in producing a similar effect on those with which he did not come in direct contact.

As a matter of fact, while the financier had been forming his great combinations with the effect of upholding prices, the workmen had gone him one better. By their unions, not only had they upheld the price of their labor, but in many cases markedly increased it, without rendering any more service than formerly; the employers, in many cases, say less. As cooperation among employers to uphold the price of their product had been so successful, it is scarcely to be wondered at that the workmen should adopt the same tactics.

On this subject Adam Smith, in his famous book, "An Inquiry Into the Nature and Causes of the Wealth of Nations," nearly one hundred and forty years ago, wrote as follows: "Our merchants and master manufacturers complain much of the bad effects of high wages in raising the price and thereby lessening the sale of goods at home and abroad. They say nothing of the bad effects of high profits. They are silent with regard to the pernicious effect of their own gains. They complain only of those of other people."

This statement made so long ago is just as applicable to the conditions of today, and admonishes us in approaching our problem to do so with an open mind and not from a partisan standpoint, for a solution cannot be permanent if it benefits one class exclusively. With regard to the mention made of the *increasing* efficiency of labor, it must be said that while the manager cannot be held responsible for the inefficiency he finds, he is responsible if he allows it to increase. It therefore seems that this problem is one of management, and if the methods now generally in vogue do not accomplish the desired results, they must be modified.

The Task Idea

In studying a problem, it is best to consider the simplest form in which that problem can be presented. A good example for our purpose is to study the methods by which a child is taught to perform a simple operation. The invariable method is to show the child, as clearly as possible, what is wanted, and then to set a task for it to accomplish. The accomplishment of the task is rendered much easier for the child if a suitable reward is offered. As a matter of fact, the setting of tasks and rewarding the performance is the standard method of teaching and training children. The inducement to perform a task is always some form of benefit or reward. It may not always be as immediate as the lump of sugar that the child gets, but the work is still done for some reward.

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[*] Abstract of a paper read by Mr. H. L. Gantt before the convention of the National Machine Tool Builders' Association, October, 1911.

[†] See MACHINERY, April, 1907, engineering edition, "The Utilization of Labor."

immediate or prospective. Further, it is acknowledged that to work at a task which we recognize as being within our power to accomplish, without over-exerting ourselves, is less tiring and more pleasant than to work along at the same rate with no special goal ahead.

The idea of setting for each worker a task with a bonus for the accomplishment seems, therefore, to be in accord with human nature, and hence is the proper foundation of a system of management. Our problem, then, is to find out how to set a proper task and what the reward should be. The ideal industrial community would be one in which every member had his proper daily task and received a corresponding reward. This is what scientific management in its highest development aims to accomplish, for it aims to assign to all a definite task each day, and to give to each individual such a reward as will make his task not only acceptable, but agreeable and pleasant.

The greatest obstacles to the introduction of these methods have not in the past come from workmen, but from foremen and others in more or less authority. Those objecting have, as a rule, either not understood the principles of the new methods, or felt their inability to hold their jobs if they were asked to perform their work in accordance with the high standards set. The new system bears hardest on those who hold their jobs by "pull" or "bluff," and from them comes the greatest opposition. In fact, there is only one class that opposes the new methods more strongly, and that is the class that uses official positions for private gain. Such people will often commit serious crimes in an attempt to prevent the exposure of their irregularities. No firm should, therefore, undertake the installation of these methods unless there is an avowed purpose to eliminate all kinds of graft and special privileges.

Schedules as Tasks

The task idea is really so common that we do not recognize it. Every railroad schedule consists of a series of tasks, and in the manufacture of such articles as sewing machines, typewriters and locomotives, the task idea is illustrated by the schedule according to which various parts are started on their way through the different departments, and day by day make such progress that they will reach the assembling or erecting shop at the proper time to complete a machine without delay. In the case of locomotives, in particular, the task idea is emphasized by the date of shipment—set often months ahead. When the shipping date of a locomotive has been set, the time when every piece must start on its course through the shop is also determined. Inasmuch as this work has been done over and over again, all the principal men in the shop know by heart the schedule of the parts with which they are concerned. When the work is of a miscellaneous character, however, the task of having each part pass through the proper sequence of operations, and arrive at the erecting shop in the order wanted, is not so easy. The inability to get miscellaneous work through the shop on time is often the source of as much expense as is inefficient work on the part of the operator.

In a small shop, one capable man can often so plan even miscellaneous work, and keep track of it in his head, that but little expense is incurred from delays, but in the large shops and in plants consisting of several shops, such a thing is impossible, and the larger the shop, the greater the loss arising from this source; hence, the greatest and most important task to be performed in any works, and one for which the management is solely responsible, is to get the work through on time and without interference.

To go into the details of how such a task is performed would be impossible in this brief account. Suffice it to say, however, that when a start has been made, and each foreman receives each day a list of jobs that must be done that day, the general efficiency of the works is much increased, even though nothing definite has been done to increase the efficiency of the individual workman. Such an order of work is a great assistance to the foreman, and its usefulness increases rapidly if the work is so planned as to avoid interference, and if all materials and appliances are ready for each workman in advance. The efficiency of the individual naturally increases with the general efficiency, and unless the inefficiency of the individual is very flagrant, it is far better to solve the general problem first and to take up the efficiency of the individual workman later. When the large problem is solved, every step in advance made by the individual stands for all it is worth, which is not always the case when work is done in wrong sequence or by inferior methods.

Having thus solved the great problem of scheduling and routing each part through the works, we come to what must be considered the real problem—that of setting a task for the workman. Indeed, it is only in cases where the number of routes is small and the sequence of operations fixed that proper tasks can be set for the workmen before the solution of the general problem.

To send a clerk into the shop with a stop-watch to time workmen and set rates or tasks, naturally arouses the opposition of the workmen, and while, no doubt, it has been possible in many cases to get out more work by so doing, its effect on the industrial conditions of the country at large have been decidedly detrimental. The working of tasks should not be a hardship, but a pleasure, if they are properly set and adequately rewarded. Before task setting can be carried on satisfactorily, the workman must be convinced that he is not approached by a scheme for driving, but by one by which he will be benefited.

Preparation for Task Setting

Among the steps taken before attempting to set a task are: getting all machines and appliances in proper order; establishing a tool-room with suitable tools for the work; arranging to supply the workman with material as required; and planning work so that one job will seldom have to be stopped to make way for another. In other words, the conditions should be so arranged that the workman can work to best advantage. This consideration includes proper ventilation and a comfortable temperature, which alone will materially increase his output, as petty annoyances of any kind reduce efficiency.

If the work requires mechanical skill, the problem should be studied by the most capable mechanic available and specific instructions given, showing the best way to do the work and the time needed when done in that way. If necessary, and it usually is, the task setter should now turn instructor and show the workman how to do the work. If the task is set in this manner by a man in whose ability and honesty the workman has confidence, there is little difficulty in getting a task-work system started, provided a proper bonus is offered.

The proper bonus is one that will make the workman feel that he is fully compensated for the extra exertion. Hence the bonus depends upon the severity of the work. It varies from 20 to 50 per cent of the day rate. Task-work does not necessarily mean more severe work, but more continuous work under more favorable conditions. To attempt to set a task so severe that very few people can perform it, would be of no advantage from any standpoint, for few will continue to strive for a reward which they cannot reach.

Performing the Task

Having set a task, the responsibility for its performance does not rest upon the workman alone, but must be shared by the instructor, who must see that the conditions under which the task was set are maintained. Therefore, every case of lost bonus must be investigated and the reason determined. Such investigations, in the case of men who know how to perform the task as required, usually lead to the discovery of slightly defective material or machines, imperfect tools, or other conditions which might reduce the output by 10 or 15 per cent, but which would not be noticed unless a special search were made for them. The setting of a task thus imposes an obligation on the management, with the invariable result of a better and cheaper product.

Task-work in a Machine Shop

The setting of a task in the machine shop today is quite different from what it was ten years ago. At that time, machine operations took a relatively long time, and the time between each operation was of much less importance. Today, machine operations are, as a rule, performed three times as fast, so that the time for changing jobs has relatively become three times as important, and to plan the work so that there will be no lost time in changing from one job to another has become a more important factor. For each machine tool operated today, nearly three times as much work must be planned. The ratio between the number of men actually engaged on mechanical work and those engaged in supervising or in preparing work must also necessarily be quite different from what it was before the advent of high-speed steel.

As has already been said, it is essential that the conditions under which the tasks have been set should be maintained permanently. Failure to maintain the conditions will bring hardship to the workman, and no one should, therefore, undertake the introduction of task-work unless he is prepared to maintain the conditions of his shop at a high standard; otherwise dissatisfaction is sure to spring up.

The sum of the tasks which can be performed by the individuals of a shop is the shop task, and the sum of the tasks of the shops is the factory task. Every foreman who succeeds in the accomplishment of his shop task should be properly rewarded. In this way, the foreman and the workman are brought together by a mutual interest, and a spirit of cooperation develops. Under such a scheme as described above, it is evident that there will also be a decided increase in profits. Having satisfied ourselves that these methods will result in an increased production of wealth, we now ask what effect this increase of wealth will have on the industrial conditions of the country.

Effect of Scientific Management on General Prosperity

General prosperity is not promoted by the accumulation of wealth in the hands of one class, but by the interchange of commodities. Unless, therefore, these methods help this interchange, the community will be but slightly benefited. Individual concerns will undoubtedly be largely benefited at first, but it is doubtful if this benefit will continue unless the public at large is also benefited. Adam Smith said, over a century ago, that prosperity was greatest when profits were small and business, or interchange, large. We know this to be a fact, and unless some of the economies of these methods are shared with the public in the shape of reduced prices, thus making possible an increase of business, it is extremely doubtful if these methods will permanently improve our industrial conditions. It should be constantly kept in mind that the individual cannot continue to prosper indefinitely unless the country at large prospers also.

Scientific management has been likened to labor saving machinery and the parallel is very close. Labor saving machinery has greatly increased wealth and improved the conditions of civilized man, but with the increase of wealth have come greater relative differences between rich and poor, and it is doubtful if the relations between employer and employe are any better today than they were two centuries ago. During the time of such an enormous increase in wealth, many of our problems should have been solved, but they were not, largely because an economic law was ignored. In the utilization of this new system, it will be of great benefit to the community if the laws of distribution are studied along with those of production.

In considering the parallel between scientific management and labor saving machinery, it should be noted that properly designed and labor saving machinery, when applied to a suitable purpose, has produced great economies and assisted materially in the production of wealth, but when improperly designed or improperly operated, it has been a source of expense. We may expect similar results from what has been called scientific management. If a proper scheme of management is devised, including proper tasks and compensation, without a question marked economies will be produced. If, on the other hand, employers are led, by the great advantages that can be obtained by this system, to adopt poorly designed schemes of management or to operate good ones in a poor manner, it is readily conceived that they may lose rather than gain by so doing.

The high-sounding term "scientific management" should not be allowed to mislead. It is not something that can be bought wholesale and utilized retail, but simply means that production problems must be studied according to scientific methods, eliminating guesswork, setting for each man a proper task, and according suitable rewards for accomplishing the task. In setting a task, emphasis should be put upon eliminating guesswork, for there is no surer way to cause dissatisfaction or inefficiency, than to change a task or a piece rate that has once been set in good faith. On the other hand, when the workmen realize that tasks once set will not be changed, and that they are set in an equitable manner, they not only do not object to the setting of tasks, but they do everything they can to help along the work.

In the following is given a description of the task and bonus system as devised and operated by the author.

Detailed Description of the Task and Bonus System

The employe is not told in a general way "to do better," but he has a definite standard set for him, and is shown how to reach that standard, for which he is awarded compensation in addition to his day's pay.

The system may be described in a general way as follows: A card is made out showing in detail the best method we can devise of performing each of the elementary operations on any piece of work, specifying the tools to be used, and giving the time needed for each of these operations, as determined by experiments. If a man follows his instructions, and accomplishes all the work laid out for him as constituting his proper task for the day, he is paid a bonus, in addition to his day rate, which he always gets. If, however, at the end of the day he has failed to accomplish all the work laid out, he does not get his bonus, but simply his day rate. The foremen receive, in addition to their day wages, compensation proportional to the number of their men who earn a bonus, and an extra compensation if all earn bonuses.

As the time for each detail operation is stated on the instruction card, the workman can continually see whether he is earning his bonus or not. If he finds an operation which he cannot do in the time set, he must at once report to his foreman, who must show him how to do it, or report to the man who made out the instruction card. If the latter has made an error, he must make out a new instruction card, explaining the proper method of working, and allowing the proper time. If, however, the instructor contends that the work can be done in the time set, he must show the workman how to do it. It is of the greatest importance that errors in making out instruction cards should be as few as possible.

As the cards are made out by a skillful man, with records of investigations at hand, they invariably prescribe a better method for doing the work than the ordinary workman or foreman could devise on the spur of the moment. As all the appliances and instructions necessary for doing the work are furnished, and a bonus is allowed the workman in addition to his regular rate if the work is done satisfactorily in the time set, it will be seen that this method is really a system of education with prizes for those who learn. The results obtained bear out this idea of education most fully, for under this plan men have learned more in a few months than the same men did before in years.

Scientific Method

In order to get the information needed to make good instruction cards, a great deal of detail work is necessary. When we realize, however, that any operation, no matter how complicated, can be resolved into a series of simple operations, we have grasped the key to the solution of many problems. Further study leads us to the conclusion that many different complicated operations are composed of a number of the same simple operations performed in different orders, and that the number of elementary operations is frequently smaller than the number of complicated operations of which they form the parts, just as the number of letters in the alphabet is smaller than the number of words in the language.

The logical method, therefore, of studying a complicated operation is to study the simple operations of which it is composed. In other words, the time needed for performing any complex operation must necessarily depend upon the time and method of performing the simple operations of which it is composed. Hence, the study divides itself into three parts, as follows:

An analysis of the operation into its elements.
A study of these elements separately.
A synthesis, or putting together of the results of our study.

This is simply the ordinary scientific method of procedure, followed whenever it is desired to make any kind of investigation. The ordinary man, whether mechanic or laborer, if not instructed, but left to himself, seldom performs any operation in the manner most economical either of time or labor. It has been conclusively proved that even on ordinary day-work, a very decided advantage can be gained by instructing the men how best to perform their work. When these instructions are the result of scientific investigation, the gain in efficiency is usually beyond our highest expectations.

Nearly every operation can be, and in actual work is, performed in a number of different ways; but it is self-evident that these ways are not all equally efficient. As a rule some of the methods employed are so obviously inefficient that they may be discarded at once, but it is often a problem of considerable difficulty to find out the very best method, and it is only by scientific investigation of all the elements, that we can hope to arrive at even an approximate solution.

Instruction Cards

When a task is set for any kind of work with which the men are not thoroughly familiar, it is obviously only simple justice to them that they should have detailed instructions how to accomplish each of the elements of the work in the time needed to earn the bonus. To get sufficient information to make out instruction cards suitable for permanent piece rates is often a long and difficult operation, but instructions may be made out to show the best method of doing work which we can devise with our present knowledge and appliances. Such cards may not represent the very best method of performing the work, but will usually represent a method far superior to that which the ordinary workman would employ. If we can get the men to do the work as directed on these cards, we can very largely increase the efficiency of their work; but to base a piece rate on such an instruction card would be simply inviting trouble, as but few men could see that it was just to change a piece rate when we changed the method of doing the work.

If, on the other hand, we allow the men their day rate and offer them a bonus for doing the work in accordance with our instruction cards, they see at once that they have nothing to lose by conforming to our wishes, and all to gain, with the result that in a short time they will make an effort to do the work in the manner and time set. We have found that there is practically no objection on the part of the men to a change of time on these cards, so long as the new time corresponds to a new set of instructions which will enable them, without additional hardship, to perform the work in the time set. This difference between ordinary piece work and our bonus system is fundamental.

Gang Bosses, Investigators and Instructors

In a shop operated on this system, where each workman has his task, one man whom we term a gang boss usually tends a group of workmen, supplying them with work and appliances and removing the work when finished. Such a man is paid a bonus for each workman who earns a bonus, and an extra bonus if all of his group earn bonuses. The result is that so long as the workmen perform their tasks, though nominally their boss, he is really their servant, and becomes the boss only when a workman fails to perform his task. The loss of money to the gang boss in case a workman fails to earn his bonus is such that he constantly has his eye on the poor workman and helps him all he can. If, however, he finds that the workman is incapable of being taught, he uses his influence to have a better man put in his place.

In starting a shop on task work, an instructor who is capable of teaching each workman how to perform his task must be constantly on hand, and must, as a rule, teach one workman at a time. This instructor may be the man who has investigated the work and set the task, or he may simply be an instructor capable of following out the work of such an investigator, but he must be readily available as long as any of the workmen need his services, for we make it a rule not to ask a man to do anything in a certain manner and time unless we are prepared to show him how to do it as we specify. If after having performed his task a workman wishes to suggest a quicker or better method for doing the same work, he is given an opportunity, if possible, to demonstrate his method. If the suggested method really proves to be quicker or better, it is adopted as the standard, and the workman is given a suitable reward. No workman, however, is allowed to make suggestions until he has first done the work in the manner and time specified.

It is the duty of the investigator to develop methods and set tasks, and unless the methods developed by him are generally a great deal better than those suggested by the workmen, he is not retained for the position. Working at tasks is pretty good training for task setting, and the writer has obtained more than one task setter from the ranks of the task doers. Inasmuch as, after a satisfactory method has been established, a large proportion of the work of the task setter is the study of the time in which the operations can be performed, he is popularly known as the "time-study" man. This term has led to a misconception of his duties, and has caused many honest people to claim that they were putting in our methods when they have put a stop watch in the hands of a bright clerk and told him to find out how quickly the best man was doing certain work. The time-study man must be of a far higher grade than this. To make real and permanent progress, he must be able to standardize appliances and methods and write such instructions as will enable an intelligent workman to follow them.

The Workmen's Relation to the System

The most intelligent of the workmen soon realize that we really mean to help them advance themselves, and the ambitious ones welcome the aid of our instructor to remove obstacles that have been in their way, perhaps, for years. As soon as one such man has earned his bonus for several days, there is usually another man ready to try the task, and unless there is a great lack of confidence on the part of the men in the management, the sentiment rapidly grows in favor of task work. When twenty-five per cent of the workers in a plant are "bonus-workers," they, with those who are striving to get into their class, control the sentiment, and a strong spirit of cooperation develops.

The development of skilled workmen by this method is sure and rapid, and wherever the method has been properly established, the problem of securing satisfactory help has been solved. The fact that the system works automatically, when once thoroughly established, puts the possibility of training their own workmen within the reach of all manufacturers.

Any system of management that did not make provision for obtaining proper materials to work with would be thought very lax. The day is not far distant when any management that does not make provision for training the workmen it needs will not be regarded as much better, for it is by this means only that a system of management can be made permanent.

An investigation of every case of lost bonus keeps the management closely in touch with the progress of the work, and as the workmen are ever ready to disclose and help remove the obstacles that prevent their earning their bonus, the managing problem is greatly simplified; for as one of my co-workers has very aptly put it, "the frictional lag due to the inertia of the workman is changed by the bonus into an acceleration."

* * *

The Pennsylvania Railroad is using reinforced concrete poles for carrying sixty aerial wires and two 1½-inch diameter lead-encased cables across the five miles stretch of swampy meadow-land just outside of the portal of the tunnels leading into the new passenger station in New York City. The concrete poles are used in order to avoid interruption from severe storms or fires from meadow-grass. The poles are from 35 to 65 feet in length and rise 25 to 50 feet above the ground.

* * *

Two men on a train argued as to the action of the vacuum brake. "I tell you it is the inflation of the tube that stops the train," exclaimed one. "Nothing of the sort," said the other. "It's the output of the exhaustion." At the next stop the matter was submitted to the decision of the locomotive engineer. He listened condescendingly to the arguments. Finally he said, "As a matter of fact you are both wrong. When we want to stop the train, we just open this valve which fills the pipe with vacuum."—*Exchange.*

THE MANUFACTURE OF MECHANICAL TOYS IN GERMANY

By CHARLES PABESHUTZ

Millions of dollars are spent every year for mechanical toys, but very little has ever been written regarding where and how these toys are made. The writer, therefore, will endeavor to give in the following a general idea of the manufacture of mechanical toys. Most of the smaller toys sold in this country are imported from Germany and France.

While almost every available material is used in the toy-making industry, the chief material is metal, and the manufacture of metal toys is the only one which is likely to be of especial interest to the readers of MACHINERY. In the manufacture of metal toys, up-to-date machinery, tools and devices are used. Most of the toys of other material than metal are made in the homes of the peasants of Oberammergau—a world-renowned place—in the mountains of Saxony, in Sonneberg and vicinity, and in Würtemberg. Mechanical toys are made principally in Nuremberg, Stuttgart and Berlin in Germany, Paris, Monbiliard, and Terre-noir in France, and Barcelona in Spain. It is safe to say that over 75 per cent of all mechanical toys are imported from Germany and France.

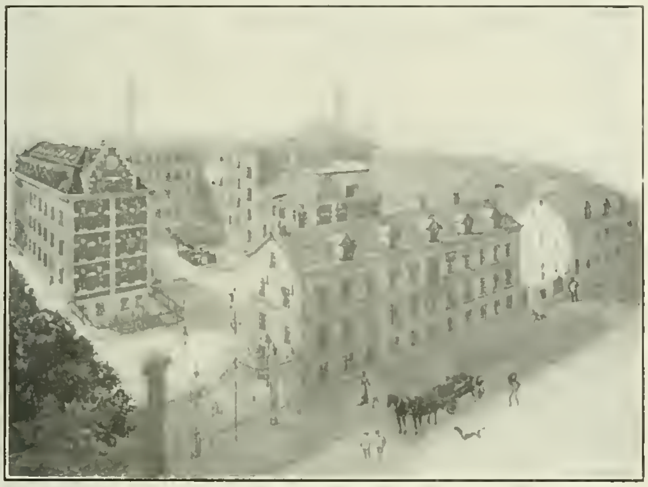

Fig. 1. The Plant of S. W. Guntherman, Nuremberg, Germany, devoted to the Manufacture of Mechanical Toys

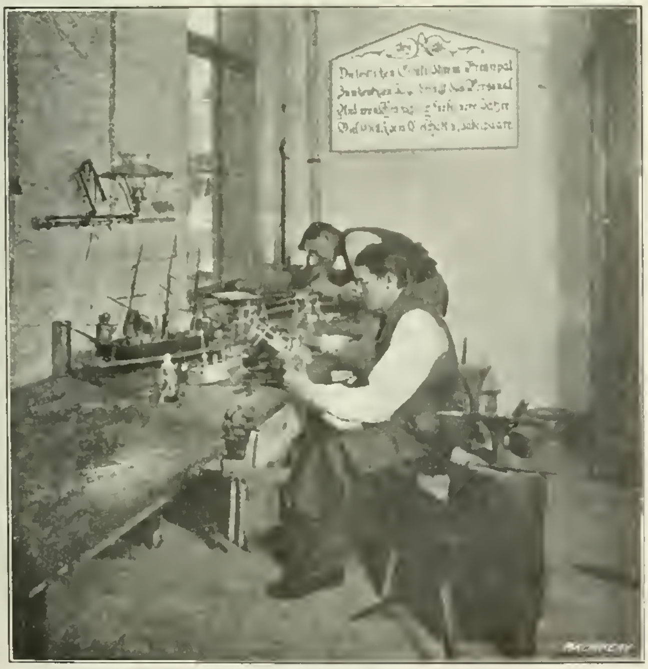

Fig. 2. The Experimental and Model Department

The manufacture of mechanical toys is an industry carried on in factories which can easily be compared with some of the plants of the big enterprises of this country, as, for instance, with those of the American Can Co. The machines and materials used are the same as those used by this company, and many hundred tool- and die-makers are constantly at work making the required tools for the sheet-metal work. The manufacture of toys requires considerable mechanical genius, and many great inventions have originated in a toy.

The best-known toy factories in Germany are S. Bing & Co., Nuremberg, employing 6000 people; S. W. Guntherman, Nuremberg, with over 400 people; Georges Carette & Co., Nuremberg, with 500 people; George Schoenner, Nuremberg, employing 300 people; and Firma Lehman, Berlin. The leading manufacturers of mechanical toys in France are Rossignol (Vve. Ch. Rossignol et Cie., Succ.), and Roullet et Decamps, Paris; the leading toy manufacturer in Spain is Schul & Windisch, Barcelona.

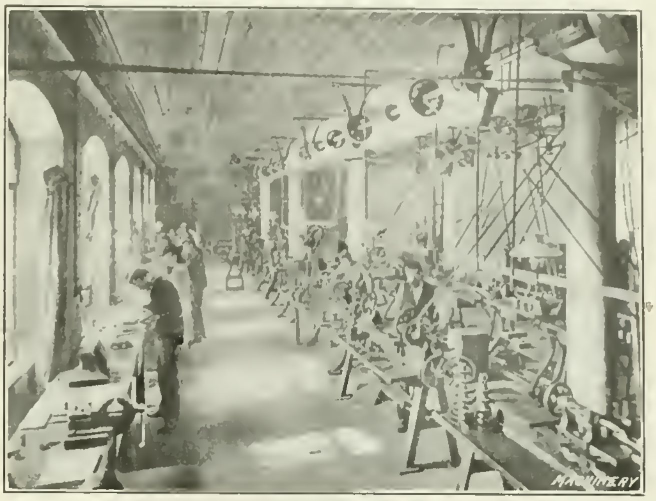

Fig. 3. The Tool-room

The illustrations accompanying this article show various views of the toy factory of S. W. Guntherman, Nuremberg. The writer has worked in this factory as a tool- and die-maker, and obtained there his first experience in the manufacture of toys. The plant of this firm, shown in Fig. 1, is a four-story stone and brick building covering an area of 40,000 square feet. The building is modern in every way and contains offices and sample-room, drawing-room, model-shop and experimental department, tool-room, press-rooms, tinshop, painting and assembling department, department for clock movements, paper box department and store-rooms. Part of the experimental room where the models are completed is shown in Fig. 2. The exporters are called upon to decide as to the merits of the sample toys produced by the manufacturer If the decision is favorable the men in the experimental room

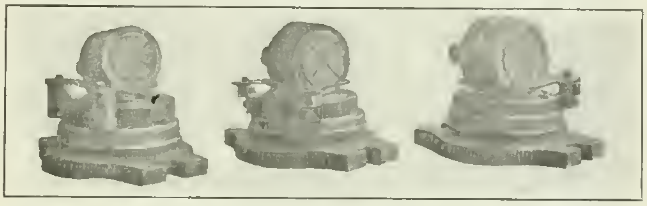

Fig. 4 A Set of Combination Dies which produce from 12,000 to 15,000 "Automobile" Wheels per Day

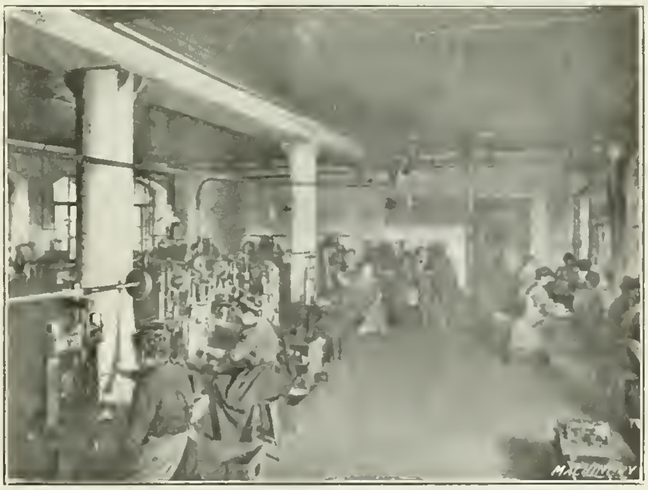

Fig. 5. Press room

are called upon to make all templets and models needed for the making of the tools, dies and special fixtures required in the manufacture of the toy.

Assume, for example, that a toy automobile with rubber tires is to be made, having a miniature chauffeur at the steering wheel and a clock movement to produce the motion. Such a toy can be bought for less than a dollar. Over fifty tools and dies are made for making the parts of this toy. All the templets or master blanks have to be cut by hand. Small prongs are provided on one blank, and corresponding slots in the other for assembling without soldering. It is important that soldering be avoided, as decorated tin is largely used.

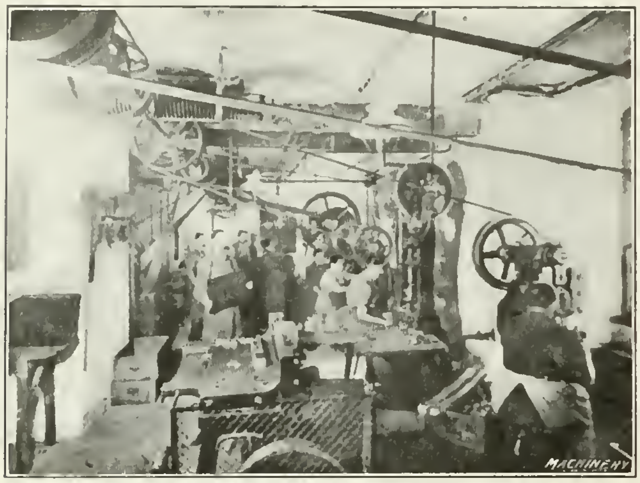

Fig. 6. Power Press and Shear Department

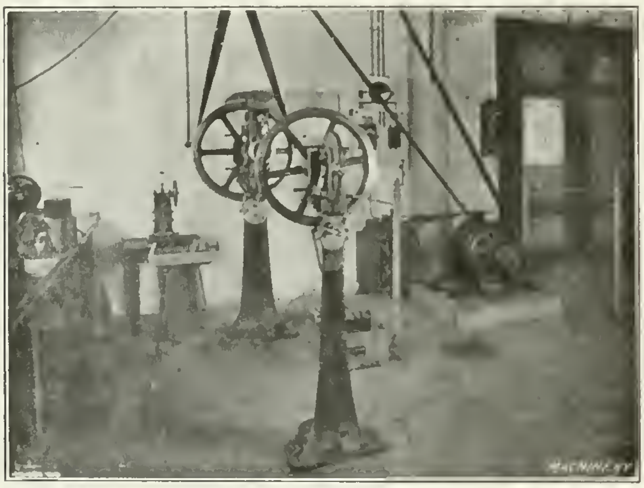

Fig. 8. Double-seaming Machines

The most difficult and expensive part of the experimental work is to produce the models for such parts as the chauffeur, riders, horses, etc. These figures are first designed on paper and are then carved in wood to the required size and shape. The wood carving is used as a pattern from which a plaster-of-paris model is made and this model, in turn, is used for making a stamping die of fine gray cast iron. The punch working with this stamping die is made of babbitt, the shape being transferred from the die. The babbitt punch is fastened to a cast-iron punch holder. The model-maker is now ready to make his sample, which he trims off by hand. As soon as the model toy is completed, all the templets and master tools are sent to the tool-room, which is shown in Fig. 3. The tool-room, in this as in other sheet metal industries, is perhaps the most expensive department, as the very highest class of skilled men is required. The equipment of the tool-room is of the very highest class. In order to reduce the cost of the dies, the punches are usually finished in the shaper. As the irregularities of the blanks would call for so many special cutters for the milling machines, these latter machines are used only for punches for gear dies, etc.

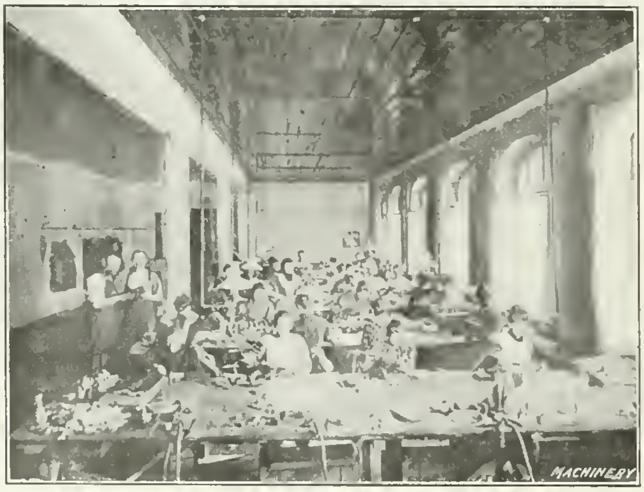

Fig. 10. The Assembling Department

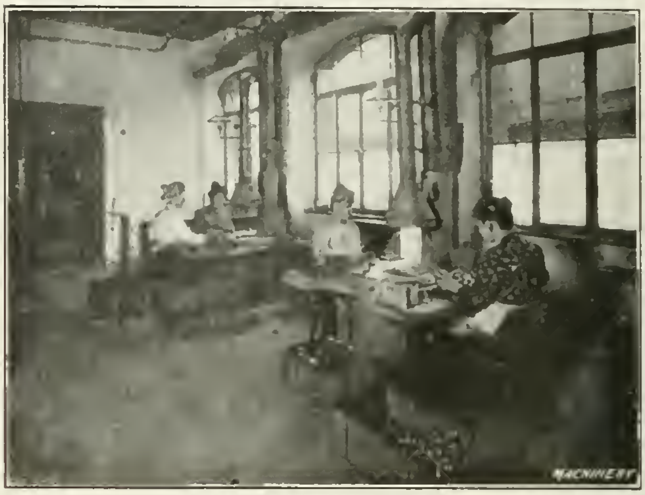

Fig. 7. Making Lead Castings

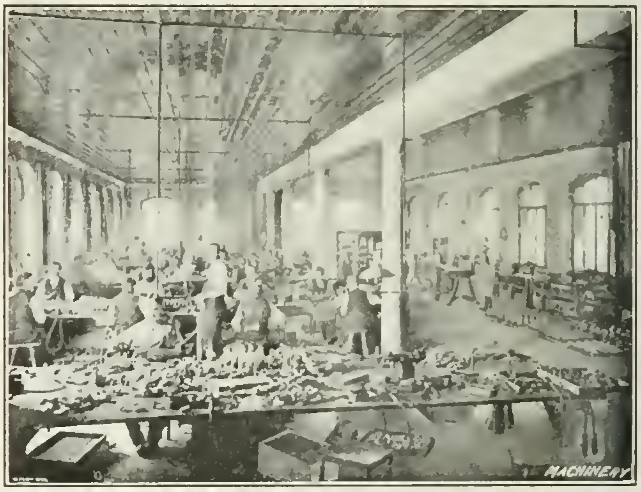

Fig. 9. The Tin Shop

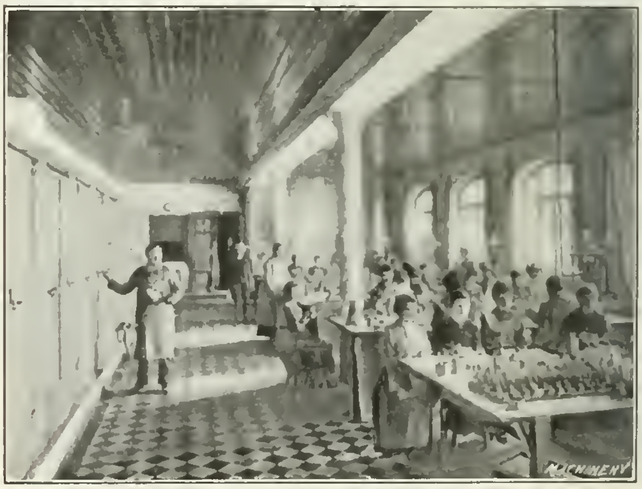

Fig. 11. Japanning and Painting Department

In Fig. 4 is shown a set of combination dies for making automobile wheels. These tools will turn out wheels at the rate of 12,000 to 15,000 a day, finished in one stroke, which means that the blanking, forming or drawing, corrugating and piercing for the spokes and the center-hole, is all done at one stroke of the press. The hub is made of a small lead casting produced in a metal mold.

The presses are placed in two large rooms, one of which contains the hand screw presses and foot presses, as shown in Fig. 5, and the other containing the power presses, shears, etc., as shown in Fig. 6. Almost all the presses are operated by girls. From the press-rooms, the many thousand parts are sent to the proper rooms to be assorted and kept in stock. All parts are inspected after completion, before being sent to the assembling department shown in Fig. 10.

Fig. 12. The Exhibition Room

The larger and more difficult parts are assembled by the tinners, while the smaller ones are assembled by girls. Many of the parts of toys of this kind are made of lithographed tin as already mentioned. Only blanks which cannot be machined without injuring the lithographic picture are hand painted. This work is also done by girls. The painted articles are placed in steam-heated compartments for drying the lacquer. Some of these compartments are shown to the left in Fig. 11. All the raw material and the half-finished and finished parts are stored in special storerooms.

An important part of the manufacture of mechanical toys is the making of the clock movements. The department where they are made is equipped with automatic and hand screw machines, automatic watch-gear cutting machines, and wire cutting and swaging machines. Millions of clock movements are turned out yearly. All the assembling of these movements is done by girls. The thousands of paper boxes used in packing the toys are also made in this plant.

CALCULATING GEARS FOR GENERATING SPIRALS ON HOBBING MACHINES

By GLENN MUFFLY*

From time to time formulas have been developed for calculating the gears to be used for generating spiral gears. Those published in the past, however, have applied only to certain types of gear-hobbing machines. In the following a formula is given which is applicable to any type of gear-hobbing machine, and which is simpler to use than any formula of this kind known to the writer. In developing this formula, simple arithmetical expressions have been made use of, as far as possible, in order to make it especially useful to the practical man.

In order to clearly understand the use of any formula, it is necessary to know something of the principles involved. Fig. 1 shows a top view of a standard hobbing machine (the No. 3 Farwell) designed for cutting spur gears. Before dealing with the change gear ratios for spiral work, it will be well to have the methods for cutting spur gears firmly fixed in our minds.

Assume the hob to be single threaded. It is evident that for each revolution of the hob, the gear being cut must move one tooth. Therefore, the hob revolves, for each revolution of the blank, as many times as there are teeth to be cut. To cut 44 teeth, we must gear the table to revolve once for every 44 revolutions of the hob.

The bevel gearing at D, Fig. 1, has a ratio of 3 to 1, the worm at E is double-threaded, and the worm-wheel F has 40 teeth. Hence the shaft B must revolve 3 × 44 times for each revolution of the table, and the worm shaft C must revolve 20 times for each revolution of the table. Hence we have:

$$\frac{\text{Revolutions of } B}{\text{Revolutions of } C} = \frac{3 \times 44}{20}$$

Inverting this ratio to get the change gear ratio required to obtain this result, we have:

$$\frac{20}{3 \times 44} = \frac{\text{Product of No. of teeth in driving gears}}{\text{Product of No. of teeth in driven gears}}$$

In the following formulas, we will designate the product of the number of teeth in the driving gears P, and the product of the number of teeth in the driven gears p.

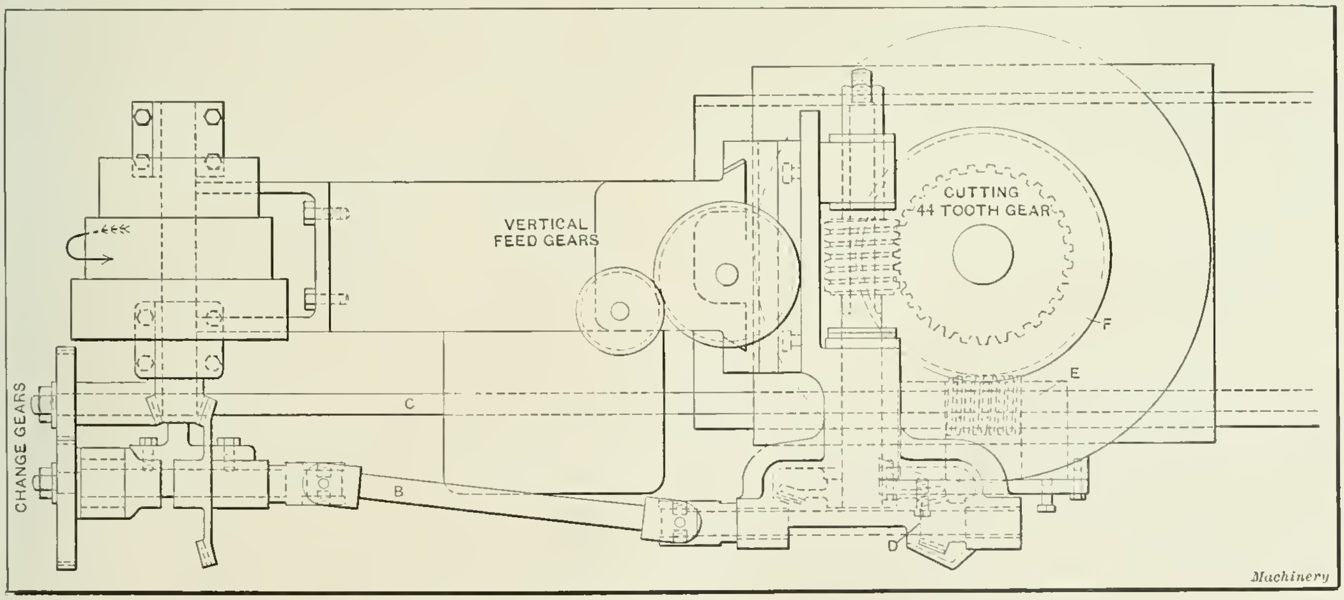

Fig. 1. Hob and Table Driving Arrangement of a No. 3 Farwell Gear-hobbing Machine

Should we use a double-threaded or triple-threaded hob, the gear we are cutting must revolve two or three teeth for each revolution of the hob; in other words, the speed of the table is increased directly as the number of threads on the hob, so we must multiply the number of teeth in the driving gears by the number of threads on the hob, giving us this formula:

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* Address: 107 Delhi St., Dubuque, Iowa.

$$\frac{20 \times \text{No. of threads on hob}}{3 \times \text{No. of teeth to be cut}} = \frac{P}{p}$$

A similar formula may be worked out in this way for any type of gear hobber.

Generating Spirals

For each revolution of the table, the head carrying the hob feeds down a certain distance across the face of the blank, this distance varying from 0.010 to 0.150 inch in common practice. To fully understand the following discussion, the action of the machine, as illustrated in Figs. 3 to 6, inclusive, should be noted. In Fig. 3 is shown the generation of a right-hand spiral gear with a right-hand hob; in Fig. 4, a left-hand spiral gear with a right-hand hob; in Fig. 5, a left-hand spiral gear with a left-hand hob; and in Fig. 6, a right-hand spiral gear with a left-hand hob. In each of these illustrations the direction of rotation of the table is indicated by the arrow showing the direction of rotation of the gear being cut. The direction of rotation of the hob is also indicated by an arrow showing the direction of rotation of its shaft. In Figs. 3 and 5, where a gear is cut with a hob of the same "hand," the angle a, as indicated, equals the difference between the tooth angle and the thread angle of the hob. In Figs. 4 and 6, where the gear and the hob are of different "hand," the angle a equals the sum of the tooth angle and the thread angle of the hob. After this preliminary introduction, we are ready to deal intelligently with the problem in hand.

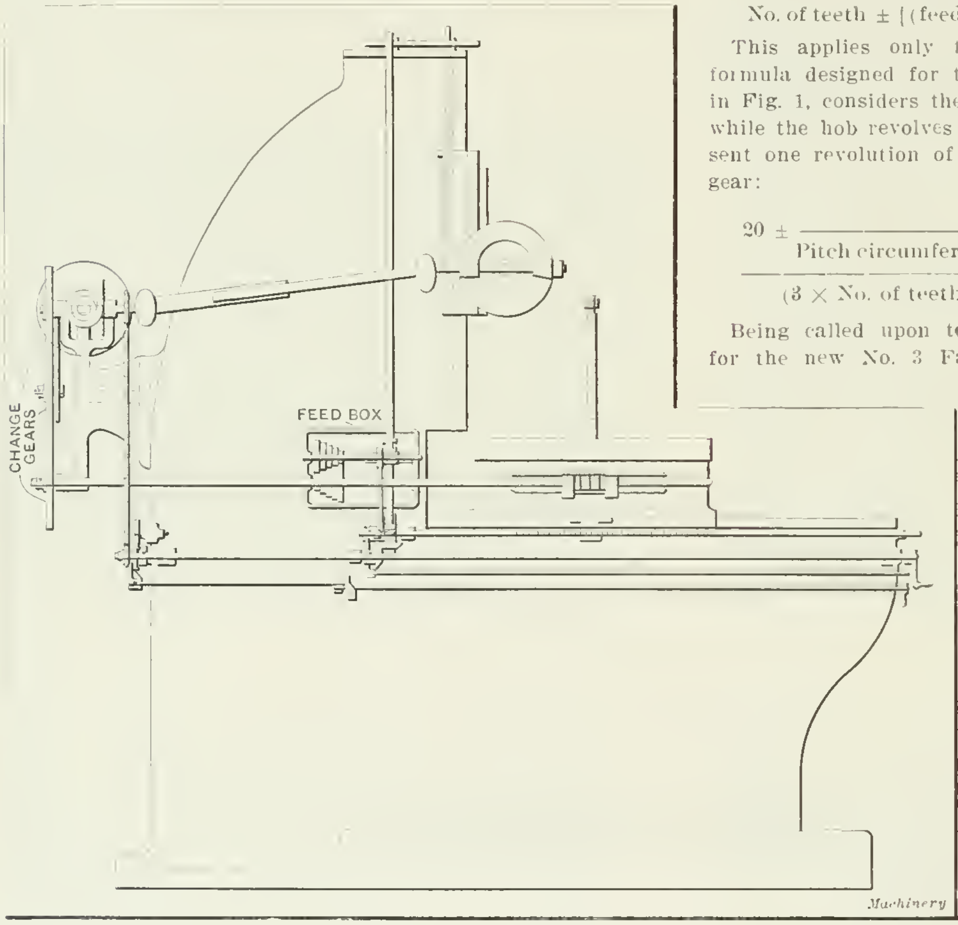

Fig. 2. Diagrammatic View of Gear-hobbing Machine

Assume the spiral gear shown in Fig. 7 to have sixty-four teeth. As indicated, the gear has a left-hand spiral and we will assume that it is cut with a left-hand hob. A single-threaded hob cutting a spiral gear would revolve sixty-four times for one revolution of the table; but since in this case the teeth are helical and the hob travels downward a certain distance, the position of the gear tooth must be advanced somewhat for every revolution with relation to the hob. In other words, if the hob revolves sixty-four times, sixty-four teeth will have passed by, but the blank is not in the same position as at the beginning.

In Fig. 7, G represents the position of the hob axis at the beginning of the cut and H the position of the hob axis after the hob has made sixty-four revolutions. This shows that the blank must make more than one revolution in this case. If we were cutting a left-hand spiral gear with a right-hand hob, as shown in Fig. 4, the blank would have to make less than one complete revolution for each sixty-four revolutions of the hob, the blank in this case being revolved in the opposite direction. It will thus be seen that when cutting a gear of the same "hand" as the hob, the table must revolve slightly faster than it would have to do when cutting a spur gear with the same number of teeth; but when the hob and the gear are of opposite "hand," the table must revolve more slowly than when cutting a spur gear. This has an important bearing upon the formula we are about to construct.

To gear the machine properly we must first find the ratio according to which the table is required to lag behind or lead ahead of its natural speed relative to the hob. In the first formula devised by the writer for the hobbing of spiral gears, the ratio was arrived at by considering the number of revolutions made by the hob, while the table makes one full revolution. The formula thus constructed for the No. 1 Farwell gear-hobbing machine is:

$$\frac{30 \times \text{No. of threads on hob}}{\text{No. of teeth} \pm [(\text{feed} \times \text{tan. of angle}) \div \text{circ. pitch}]} = \frac{P}{p}$$

This applies only to one particular machine. A later formula designed for the No. 3 Farwell machine, as shown in Fig. 1, considers the number of table revolutions required while the hob revolves a sufficient number of times to represent one revolution of the table, if we were cutting a spur gear:

$$\frac{20 \pm \dfrac{20}{\text{Pitch circumference} \div (\text{feed} \times \text{tan of angle})}}{(3 \times \text{No. of teeth}) \div \text{No. of threads on hob}} = \frac{P}{p}$$

Being called upon to derive another formula to be used for the new No. 3 Farwell universal hobbing machine, it occurred to the writer that a formula adapted to all hobbing machines would avoid much confusion. In the following is given the process by which such a formula was derived; the result is a simpler formula than any previously used.

The "lead" of a spiral gear is the axial length of the blank in which one spiral tooth makes a complete turn around the blank. Now, in hobbing a gear with a width of face exactly equal to the lead, it is evident that the blank must gain or lose one complete revolution as compared with the number of revolutions that would be made in cutting a spur gear with the same width of face and using the same feed per revolution of the blank. Assume that we wish to cut a 30-tooth, 10-pitch, right-hand spiral gear of 45-degree angle, using a single-threaded right-hand hob and feeding 1/32 inch across the face of the blank for each revolution of the blank.

The rule for finding the lead of a spiral gear is:

Pitch circumference × cot. of tooth angle = lead.

To get the pitch circumference, we must first find the pitch diameter; the rule for finding this in a spiral gear is:

Pitch diameter of spur gear ÷ cos. of tooth angle = pitch diameter of spiral gear with the same number of teeth and pitch.

A 30-tooth, 10-pitch spur gear would have a pitch diameter of 3 inches. Referring to a table of trigonometrical functions we find that the cosine of 45 degrees is 0.70711; then, $3 \div 0.70711 = 4.242$ inches, which is the pitch diameter of the spiral gear. Multiplying this by 3.1416 gives 13.3267 inches, which is the pitch circumference of the spiral gear.

Since the cotangent of 45 degrees is exactly 1, multiplying by this gives the same quantity (13.3267 inches) as the lead.

The next step is to find how many times the blank must revolve while the hob feeds 13.3267 inches across its face. Since the feed is 1/32 inch (0.03125) for each revolution, we can divide by 0.03125 or multiply by 32 to get the number of revolutions. This gives 426.454 revolutions. The table has been traveling faster in relation to the hob than would be the case in cutting a spur gear with the same number of teeth; in fact, the table has gained exactly one revolution on the hob. In other words, the table speed in cutting this spiral gear is to the table speed in cutting an equivalent spur gear as 426.454 is to 425.454. From this we may construct the following formula:

$$\frac{\text{Lead} \div \text{feed}}{(\text{Lead} \div \text{feed}) - 1} = \frac{\text{required table revolutions}}{\text{normal table revolutions}}$$

For a gear of opposite "hand" from that of the hob the sign would be changed to + in this formula. Use the — sign only when gear and hob are of the same "hand."

By adding a 426-tooth gear to the drivers and a 425-tooth gear to the driven gears in the regular combination used to cut a 30-tooth spur gear, we would get approximately the desired ratio, but for greater accuracy we can carry the figures to a few decimal places and factor:

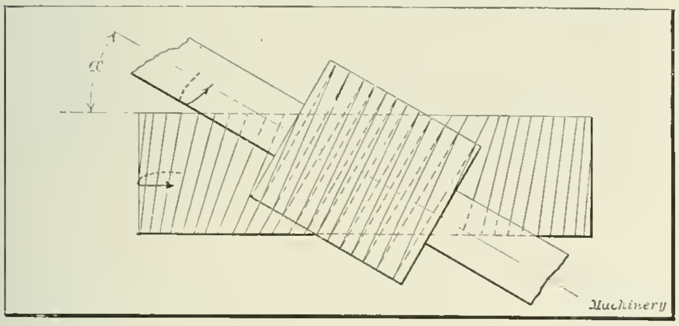

Fig. 3. Cutting a Right-hand Spiral Gear with a Right-hand Hob

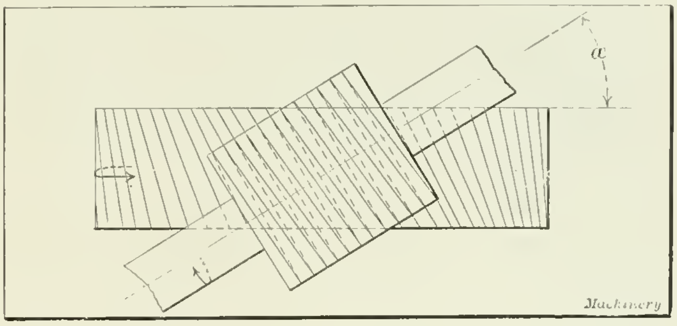

Fig. 4. Cutting a Left-hand Spiral Gear with a Right-hand Hob

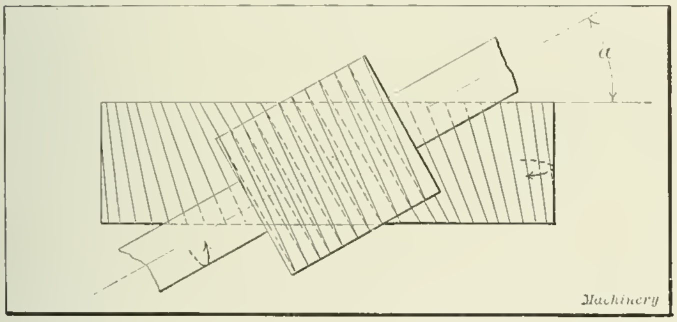

Fig. 5. Cutting a Left-hand Spiral Gear with a Left-hand Hob

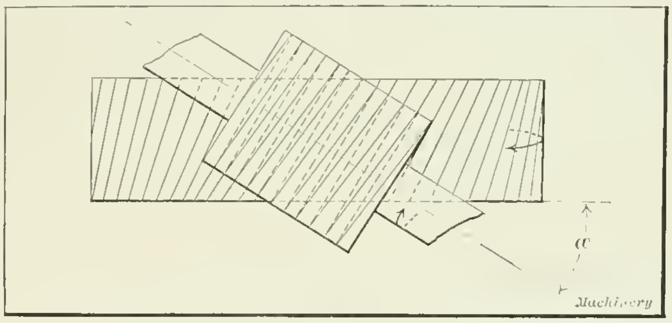

Fig. 6. Cutting a Right-hand Spiral Gear with a Left-hand Hob

$$\frac{42645}{42545} = \frac{8529}{8509} = \frac{3 \times 2843}{67 \times 127}$$

But 2843 is a prime number. We, therefore, try

$\frac{4265}{4255} = \frac{853}{851}$; but 853 is a prime number. We, therefore, try

$\frac{4264}{4254} = \frac{2132}{2127} = \frac{4 \times 533}{3 \times 709}$, but 709 is a prime number. Hence, we must make another slight change and try again, remembering that whatever change is made in the numerator must be exactly duplicated in the denominator to maintain the ratio as nearly as possible. The dropping of all decimals would cause a very small error, but dropping them from one side only would cause a great error. We find upon trial that

$\frac{426}{425} = \frac{2 \times 3 \times 71}{5 \times 5 \times 17}$.

Multiplying this with the change-gear combination ordinarily used to cut spur gears with 30 teeth, we have the gear combination required for any gear-hobbing machine used for cutting this gear. Thus, on the No. 3 Farwell universal hobbing machine, the spur gear ratio for cutting 30 teeth is $\frac{30}{60}$, which multiplied by $\frac{2 \times 3 \times 71}{5 \times 5 \times 17}$ gives $\frac{3 \times 71}{5 \times 5 \times 17}$, and arranging this ratio in convenient gear sizes, we have:

$$\frac{24 \times 71}{40 \times 85} = \frac{\text{Product of teeth of driving gears}}{\text{Product of teeth of driven gears}}$$

It will be noted that the last operation before factoring was to divide by the feed. Should prime numbers be encountered repeatedly in trying to factor, it is possible to get altogether new figures to work with, by making a slight change in the feed and dividing into the lead again.

Having found the gears, set the feed for exactly 1/32 inch per revolution, see that the table is revolving in the right direction, and tilt the hob spindle to bring the *thread angle* to 45 degrees and the machine is ready for business.

Recapitulation and General Remarks

The general formula for gearing any hobbing machine for generating spiral gears is thus:

$$\frac{L \div F}{(L \div F) \pm 1} \times \frac{P}{p} = \frac{S}{s}$$

in which

L = lead of spiral,
F = feed per revolution,
P = product of driving gears for cutting spur gears with same number of teeth,
p = product of driven gears for cutting spur gears with same number of teeth,
S = product of driving gears for cutting spiral gears,
s = product of driven gears for cutting spiral gears.

Use + sign when gear and hob are of opposite "hand," and — sign when they are of the same "hand."

In cutting teeth at large angles it is desirable to have the hob the same hand as the gear, so that the direction of the cut will come against the movement of the blank, but at ordinary angles one hob will cut both right- and left-hand gears.

The actual feed of the cutter depends upon the angle of the teeth as well as the vertical movement of the hob. This is obtained by dividing the vertical feed by the cosine of the tooth angle; thus:

$$\frac{0.03125}{0.70711} = 0.043 \text{ inch actual feed.}$$

The last computation need not be made except to see that we are not figuring on too heavy a cut, as it has nothing to do with the gearing of the hobbing machine. In setting up a hobbing machine for spiral gears, care should be taken to see that the vertical feed does not trip until the machine has been stopped or the hob has fed down clear of the finished gear. Should the feed stop while the hob is still in mesh with the gear and revolving at the ratio required to generate a spiral, the hob will cut into the teeth and spoil the gear.

Should the thread angle of the hob be exactly equal to the tooth angle of the spiral gear, and both hob and gear be the same "hand," the axis of the hob spindle will be at right angles to the axis of the gear. This is in conformity with the rule that when hob and gear are of the same "hand," the hob spindle is set at the tooth angle minus the thread angle of the hob. In cutting a spiral gear to take the place of a worm-wheel, it is possible to use the same hob that was used in cutting the worm-wheel. This would be a case where it is not necessary to tilt the hob spindle. Sometimes multiple-threaded hobs are used in order to make the thread angle approximately equal to the tooth angle, when it is desired to cut spiral gears with machines on which the hob spindle swivels through only a small angle.

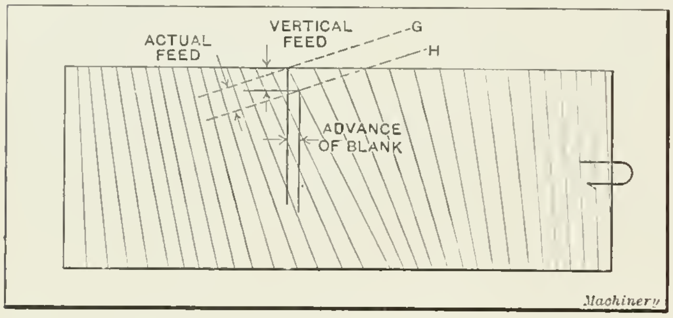

Fig. 7. Diagram showing Advance Required in Table Motion when cutting a Left-hand Spiral Gear with a Left-hand Hob

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"CALORIZED" ELECTRIC SOLDERING IRON

The ordinary soldering iron has two serious drawbacks—the impossibility of keeping it hot continuously, and the rapid wasting away of the copper. The electric soldering iron has obviated the former difficulty, but the second fault has still remained in the improved electric type. Frequent renewals have been necessary, and hence there has been no reduction in the cost of maintenance. The General Electric Co., Schenectady, N. Y., has, however, made experiments in order to eliminate this drawback of the electric soldering iron, and recently a process of treating copper has been discovered which makes it possible to heat the copper to a high temperature without oxidation. At the same time corrosion caused by the acids used in soldering is eliminated, and the dissolving action of molten tin, with which the working tip of the soldering iron must always be coated, is reduced to a minimum. The "calorizing" process, as it has been called, changes the characteristics of the copper to an appreciable depth, so that the durability and working life of the soldering iron is increased to such an extent that marked economy results.

* * *

MAKING PORTLAND CEMENT

The following simple (!) directions for the making of Portland cement are taken from one of the leading daily papers of the Middle West. The clipping reads:

"It really seems as though nothing were worthless, if men only knew how to use it. The blast furnace affords an illustration. Stone is lighter than iron, and hence will float upon it like oil on water when both the stone and the iron are melted in a furnace. Some of the stone which rises to the top becomes slag. For years millions of tons of slag were thrown away or used to fill up gullies on vacant land. But at last a use was found for it worth while. It is thrown while white hot into water, and is at once without further ado changed into Portland cement. As cement was never so much in demand for all sorts of purposes as to-day it is fortunate that this very cheap way of making it was discovered. The man who first learned to do the trick deserves a monument more lasting than bronze."

"Why not erect a concrete monument? It would be so eminently fitting," says one of our contemporaries.

COMPOSITION AND CHARACTERISTICS OF STEEL AND IRON CASTINGS

The specifications given in the following article have been abstracted from a paper submitted to the Society of Automobile Engineers, which gives the desirable composition and characteristics of iron and steel castings, prepared especially for automobile construction. However, as a good and reliable casting can be made from the compositions given, their use will also be applicable to other classes of work.

Composition of Steel Castings

Carbon.......0.30 to 0.40 per cent (0.35 per cent, desired)
Manganese....0.60 to 0.80 per cent (0.70 per cent, desired)
Silicon.......0.10 to 0.30 per cent
Phosphorus, not over 0.06 per cent
Sulphur, not over 0.06 per cent

Steel castings are commonly made by open-hearth and crucible manufacturers. Genuine steel castings, and not malleable iron and complex mixtures often found on the market masquerading under the name of steel, are referred to in the foregoing composition. Genuine steel castings may be annealed or heat treated to advantage for important parts. A steel casting of the composition given should be tough enough to bend to a considerable angle before breaking. The elastic limit of such a casting in an annealed condition is about 35,000 pounds per square inch. Like other castings, steel castings are subject to blow-holes, consequently they should not be used for any vital parts. It is impossible to inspect castings for blow-holes so that axles, countershafts, steering spindles, etc., made from steel castings can be used only at great risk.

Composition of Gray Iron Castings

Total carbon..3.25 to 3.50 per cent
Manganese....0.40 to 0.70 per cent (0.50 per cent, desired)
Silicon.......1.90 to 2.20 per cent (2.00 per cent, desired)
Phosphorus...0.60 to 1.00 per cent
Sulphur, not over 0.10 per cent.

An analysis of cast iron in the present state of the foundry art is not easy. The foundryman if not accustomed to working to an analysis will object, although the iron he uses may be within the specifications given 98 per cent of the time. Moreover, if there are any defective cylinders he will likely blame the composition of the iron, whereas it may lie in his foundry methods apart from the composition. Consequently, these specifications should be used as indicated as the ideal mixture. If trouble is experienced with cylinders an analysis of samples of iron will show whether or not the composition is somewhere near what it should be, and if the composition is found to vary much from that given, the purchaser will be justified in putting up strenuous objections. Iron made to these specifications will be strong and reasonably cross-grained, and will wear well.

Composition of Malleable Iron Castings

Manganese....0.30 to 0.70 per cent (0.50 per cent, desired)
Silicon, not over....1.00 per cent (0.60 per cent, desired)
Phosphorus, not over.0.20 per cent (0.17 per cent, desired)
Sulphur, not over 0.06 per cent.

The remarks made in connection with gray iron castings apply even more strongly to malleable iron. Iron of the composition given properly annealed will make a strong and good casting, but if improperly annealed it will not make a good casting. Brittle castings as a rule result from two causes: First unsuitable mixture of iron, and second, improper annealing. Consequently, if brittle castings are received they should be analyzed, and if the analysis is correct, then it is certain that the annealing operation was not properly conducted. Malleable iron castings varying decidedly in composition from that given, especially as to phosphorus content, are liable to be brittle even if properly annealed, and should therefore be avoided.

* * *

A vote was taken among the members of the trade unions connected with the ship building and engineering industries in Great Britain, in order to ascertain whether the members were in favor of abolishing the premium bonus system. The returns of the voting were 10 to 1 for the abolishing of the system.

MILLING, CROSS-DRILLING AND BURRING ATTACHMENTS—4

APPLICATION TO THE BROWN & SHARPE AUTOMATIC SCREW MACHINES

By DOUGLAS T. HAMILTON[*]

Quite frequently it is found necessary to drill holes in both ends of a piece of work, which cannot be accomplished while the piece is attached to the bar, thus necessitating rehandling the work. The Brown & Sharpe Mfg. Co. has designed what is called a "burring" attachment, which is used in connection with its automatic screw machines for drilling and chamfering holes in both ends of the work. In this article reference is made to Figs. 4, 5 and 7 in the September, 1911, number.

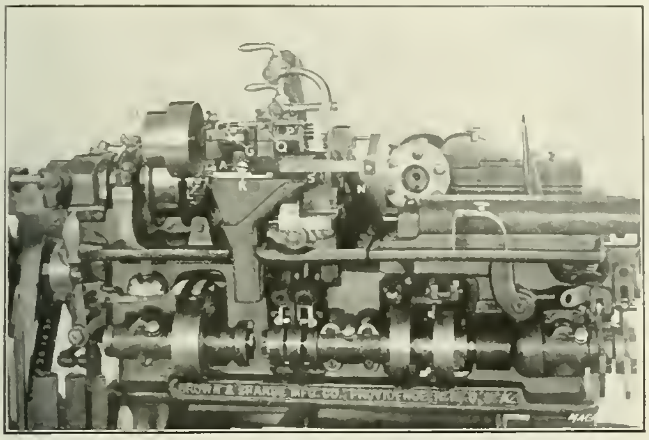

Fig. 26. Front View of No. 00 B. & S. Automatic Screw Machine equipped with a Burring Attachment

Burring Attachment

A front view of the burring attachment fastened on a No. 00 Brown & Sharpe automatic screw machine is shown in Fig. 26. Fig. 27 shows a rear view, while Fig. 28 shows plan, end and sectional views, respectively. The attachment consists essentially of a cast-iron base *A*, provided with bearings *B*, in which a spindle *C* is free to rotate, being driven by the two-stepped cone pulley *D*. The bosses *B* are provided with phosphor-bronze sleeves *E* and a thrust washer *F*. The nut *G* is provided for taking care of the end play of the spindle. The burring tool is held in a bushing *H*, fitting in the nose of the spindle *C*, and is furnished with a clamping block *I* acted upon by a set-screw *J*.

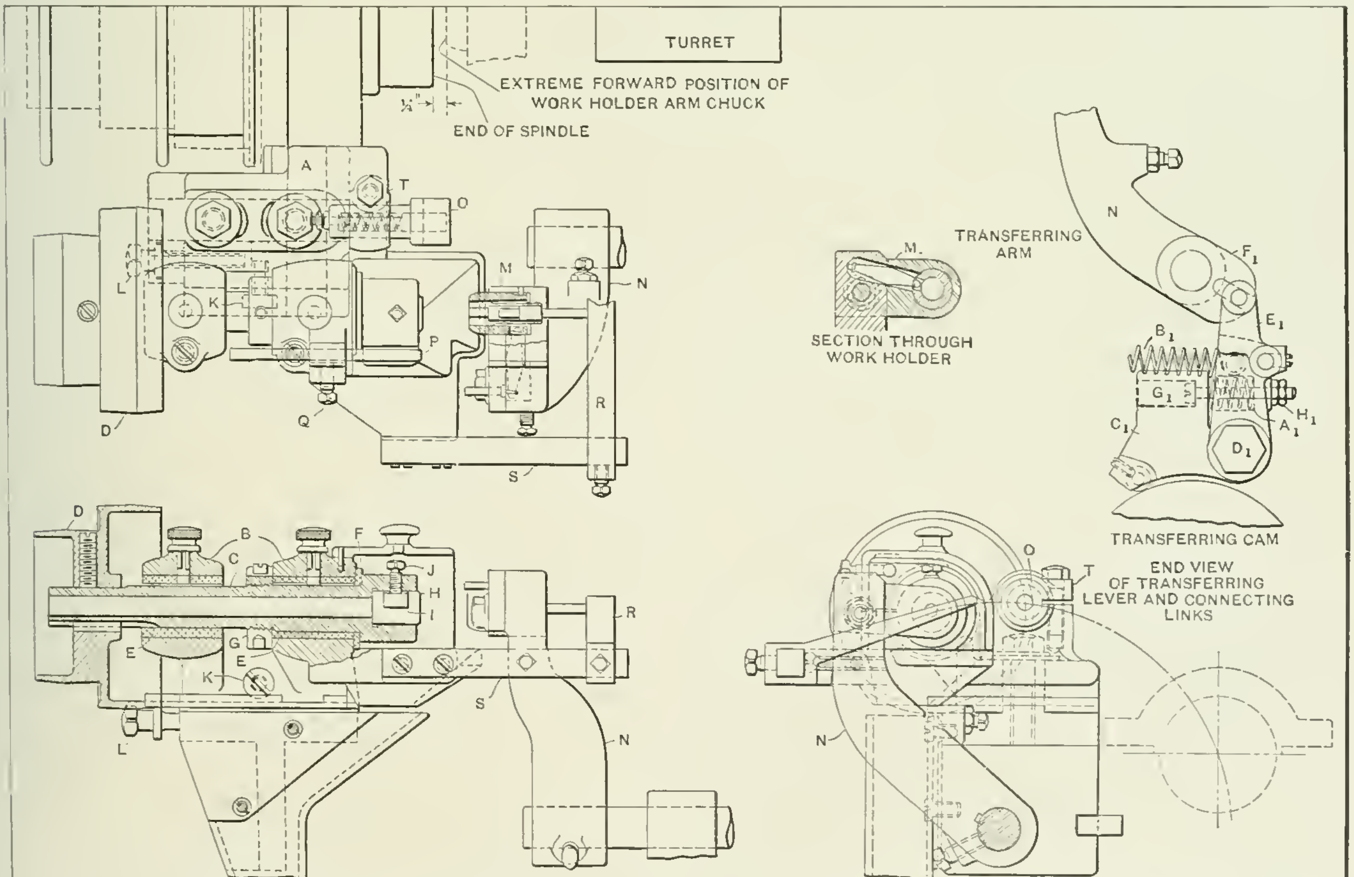

Fig. 28. Plan, Sectional and End Views of the Burring Attachment used on the No. 00 B. & S. Automatic Screw Machine

This burring attachment can be adjusted to and from the machine by means of the collar-head screw *K*, and the top part of the attachment can be adjusted on its base in a plane with the axis of the spindle, by means of the collar-head screw *L*. The standard work-holder *M* is shown in section in Fig. 28, and more clearly in Fig. 32, to which reference should now be made. Here *A* is the chuck, slotted and spring tempered, *B* the chuck-closing sleeve and *C* the ejector. The chuck-closing sleeve is operated by means of a lever *D*, which is acted upon by pin *E*. To close the chuck, the arm *N*, Fig. 28, is made to dwell in an intermediate position between the work-spindle and the burring spindle, or, in other words directly in front of the chuck-closing device *O*. The arm *N* is then advanced, when the device *O* forces the sleeve *B* onto the chuck *A*, thus closing the latter on the work.

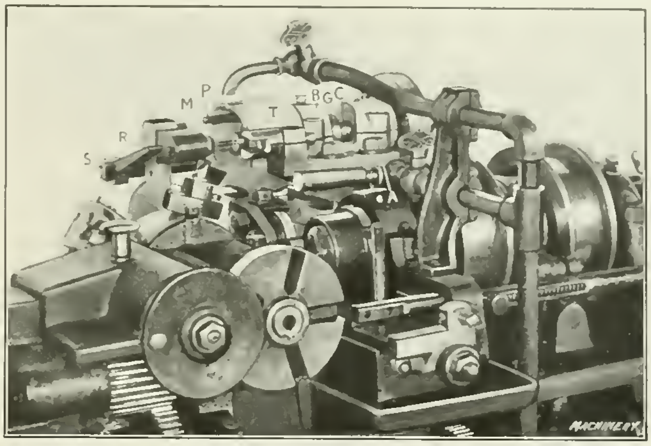

Fig. 27. Rear View of the Burring Attachment placed on a No. 00 B. & S. Automatic Screw Machine

The chuck *A*, Fig. 32, which is screwed into the transferring block, is opened by means of the pin *E* coming in contact with the end of the rod *P* held in the burring head by a set-screw

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[*] Associate Editor of MACHINERY.

Q, see Fig. 28. When pin *E* comes in contact with rod *P*, the former forces back lever *D*, which, in turn, releases the chuck-closing sleeve *B* and allows the chuck to expand, thus facilitating the removal of the work. The work is removed by means of the plunger *C*, which comes in contact with the finger *R*, Fig. 28, when the arm *N* drops back. This finger is held by a set-screw on a square rod *S*, which, in turn, is fastened to the base of the burring attachment.

Referring now to the view to the right in Fig. 28, the transferring arm *N* is made to dwell in an intermediate position by the combined action of the two cams—transferring and burring—and the two springs A_1 and B_1. The transferring lever C_1 is fulcrumed on the stud D_1 and works in a slot in the connecting link E_1. The link E_1, in turn, is connected to a slotted block F_1, which is fastened to the transferring arm shaft by a cone-pointed set-screw, not shown. The spiral spring A_1 bears against the face of the transferring lever C_1, the transferring lever being held to the link E_1, by means of the fillister head screw G_1 and two check nuts H_1. The spring B_1 is used to keep the roll in the lever C_1 in contact with the transferring cam, while the spring A_1 is used to steady the transferring arm. When the set-screw in the arm *N* comes in contact with the square rod *S*, the lever C_1 continues compressing the spring A_1, thereby keeping a tension on the arm *N* while the burring operation is being performed. The spring B_1 is fastened to the link E_1 and to the tray or bracket-holder for the transferring arm rod. The height of the lobe on the transferring cam governs the angular position of the arm *N*.

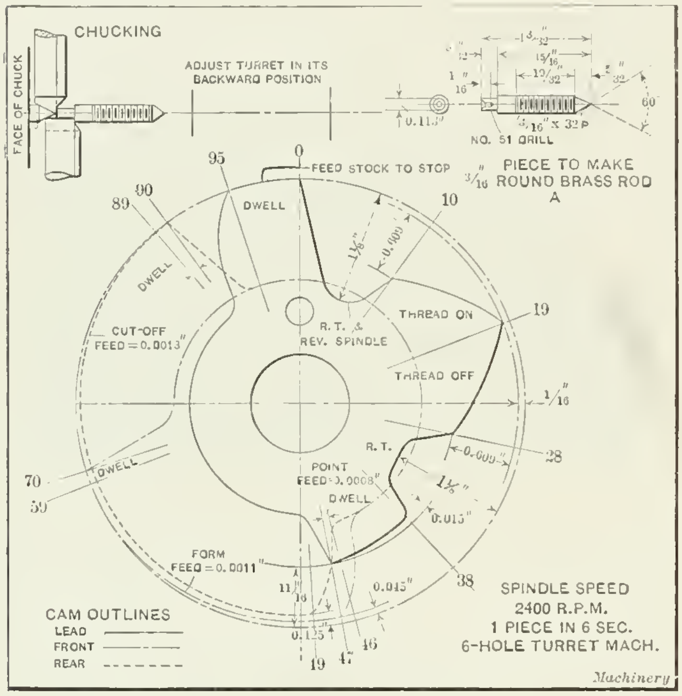


Fig. 29. Lead and Cross-slide Cams for Making a Cone-pointed Screw having a Hole drilled in the Rear End

Laying Out Cross-slide and Lead Cams for Burring Operation

The same remarks which we made in the November number in regard to laying out cross-slide cams for cross-drilling operations apply to the laying out of cross-slide cams for burring operations, it being absolutely necessary to leave sufficient clearance for the arm to ascend and descend to and from the work-spindle. The character of the work and the shape and size of the work-holder also play an important part in regard to the amount of clearance necessary. This, of course, has to be worked out for each individual case. To illustrate clearly the method of designing a set of cams which accomplish a burring operation, we will lay out a complete set of cams for producing the cone-pointed screw shown at *A* in Fig. 29. As can be seen a No. 51 drill hole is to be produced in the rear end of this screw, which without the use of this attachment would necessitate rehandling the work and performing a second operation on it.

The cross-slide and lead cams for making this screw are also shown in Fig. 29, where the functions of the various lobes are clearly indicated. It might be mentioned, however, that it was necessary to adjust the turret slide back to the extreme limit to make this long screw in a No. 00 B. & S. automatic screw machine. The time allowed to feed stock is also less than that usually provided, being 5 hundredths instead of 10 hundredths of the cam circumference. The reason for this is that the turret is not revolved, but is just advanced to gage the stock to length.

Laying Out the Transferring and Burring Cams

Before proceeding to lay out the transferring and burring cams, a diagram similar to that shown in Fig. 30 should be made. Here the work-chuck, chuck-closing device, burring tool and chuck-opening pin should be laid out in their respective positions, and the angular movement of the arm from one point to the other should be determined.

A good method for obtaining the angular movement of the arm *A*, is to make a diagram as shown in Fig. 30, drawing in all those parts which are designated by full lines. Then make a templet of the arm *A*, work-holder *B* and slotted block *C*, on tracing cloth. Now by pivoting this templet on the center of the transferring arm rod, and swinging it around to the various positions, the lines *D*, *E*, *F* and *G* can be drawn, which represent the center of the slot in the block *C*, when the arm is swung to the various positions. Next draw the circles *H* and *I*, representing the largest and smallest diameters of the transferring cam, after which a templet of the transferring lever *J* and connecting link *K* should be made on tracing cloth.

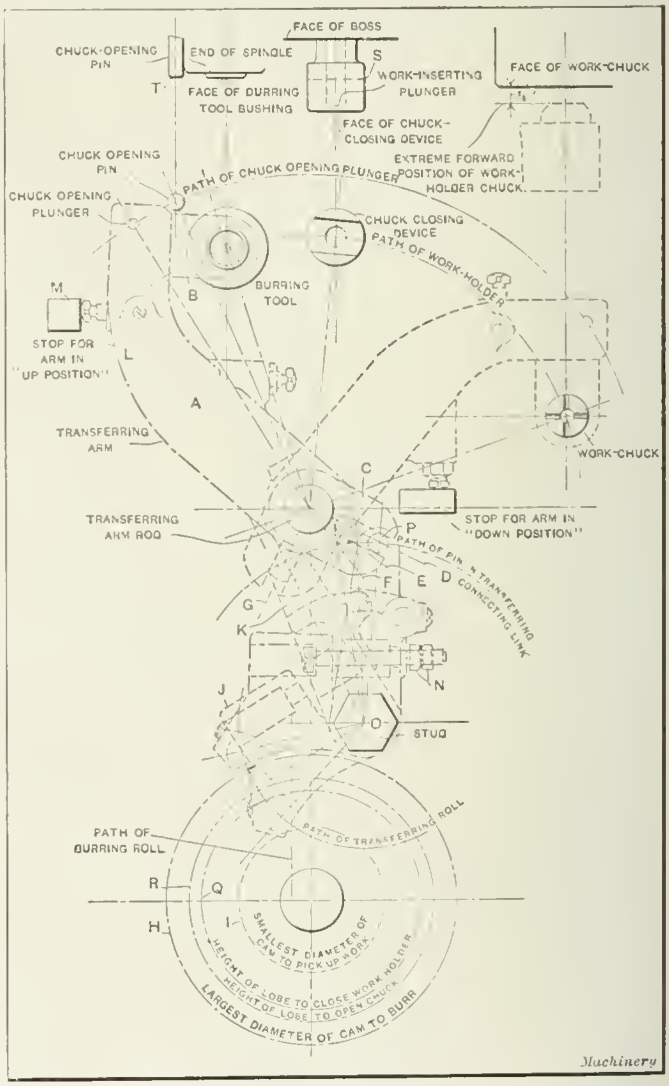

FACE OF BOSS
CHUCK-OPENING PIN
END OF SPINDLE
S
WORK-INSERTING PLUNGER
FACE OF WORK-CHUCK
T
FACE OF BURRING TOOL BUSHING
FACE OF CHUCK-CLOSING DEVICE
CHUCK OPENING PIN
EXTREME FORWARD POSITION OF WORK-HOLDER CHUCK.
PATH OF CHUCK OPENING PLUNGER
CHUCK OPENING PLUNGER
CHUCK CLOSING DEVICE
PATH OF WORK-HOLDER
M
B
BURRING TOOL
STOP FOR ARM IN "UP POSITION"
L
A
TRANSFERRING ARM
WORK-CHUCK
C
TRANSFERRING ARM ROD
P
STOP FOR ARM IN "DOWN POSITION"
PATH OF PIN IN TRANSFERRING CONNECTING LINK
F
E
D
G
K
N
J
O
STUD
PATH OF TRANSFERRING ROLL
PATH OF BURRING ROLL
R
Q
H
I
SMALLEST DIAMETER OF CAM TO PICK UP WORK
HEIGHT OF LOBE TO CLOSE WORK HOLDER
HEIGHT OF LOBE TO OPEN CHUCK
LARGEST DIAMETER OF CAM TO BURR
Machinery

Fig. 30. Diagram used in Determining Rises on the Transferring and Burring Cams

As was previously mentioned, the lever *J* should compress the spring A_1, see Fig. 28, when the set-screw *L* touches the square rod *M*, thus steadying the arm during the burring operation. To provide for this the nuts *N* are adjusted, so that the spring A_1 will bear the weight of the arm *A*. To proceed, pivot the templet of the transferring lever and connecting link on the center of the stud *O*, swing the templet so that the center of the pin *P* comes in line with the lines *E* and *F*, respectively, and draw circles *Q* and *R* representing the heights of the lobes for closing and opening the chuck. Care should be taken in laying out the lobes to lift the arm from the chuck-closing device to the chuck-opening pin, as the space between the two members is not adjustable.

As the spring A_1, see Fig. 28, is compressed further when the arm *A* is in the "up position" than when it is in the "down position," it is necessary to start swinging the arm *A* from the work-chuck, and to proceed towards the burring tool. It will be found that the roll in the lever *J* will fall below the largest diameter of the cam, when the arm is in line with the burring tool; this allows the spring A_1 to be compressed and thus steady the arm.

To obtain the heights of the lobes on the burring cam, a diagram similar to that shown in the upper view of Fig. 30, should be made. The burring tool should be drawn in position, as well as the work in the work-chuck. The chuck-closing device *S*, and chuck-opening pin *T* are adjustable within a considerable range, but it is best to work from a setting which will be most convenient to the burring tool and work.

The method used in obtaining the heights of the lobes on the advancing cam was described in connection with Fig. 4, while the proper procedure to follow in laying out the lobes on the transferring cam in their correct relation to the lobes on the advancing cam was described in connection with Fig. 5. The diagrammatical method used in laying out the transferring and advancing cams for the Nos. 0 and 2 B. & S. automatic screw machines was illustrated in Fig. 7.

The transferring and burring cams used in connection with the piece shown at *A* in Fig. 29 are shown in Fig. 31, as is also a sectional view of the work-holder with the work in position. The order of operations for making the piece shown at *A* in Fig. 29, is as follows:

Lead and Cross-slide Cams

Operations	Revolutions	Hundredths
Feed stock to stop	12	5
Revolve turret and reverse spindle	24	10
Thread on	21.6	9
Thread off	21.6	9
Revolve turret	24	10
Point, 0.015 inch rise at 0.0008 inch feed, dwell 0.10	21.6	9
Form, 0.045 inch rise at 0.0011 inch feed, dwell 0.10	(55.2)	(23)
Cut off, 0.125 inch rise at 0.0013 inch feed, dwell 0.10, and revolve turret four times	98.4 + 4.8	41 + 2
Clearance to bring down arm	12	5
Total	240	100

Transferring and Burring Cams

Operations	Revolutions	Hundredths
Drill and countersink, 0.070 inch rise at 0.00162 inch feed, dwell 0.20	48	20
Drop back with piece	7.2	3
Rotate to open chuck	28.8	12
Dwell on burring cam to open chuck	2.4	1
Drop back to eject piece	10.7	4½
Drop down to grip work	36	15
Dwell with arm before advancing	4.8	2
Advance on work	21.6	9
Raise arm to close chuck	26.4	11
Advance arm to close chuck	9.6	4
Close chuck	2.4	1
Rotate to burring spindle	19.2	8

Referring to Fig. 31, the lobe *A* on the burring cam moves the arm forward to close the chuck, and during this period the transferring arm roll is on the "dwell" on the lobe *B* of the transferring cam. The springs previously referred to steady the arm when in this intermediate position, but on account of this undependable method of steadying the arm, it is not advisable to make a piece in less than three seconds on the No. 00 B. & S. automatic screw machine.

Work-holders and Chuck-closing Devices

The standard work-holder furnished in connection with the burring attachment is shown in detail, connected to the arm *N* in Fig. 32, where its construction can be clearly seen. The operation of this work-holder has been described, but it may be advisable here to give a few more particulars regarding it. The diameter *G* of the chuck *A* is made equal to the maximum diameter of the work. The chuck-closing sleeve *B* is made with a tapered hole to suit the chuck *A*, the taper being about ten degrees, and is provided with a slot in which a pin *F* fits, preventing the sleeve from turning around. The sleeve is also cut out to receive the ball end of the lever *D*, which is used for releasing it from the chuck, thus allowing the work to be pushed out by the plunger *C*. The lever *D* as before mentioned, is operated by means of the headed pin *E*.

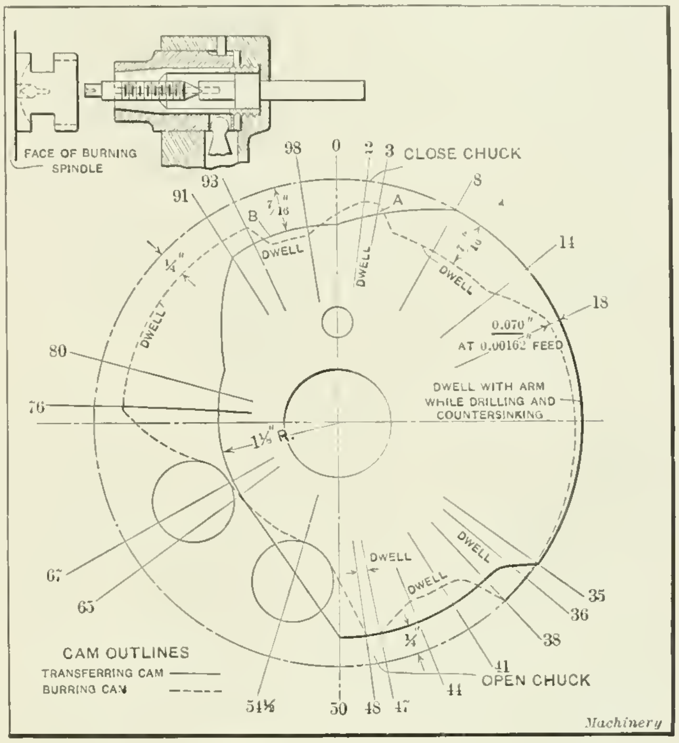


Fig. 31. Transferring and Burring Cams for the Piece shown at A in Fig. 29

Another type of work-holder, which was developed for a special piece, is shown in Fig. 33. This was for holding the threaded piece *A*, which, as can be seen, could not be gripped in a chuck of the type shown in Fig. 32 on account of the end which is placed in the chuck being tapered and threaded, thus preventing the chuck from gripping it securely. The work-holder consists essentially of a machine steel block *B* of the shape shown, which is fastened to the transferring arm by a cap-screw. This block is provided with a boss in which holes are drilled for the work-holder *C*, locating pin *D*, and ejecting pins *E*. The locating pin *D* comes in contact with the flats of the hexagon, and thus prevents the work from turning around on the work-holder *C*. The work-holder *C* is driven into the block *B*, and two studs or pins *E* pass through the block *B*, on the forward end of which is fastened an ejecting block *F*, forming a link connecting the two studs. The rear ends of these studs are also provided with a link *G*

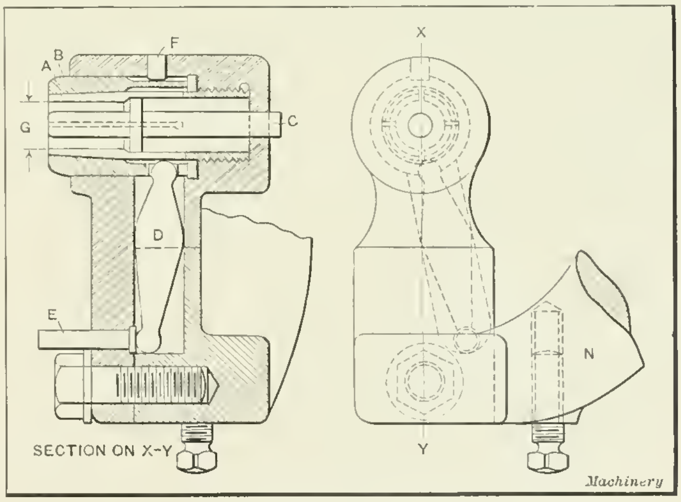


Fig. 32. Standard Work-holder used in Connection with the Burring Attachment

held to them by nuts *H*. An adjustable pin *I* located in the link *G* is retained by the set-screw *J*. This pin *I* comes in contact with the finger *R*, Fig. 28, and ejects the work after it has been burred.

The standard chuck-closing device provided with the burring attachment shown at *O*, Fig. 28, is shown more clearly at *A* in Fig. 34. It consists of a body *b* provided with a slot *c* in its front end through which the chuck passes on its transit from the work-spindle to the burring tool. The body *b* is counterbored to receive the spring plunger *d*, which is acted upon by the spiral spring *e*. The plunger is adjusted by means of the check-nuts *f*, and forces the work into the chuck *A* against the ejecting pin *C*, see Fig. 32.

A special locating device used in connection with the work-holder shown in Fig. 33 is shown at *B*, Fig. 34. This, as before, consists of a body *g*, which fits in the clamping bracket *T* on the burring attachment (see Fig. 28). The device is provided with a spring plunger *h* acted upon by the spring *i*, and is retained in the holder by means of pin *j*. This plunger *h* is used for forcing the work onto the pin *C*, Fig. 33. The plunger *k*, which rotates the work *A*, Fig. 33, on the work-holder, and thus locates it correctly against pin *D*, is held in a bushing *l* counterbored to receive a spring, and is retained in the holder by means of the pin *n*. The bushing itself is held in the holder by means of the set-screw o.

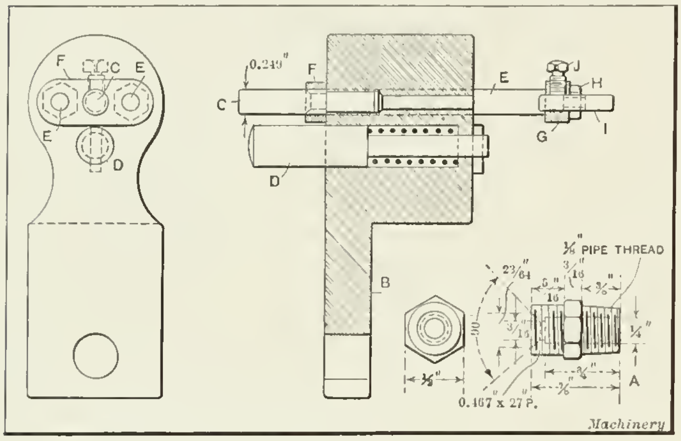


Fig. 33. A Work-holder of Special Design

Burring Tools and Holders

The type of burring tool and holder used in the burring attachment is governed entirely by the work it is to perform.

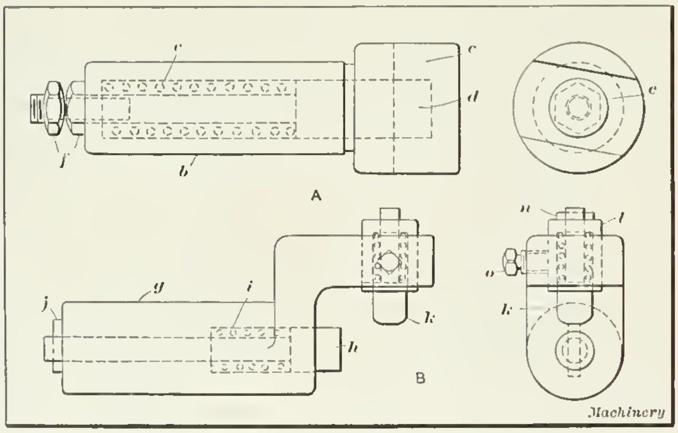


Fig. 34. Standard Work Chuck-closer, and Device for Locating Work on the Holder shown in Fig. 33

In Fig. 35 are shown a few representative types of burring tools and their respective holders. *A* is the burring tool used for burring the piece shown at *A* in Fig. 33. This is made from round drill rod, as shown, and is provided with a leader fitting in the work, the cutting face being tapered to the required angle. The type of burring tool and holder used for drilling and countersinking the screw shown at *A* in Fig. 29, is shown at *B*. The holder *a* is made to fit in the burring spindle, and is slotted out to receive the clamping block *b*. A combination drill and countersink *c* of the required shape and diameter is held in this holder by means of a set-screw bearing on the clamping block. The front end of the holder is counterbored to receive the work-holder chuck, and is also provided with two slots *d* which allow the chips to escape.

Another type of burring tool, and the work on which it is used is shown at *C*. In this case the burring tool is a combination holder and tool, being made to fit the hole in the burring spindle. It is also provided with a leader *e* to fit the work, which is turned down on the rear end to suit the holder and held in it by a set-screw as shown.

Three views of still another type of burring tool and holder are shown at *D* and *E*. This holder and tool is used principally for chamfering the inside and outside of tubing as shown at *f*. The tool used is similar to a circular form tool except that it is of small size. It is held in the holder *g* on a stud *h*, which is threaded into the holder and is provided with a nut *i* for locking it in the desired position. The stud carrying the circular tool is slotted in the lower end, so that it can be adjusted, thus bringing the tool in the correct position to chamfer the inside and outside of the work.

The circular tool *l* is held on the stud by means of a screw *j* and washer *k*. The front end of the holder is provided with a bushing *m*, which fits the external diameter of the work and is held in place by a headless screw as shown. When designing this type of tool, it is preferable to lay out the work on a large scale, about 10 to 1, and from this obtain the diameter of the tool, and the distance it is to be cut down below the center, so that the tool will clear and not rub, which would tend to produce a poor finish on the work. The depth of the recess *n* should only be a few thousandths greater than the length of chamfer required on the work, because the greater the depth *n*, the smaller the diameter of the tool, and also the smaller the amount of tool circumference that can be utilized for cutting. From the diagram the location of the stud *h* can also be obtained.

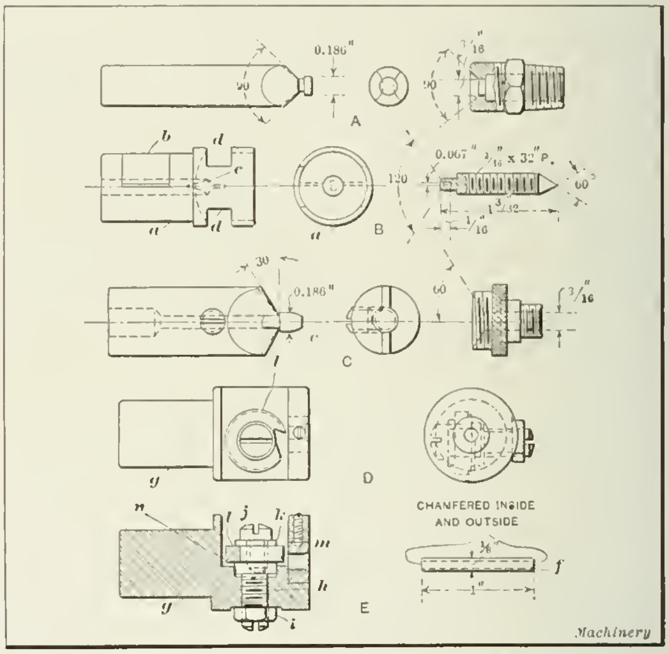


Fig. 35. Various Types of Burring Tools and Burring-tool Holders

Speeds and Feeds for Burring

The speeds used for burring when the tools are made from ordinary carbon steel should be similar to those used for drills, a table of which was given in the September, 1910, number of MACHINERY. The feeds used where the burring tool is smaller in diameter than ¼ inch should never be greater than 0.003 inch for brass, 0.002 inch for machine steel, and 0.001 inch for tool steel. The feeds should also be decreased near the end of the cut, and a dwell equal to at least three revolutions of the burring tool should be allowed on the burring cam. Where the burring tool is ¼ inch or greater, the same feeds as those used for centering tools, given in the article previously referred to, can be used with satisfactory results.

REMARKS BY THE ONLOOKER

It is not unusual to come across some mechanical idea which makes one wonder why it has never been thought of before. In the advertising pages of the November number of MACHINERY is shown a high-speed drill press which prompted this reflection. The drill press has an arm which can be swung out of the way, and in it is a removable bushing to steady the drill; in other words, the attachment is the simplest kind of a jig, and a very effective one. I can see no reason why this simple fixture cannot be fitted to the usual type of sensitive drill press, as well as to the round-column type shown.

To produce an elongated hole in a piece of steel, in a drill collet or drill spindle, is usually a difficult job. In most shops it is done by laying out and drilling several holes, and then filing out the metal between them. This requires considerable time, and the work is often unsatisfactory. It is, therefore, a revelation to compare with the results thus obtained those shown on page 5 in the advertisements, produced by a specially designed spline milling machine. When these holes are produced in the usual way, the table of time required would almost have to read "hours" for "minutes," and "minutes" for "seconds," to say nothing of the quality of the work.

Keyseats are another thing which the average shop finds expensive to cut. A shaper is commonly used with a long tool which is, of course, expensive, and at best a "nibbling" affair. The keyseating arrangement shown on reading page 171 (engineering edition) is inexpensive and effective, but I cannot think that the grinding rig also shown can be considered more than a makeshift of questionable wisdom, as a grinding machine always requires special provision to prevent the abrasive from working into the moving parts and joints. Without such provision, the life of the tool is shortened and its accuracy impaired. The arrangement, however, is most handy at times in a shop where it would not pay to install a surface grinder; with careful cleaning, injury to the machine can be largely averted.

The portable grinder is becoming more and more understood and appreciated. The pages of the technical press show how it has made its way into the shops, air and electricity being the motive power. In small shops the electric tool seems to be far cheaper to install, but in large shops the air-driven tool has some great advantages. Even for shops of medium size, small air-compressor sets are obtainable at a moderate cost. In many cases portable tools can complete the work, and the machine can be carried to the part to be machined much quicker than the part can be carried to a stationary machine. Furthermore, portable tools can be used while other operations are carried out on the same piece.

A very useful table is given on page 220 of the sizes of the small ends of taper pins; it is a wonder that taper-pin makers have not provided such a table long ago. If it has ever been published, I have never happened to see it.

The editorial and the articles on the prevention of accidents bring to my mind very forcibly a remark attributed to Bismarck: "All but a fraction of mankind is unable to take care of itself, and even that fraction cannot be depended upon at all times." The idea that it is a disgrace for a person to become injured is, to my mind, a correct one. Ridicule or disgrace is something that few can stand, and that it is unpardonable to hurt others should be duly impressed upon all, including the proprietor who does not provide reasonable guards against thoughtlessness.

I have had an experience with large corporations in this connection. I was interested in sanitary conditions with a view of preventing tuberculosis, and in no case did I meet with any objection to the suggestions made to add to the comfort of the workman or to prevent accidents or illness; instead, the suggestions were acted upon at once. To prevent accidents is the desire of any right-minded man, and I think we are safe in assuming Bismarck's utterance to be true, although I do not think that to relieve a man from all responsibility is wise. The New Jersey accident law, lately passed, relieves the workman of responsibility under all circumstances, no matter if his injury is the result of direct disobedience. The fact that he is hurt is all that is necessary to entitle him, under the law, to a money compensation, the amount of which is fixed. In my personal opinion such a law will lower the standard of moral responsibility, just as, I believe, the pension act in Germany has deteriorated the German character. When people are relieved of responsibility they degenerate.

To illustrate the desire of proprietors to prevent accidents, I was recently in a New England shop when a salesman representing a concern making hollow set-screws called. After he had told his story, the customer asked how soon he could get the set-screws required, and was assured that they could be furnished out of stock. At noon there were ten or twelve men busy taking out the set-screws in the lineshaft pulleys and replacing them with screws of the hollow style. Before the end of the week no projecting screws could be found in the establishment. These hollow set-screws are of great value not only as accident preventors, but from the point of economy, as so few lengths have to be carried in stock.

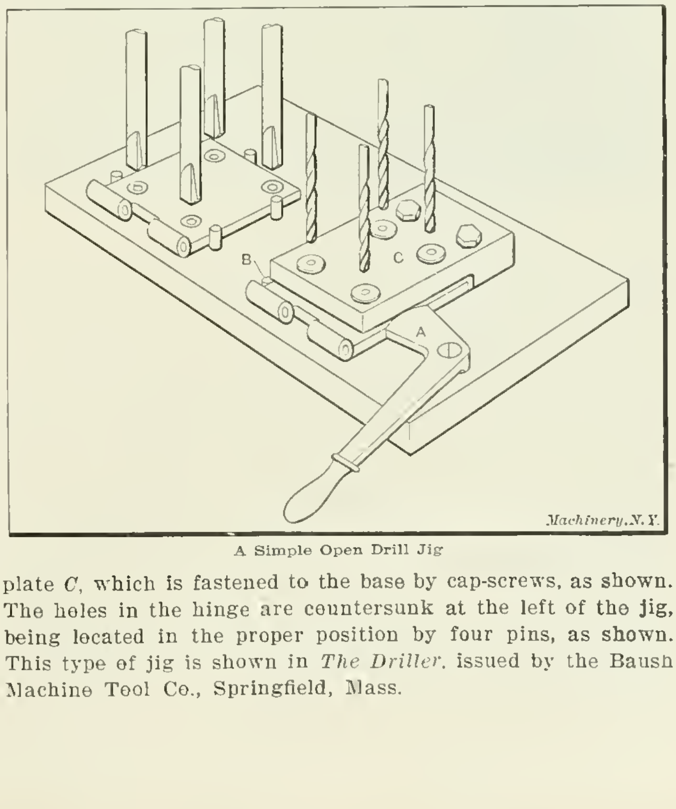
The account given in the November number of the extruded tubes reads like a fairy tale, and illustrates how persistency pays not only the inventor, but the world. It seems almost incredible that such work can be done cold, and the inventor, and those who had the stamina to risk their money on the process, should be commended. Few men, however well versed in metal drawing would have believed the process possible—let alone practicable—before it was actually demonstrated. We are often astonished at what is possible. I recently saw a lot of small bent wire pieces which had been japanned, and could not understand how the work could be so evenly done. I was told that the articles were put in a tumbler with the japan and after having been tumbled a few minutes by hand they were dried in an oven. I could hardly believe this, but I saw it done, and the only additional treatment was to occasionally shake the pans in which the articles were dried. The shaking seemed to be the secret of the process and prevented the wires from sticking together when drying.

In talking with a reader of MACHINERY a few days ago he said: "I now keep the issues of this journal instead of catalogues. I had such a number of catalogues that I could not care for them properly, and I found that practically everything in my line was advertised in MACHINERY, so I threw away the catalogues to save space." W. D. F.

* * *

A SIMPLE AND EFFICIENT DRILL JIG

The accompanying illustration shows a simple and efficient drill jig for drilling and countersinking hinges in an eight-spindle multiple drill press. These hinges are 3 1/2 by 3 5/16 inches and are held for drilling by the cam *A*, which presses the hinge against pins *B*. The bushings are held in a top plate *C*, which is fastened to the base by cap-screws, as shown. The holes in the hinge are countersunk at the left of the jig, being located in the proper position by four pins, as shown. This type of jig is shown in *The Driller*, issued by the Baush Machine Tool Co., Springfield, Mass.



A Simple Open Drill Jig

METHODS, MACHINES AND FIXTURES FOR AUTOMOBILE MANUFACTURE[*]

PRACTICE OF THE NATIONAL MOTOR VEHICLE CO.

By F. B. HAYS[†]

The plant of the National Motor Vehicle Co., Indianapolis, Ind., is one of the oldest automobile factories in the United States, and contains some very interesting special tools and machinery. The general methods used in manufacturing the automobiles made by this company are similar to those used in other motor car factories. However, many of the individual processes, machines, tools, and jigs are peculiar to the National Motor Vehicle Co.'s plant.

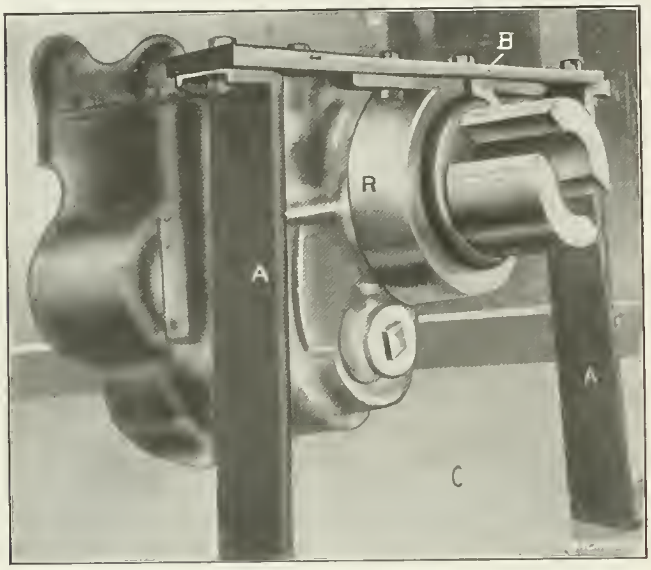


Fig. 1. Fixture for Holding Transmission Cases while Assembling

Transmission Fixture

Fig. 1 shows a fixture for holding transmission cases while assembling. It is made of two vertical pieces of angle iron *A*, and one horizontal piece of flat stock *B*, bolted together and screwed to the assembler's bench *C*. Bolted to the middle of piece *B* is a ring *R* which has the same inside diameter as the cylindrical end of the transmission case. This ring clamps around the end of the case and holds it in position while the transmission is being assembled. This arrangement permits the case to be held at any angle with its vertical axis while being worked upon.

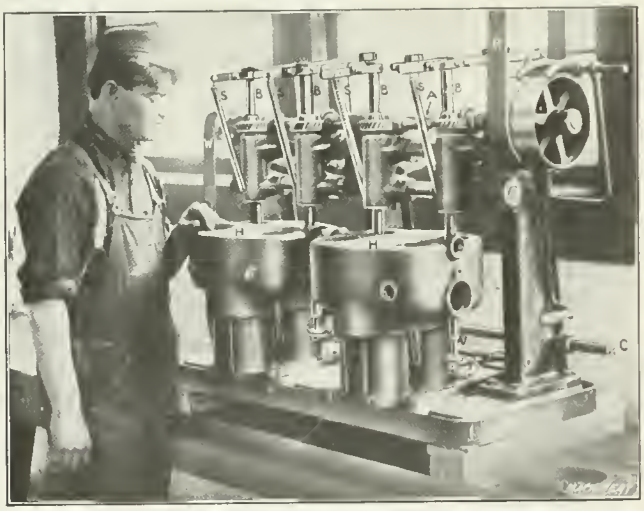


Fig. 2. Valve Grinding Machine

Valve Grinding Machine

One of the most interesting machines in the factory is that used for grinding intake and exhaust valves shown in Fig. 2. This machine is driven by the driving shaft *A*, which is rotated by the belt *R*. Shaft *A*, in turn, revolves the grinding spindles *B* through spiral gearing, and the cam-shaft *C* by means of the belt *W*. Into the lower ends of the grinding spindles *B* are inserted rectangular drivers which fit into the slots of the valve heads and which cause the valves to rotate with the grinding spindles. By means of the springs *S*, considerable pressure is exerted by the grinding spindles on the valve heads. The grinding spindles are splined, and are free to move vertically in their gears. As the grinding spindles revolve, the arms *X* are raised and lowered by cams on shaft *C*, which produces a slight vertical motion of valve stems *V*.

The operation of this machine is as follows: The springs *S* are unhooked and the grinding spindles *B* raised to clear the cylinders *H*. The latter are then slid into place in the slots on the base of the machine, so that the valve centers come approximately central with the centers of the grinding spindles. The valves and valve seats are then "doped" with a valve grinding compound, and the ends of the grinding spindles are inserted into the slots of the valve heads. The springs *S* are "hooked up," and the machine is started. The grinding spindles rotate the valves, producing an abrasive action between the valves and their seats, and the cam levers *X* raise and lower the valves, allowing the grinding compound to work into the surfaces being ground. This method not only prevents the surfaces from becoming dry, but also distributes the abrasive in such a manner as to produce uniform and even results.

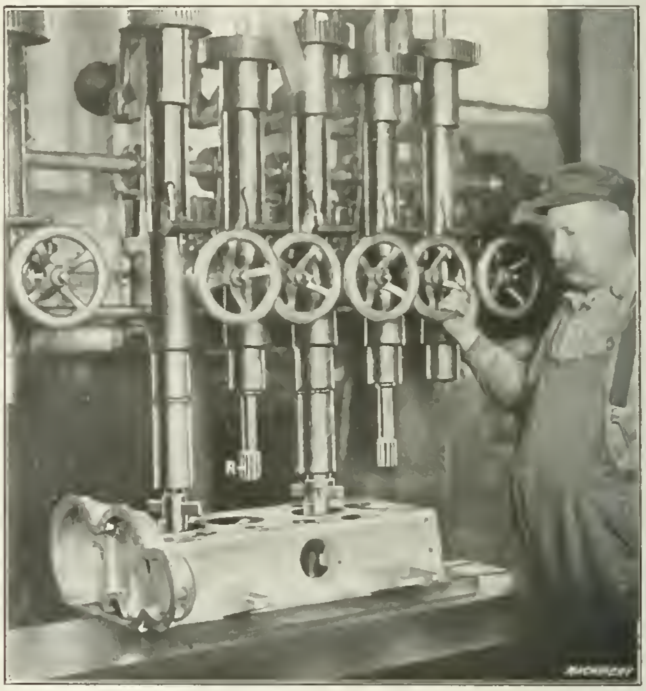


Fig. 3. Boring Cylinder Holes and Reaming Push-rod Holes in Crank-case

Fig. 3 shows the method used for boring cylinder holes and reaming push-rod holes in the upper half of the aluminum crank-case. The jig to which the upper half of the crank-case is fastened is bolted to the drill-press table. The table is moved to a position which brings the centers of the cored holes as nearly as possible in line with the center lines of the drill-press spindles. The machine is then started, the boring and reaming tools being fed by hand as shown. The cylinder holes are bored by the tools *T* and the valve-tappet holes by the reamers *R*. Two sets of holes are drilled in one operation, after which the drill-press table is moved over and the next set drilled in the same manner. This process produces absolute accuracy, as the center to center distances of the drill press spindles are the same as the required center to center distances between the cylinders and the push-rods.

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[*] For other articles dealing with tools and methods used in the automobile industry, see MACHINERY, August, 1911, "Machining Automobile Connecting-Rods"; October, 1910, engineering edition, "Making Automobile Radiators"; October, 1910, "Automobile Factory Practice," "Automobile Motor Testing Plant," "Machining a Motor Fly-wheel," and "Examples of Modern Turning Practice in Automobile Construction"; July, 1910, engineering edition, "Automobile Factory Practice—Olds Motor Works"; March, 1910, "Milling Fixtures for Automobile Parts"; January, 1910, "Making Accurate Automobile Engine Pistons"; January, 1910, engineering edition, "Automobile Factory Practice—Nordyke & Marmon Co."; December, 1909, "Manufacturing Automobile Equalizing Gears"; October, 1909, engineering edition, "Manufacturing Methods in the Stevens-Duryea Automobile Works," "Efficient System for the Rapid Assembly of Motor Cars," and "Treatment of Gears for Automobile Motors and Transmission"; October, 1909, "Automobile Factory Practice—The Dayton Motor Car Co."; June, 1909, "Machines and Tools for Automobile Manufacture"; May, 1909, "Special Automobile Factory Tools and Devices," and other articles there referred to. See also MACHINERY'S Reference Book No. 59, "Machines, Tools and Methods of Automobile Manufacture," and No. 60, "Construction and Manufacture of Automobiles."

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The holes for the squared ends of the live spindles of the rear axle in the axle dogs are produced by broaching, as shown in Fig. 4. The dogs are held in position by the hollow jig *A*, which is bolted to the base of the machine, the jig being slotted to conform to the teeth of the dog, as shown at *D*. The operation of the machine, which is of the worm-and-gear type, can be readily understood from the illustration. The dial on the column registers the pressure exerted in tons, the maximum allowable pressure being 30 tons. At *R* is shown one of the dogs after it has been broached.

The process used for reaming the holes for cam- and magneto-shaft bearings is rather unique. This work is accomplished by means of a reaming fixture *F* bolted to the table of an open-side planer, as shown in Fig. 5. The reaming fixture is operated by the spindle *V*, which is connected to the gear box *D* by the coupling *S*. At *C* are shown spindles passing through the guide plate *H*. To the ends of these spindles are attached the fluted reamers. At *G* is placed a spiral driving gear which meshes with two spiral pinions on the spindles *C*. These gears are enclosed in the gear box *D*. The small spindle next to the operator is driven by a third pinion meshing with a gear on the right-hand camshaft reaming spindle, and is used for reaming the magneto-shaft bearing holes. The gear box *D* is so constructed that it slides freely in the guides at the sides of the base-plate, indicated in the illustration. The crank-case *W* is held in position by the clamps *B*.

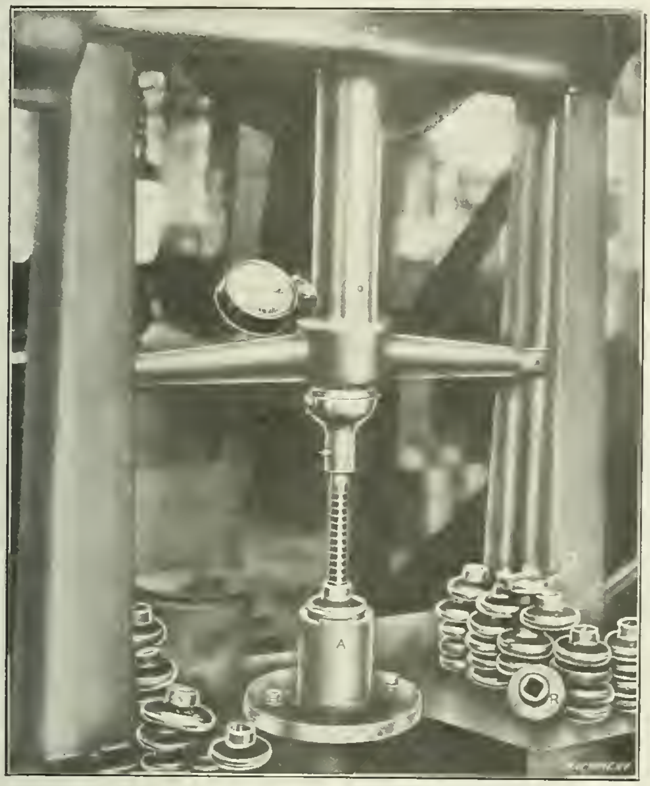

Fig. 4. Broaching Operation on Rear Axle Dogs

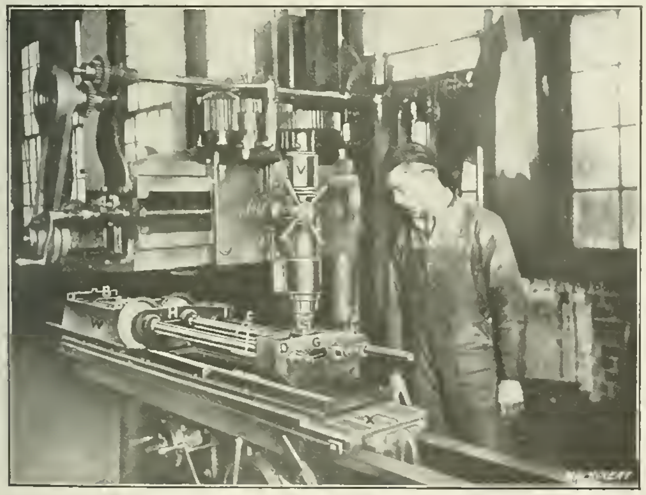
Fig. 5. Reaming Cam-shaft Bearings in a Crank-case

The operation of the device is as follows: The machine is started, causing the gear *G* to revolve, which, in turn, revolves the reaming spindles *C* and the spindle for reaming the magneto-shaft bearing holes. At the same time the planer table *X* is fed toward the operator, while the gear case, spindles, and reamers, remain stationary, except for their rotary motion. The transmission case, being fixed to the base-plate of the fixture, moves with the planer table. This causes the reamers to enter and pass through the bearing holes, from one end of the case to the other.

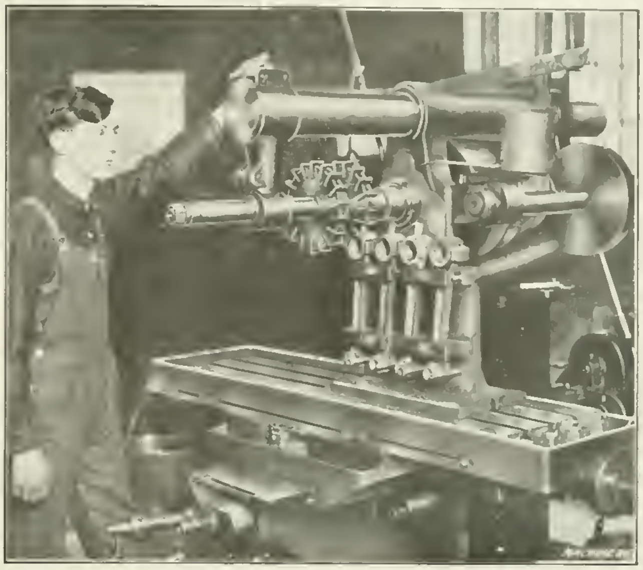
Fig. 6. Method of Facing Connecting-rod Stubs

Connecting-rod stubs are faced in a milling machine as shown in Fig. 6, the rods being held during the operation in the simple clamping fixture shown in the illustration. Both sides of the rods are faced in one operation by the two milling cutters, which prevents any variation in width.

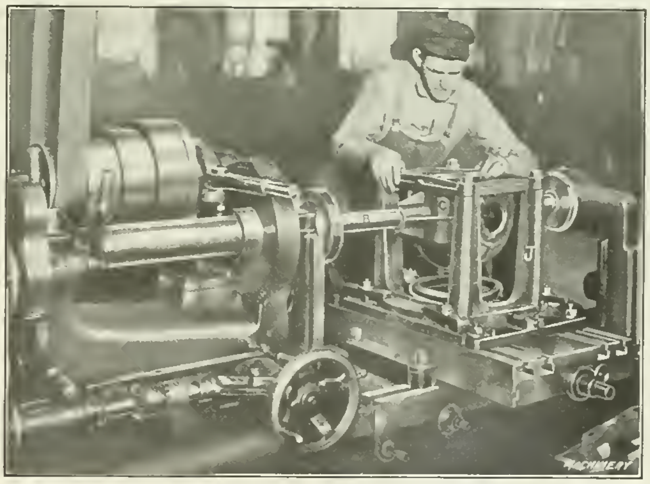
Fig. 7. Boring a Differential Case

The holes in the differential case, into which are brazed the live axle housings, are bored on a horizontal boring machine. The case is held in a special jig during this operation. Fig. 7 shows the boring machine and jig; *B* is the boring bar, *J* the jig, and *C* the differential case. The top plate of the jig is removable and has lugs on its under surface which hold the case in position while boring. The case is pressed against this plate by means of the handwheel at the bottom of the jig. The jig is clamped to its base instead of being made integral with it in order to allow a wider range of adjustment.

Jig used in Reaming Intake and Exhaust Valves

The reaming of intake and exhaust valves is an operation that requires unusual accuracy. The jig used for this purpose is very interesting, and is shown in Figs. 8, 9 and 10. Fig. 8 shows the jig ready for use. Part *A* is a bushing for guiding the reamer (several different bushings are used to suit the various-sized reamers). At *B* is shown a hand screw for raising and lowering the flat plate on the lower side of the top of the jig. This plate exerts a downward pressure, while the adjusting screws *C* exert an upward pressure on the cylinders. By means of these screws accurate vertical alignment is obtained. At *F* is shown a turn-table which can be revolved on the base-plate *H* of the jig; *G* is a sliding plate on the turn-table, to which the cylinder is fastened by means of clamps *I* and *L*. At *E* is shown a plunger held by a spring, which prevents the turn-table from revolving; *K* is an adjusting screw for holding the slide *G* in the desired position. To revolve the turn-table, the plunger *E* is pulled back by means of the lever. Fig. 9 shows a pair of cylinders being inserted into the jig, and Fig. 10 shows the jig set up and bolted to the bed-plate of the drill press used in connection with the work.

When the reaming of one valve is completed, plunger *E* is pulled back, and the turn-table revolved until the next valve is brought into position, and so on, until all four valves have been reamed. The pair of cylinders is then released from the adjusting screws and clamps, and slid out of the jig in the same manner that it was put in.

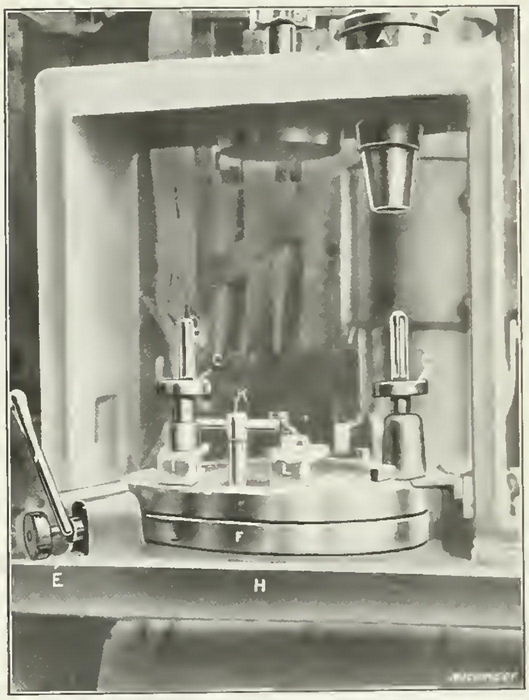

Fig. 8. Jig for Reaming Exhaust and Intake Valves

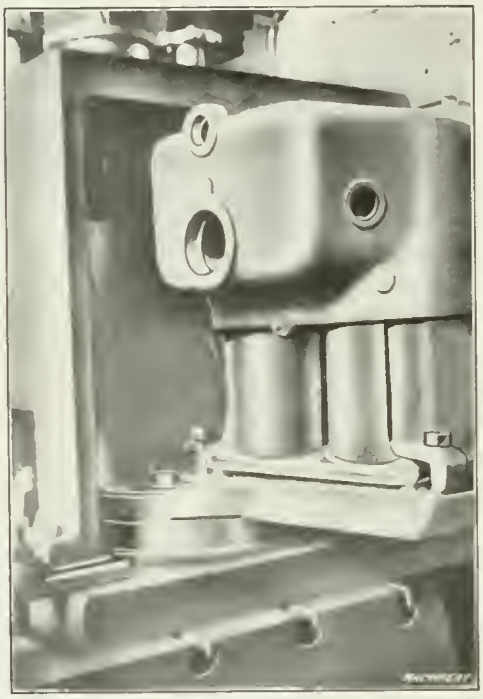

Fig. 9. Method of Inserting and Removing Cylinders

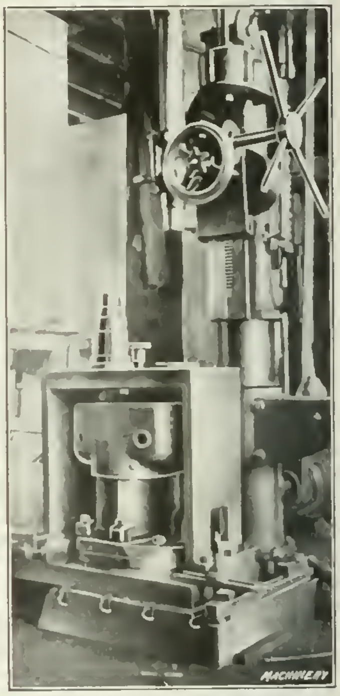

Fig. 10. Jig in Position in Drill Press

The foregoing tools and methods are of more interest from the standpoint of accuracy of results than from that of quantity of production. The machines described are so constructed that a very high degree of accuracy is obtained in the work turned out by them. Were increased production, with the same degree of accuracy, required, machines designed and built along the same general principles would probably produce the desired results. The machines, methods, jigs and fixtures described represent interesting examples of the successful means employed by a well-known company in converting rough forgings and castings into accurately finished parts.

* * *

According to a statement made in a paper read before the British Association for the Advancement of Science, the gyro-compass is now in use on a number of warships, and its installation on some of the large ocean liners is under consideration. Its advantage over the magnetic needle lies in the fact that it is not affected by large masses of steel, such as are used in the construction of battleships and other large vessels. The Anschutz gyro-compass, running on ball bearings, makes 20,000 R. P. M., and is driven by an induction motor whose armature forms the gyroscopic disk. The whole weight of the device is carried by a steel rim floating in mercury.

DON'TS FOR TOOLMAKERS

By WILLIAM YOUNG[*]

Don't leave a lapping block where it will be nicked or greased.

Don't forget that copper and cast-iron laps do not change in size easily.

Don't lap a piece of work continually in one place; keep moving it.

Don't use a steel plate for a lapping block; a cast-iron one is much better.

Don't forget that No. 1 diamond dust is the best for ordinary classes of work.

Don't forget that a lapping block with scored grooves is the best for flat surface work.

Don't forget that a boxwood lap charged with diamond dust is good for work which requires a high finish.

Don't forget when making ring gages to grind them within 0.0005 inch, leaving that amount for lapping.

Don't forget when lapping a hole to keep the work in motion so that the emery will not cut a groove in the work.

Don't forget when lapping a ring gage to cool it in benzine to the temperature of the plug and clean it before trying it on the plug.

Don't forget when lapping holes to always keep the work square with the lap to avoid the hole being irregular or bell-mouthed in shape.

Don't forget when lapping a piece of work on a lapping block that the pressure should be equally distributed, so as not to lap the work unevenly.

Don't forget that a good lap for accurate work can be made from copper or cast iron, which should be made a good running fit in the hole so as to lap the high parts.

Don't forget in lapping bronze or brass that crocus and Vienna lime freshly crushed and used on a hard wood or a lead lap gives a very good finish, but is slow.

Don't forget when lapping small holes that copper or Bessemer rod charged with diamond dust is very satisfactory, but should not be forced too much as they will strip easily.

Don't forget that a quick and cheap method of making a circular lap is to split a piece of wood and wrap emery cloth around it; but care should be taken to see that it fits the hole to be lapped.

Don't forget that it is good practice to leave a thin collar on each end of the hole in making a ring gage, so that the bell-mouthed portion produced in lapping can be ground off after the hole is lapped to size.

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[*] Address: 13 River St., Rockville, Conn.

LETTERS ON PRACTICAL SUBJECTS

We pay only for articles published exclusively in MACHINERY.

ATTACHMENT FOR MACHINING ANGULAR FACES OF BEVEL GEARS

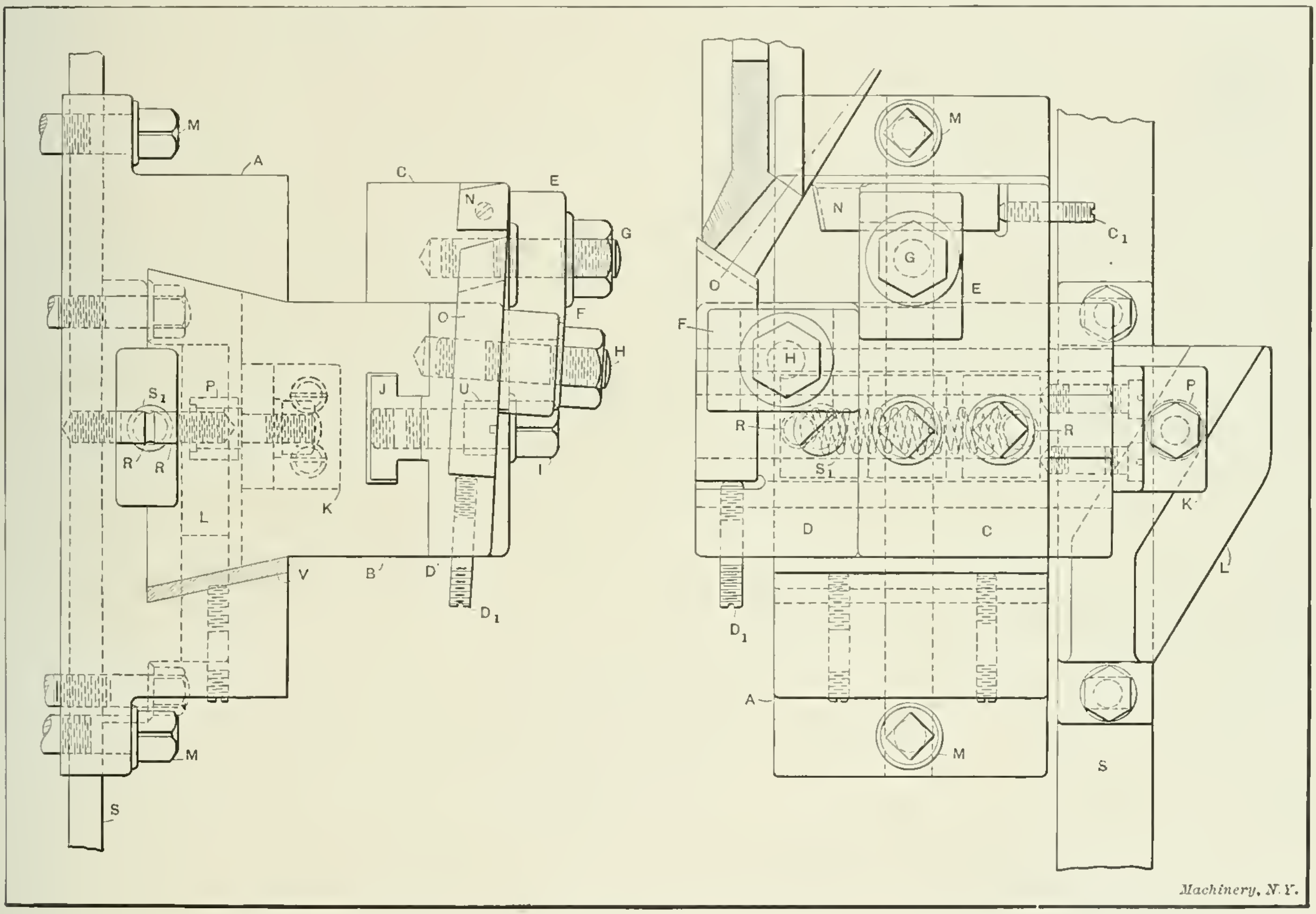
An attachment which can be used on any automatic turret lathe having a cross-slide is shown in the accompanying illustration. This attachment was used on a Gridley automatic turret lathe for machining the front and back face angles of bevel gears, and consists mainly of a base holding an adjustable member to which the turning tools are attached, this adjustable member being actuated by a guide.

The base *A* is fastened to the cross-slide by bolts *M*, while guide *L* is held to the cross-slide strap *S* as shown. The adjustable member or slide *B* is fitted in a dovetailed groove cut in the casting *A*, and is furnished with a gib *V*, to provide for wear. Attached to the sliding member *B* are two blocks. *C* and *D*, held to it by fillister-head screws *U* and T-nuts *J*. These blocks hold the turning tools, and are provided so that the tools can have a wider range of adjustment. The top face of the block *C* is milled out to hold the facing tool *N*, which is held with a clamp *E*, studs *H*, and nuts *G*. An adjusting screw C_1 tapped into the block is used for adjusting the tool. The back facing tool *O* is set in a milled seat in the block *D*, and is held with a clamp *F*, studs *H*, and nuts *G*, being adjusted by screw D_1. A bracket *K* attached to the slide *B* by fillister screws, carries the roll *P*, which slides in the groove cut in the guide *L*. The tools are kept in contact with the work by means of a spiral spring S_1, attached to studs *R*, one of which is screwed into the movable slide *B*, while the other is screwed into the base. These studs are provided with grooves, as shown, in which the rings on the end of the spring fit.

In operation, as the cross-slide travels forward, the roll *P* moves in the guide *L*, thus drawing out the slide *B*. This guide is provided with the same angle as the angle required on the face of the gear, so that as the cross-slide travels in, the front face is machined to the correct angle by means of the cutter *N*. As soon as the front face is finished, the cutter *O* comes in contact with the back face of the gear, and finishes it; then as the cross-slide retreats, the slide *B* is returned to its former position by means of the spring S_1 and guide *L*. The turning tools *N* and *O* are made from Novo Superior tool steel, which has been found to give very satisfactory results for machining cast iron and steel. The tool *O* has to be ground to the angle required on the back face of the gear, while the tool *N* is only ground to provide for clearance. This attachment can be used for turning other face angles simply by changing the guide *L*, and the angle on the cutter *O*.

HAROLD E. MURPHEY

Westerly, R. I.



Attachment for Machining Front and Back Faces of Bevel Gears in an Automatic Turret Lathe

ECCENTRIC TURNING DEVICE FOR AUTOMATIC SCREW MACHINE

The writer has seen several articles in MACHINERY concerning work done on the automatic screw machines, and contributes the following article with the hope that it will be of interest to the readers. The eccentric turning attachment shown in Fig. 2 was made for a No. 1 Hartford automatic screw machine. The piece for which this attachment was made is shown in Fig. 1, and is called a "spooler gear stud." It is used to adjust the spooler gear to the worm on the end of the spooler spindle of a Davis sewing machine. The threaded body of this spooler gear stud is 0.025 inch eccentric with the rest of the piece and it is entirely completed in the turning attachment shown in Fig. 2.

The turning attachment comprises a special spindle *A*, practically the same as the regular machine spindle with the exception that the front end is turned 1/8 inch eccentric with the bearings and is made to hold a special hood *B*. A 3/16-inch groove is cut in the nose of the spindle and also in the hood in which a chain of 3/16-inch balls is placed, a hole being drilled through the side of the hood for the insertion of these balls, which act as a friction lock between the spindle and hood, allowing the latter to turn freely when necessary. A depression is cut in spindle *A* for the key *C* so that the latter acts as a stop to prevent the hood from turning completely around on the spindle, the hood having an annular groove cut in it which allows an angular movement of the hood of about 20 degrees. When the key *C* is against one end of the slot in the hood, the chuck *E* is in the eccentric position, and when it is against the other end of the slot, the chuck is in the concentric position. The hood *B* is made a good fit on the end of the spindle, both the hood and the spindle being hardened, ground and lapped to size.

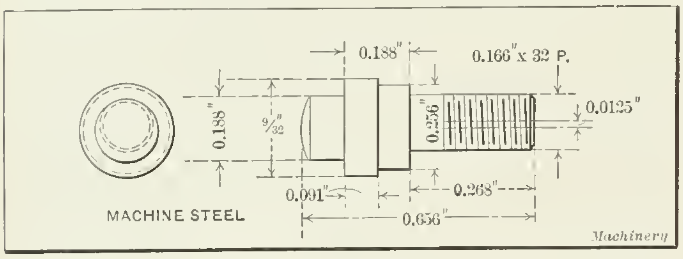


Fig. 1. The "Spooler Gear Stud" made with the Attachment shown in Fig. 2

The hood *B* is bored and tapped to receive a bushing *D*, which holds the chuck *E* in position. The hole in the bushing *D* is bored concentric with the bearings of the spindle *A*, making it possible to use an ordinary spring collet. The rear end of the bushing *D* is slotted to fit a projection on the chuck *E*, so that the latter will be held in the same position in relation to the hood at all times. An ordinary ball bearing *F* is used between the chucking rod and the chuck *E*, to give an easy movement when shifting from the concentric to the eccentric position.

A bracket *G*, fitted to the front side of the spindle head, holds two swiveling fingers *H*. The swiveling fingers are fitted with steel pads *I*, so that when they are drawn together on the steel ring *J*, which is fitted to the hood *B*, they act as a friction grip for shifting the hood from the eccentric to the concentric position. The rear ends of the fingers *H* are beveled to fit the cone-pointed adjusting screw *K*, which is fitted into a block *L* held on the front cross-slide, this block *L* being operated by cams on the front cross-slide disk. The cone-pointed screw *K* is used to adjust the tension of the steel pads *I* on the steel ring *J*, and when the proper tension is obtained it is locked by nut *N*.

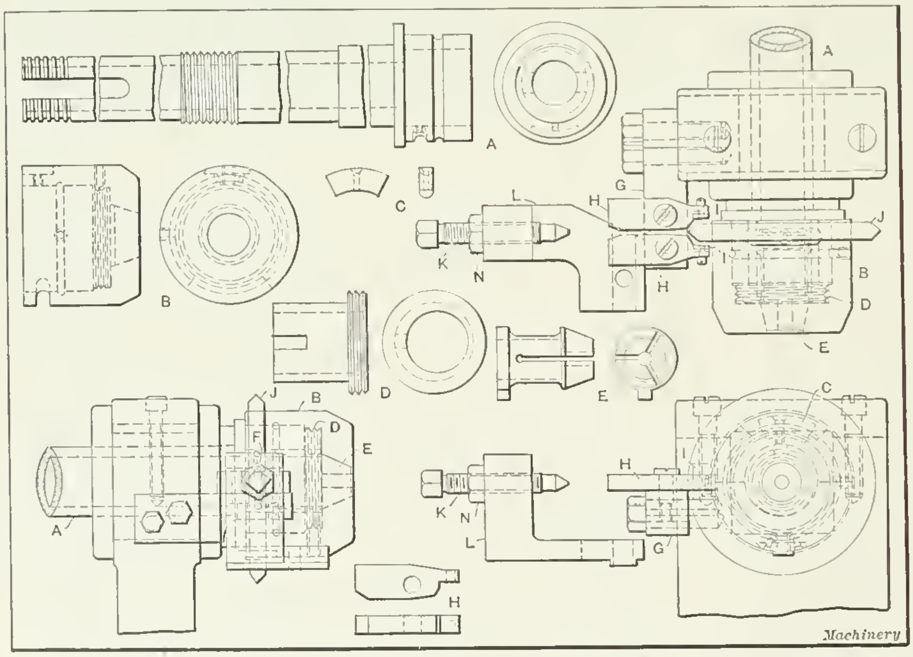


Fig. 2. Assembly and Detail Views of Eccentric Turning Device for Hartford Automatic Screw Machine

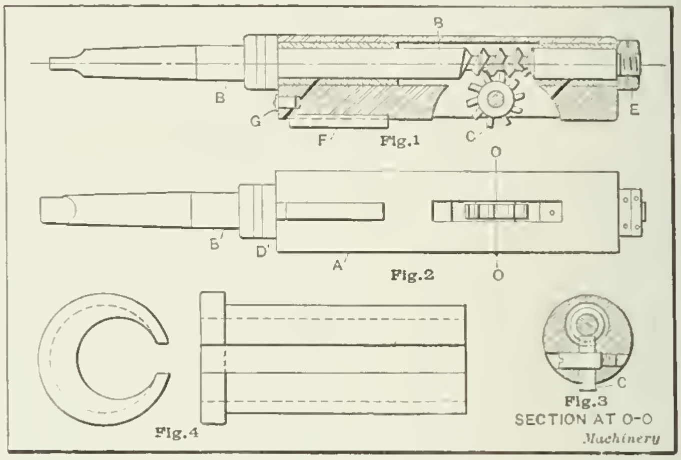
The order of operations for completing the piece shown in Fig. 1, is as follows: First, feed stock out to stop and shift hood *B* from eccentric to concentric position, while the machine is "unchucked"; second, form with form tool on rear cross-slide with spindle running backwards, cutting off preceding piece and forming new piece; third, finish shoulders to size and length with box-tools; fourth, bring pads *I* in contact with ring *J* on the hood *B* with spindle running forward, and force hood *B* to the eccentric side of the key *C* (Special cams on the rear cross-slide drum partly "unchuck" the machine, so that the hood *B* will move easily on the spindle to its position against the key, care being taken to have sufficient tension to hold the work in position. Another cam placed on the rear drum shifts the chuck until it is under its original tension); fifth, rough-mill forward and true up eccentric threaded body; sixth, finish-mill threaded body to size and true up shoulder; and seventh, thread.

This attachment has been in constant use for over three years, and has been turning out an average of 700 pieces per day without any trouble. Michael T. Byrne

Dayton, Ohio.

TOOL FOR CUTTING LONG INTERNAL KEYWAYS

The accompanying illustration shows a tool made in our shop for cutting long internal keyways, which has given satisfactory results. The tool consists of a machine-steel body *A*, bored out and bushed to receive the spindle *B*. A recess is cut in one side of the body as shown in Figs. 1 and 2, to receive the cutter *C*. The spindle *B* is made with a coarse-pitch thread of the proper size to engage with and drive cutter *C*. The upper end of the spindle is turned to fit a standard drill press socket, although, of course, this may be varied to suit requirements. The cutter *C* is made by cutting the blank with a small gear-cutter and grinding one side of the teeth to the proper shape. Suitable pressure collars are provided at *D* and adjusting nuts at *E*. A guide key *F* is staked in place to insure the tool cutting a straight keyway. Suitable means for oiling the spindle and cutter are provided, as shown in Fig. 1, a handy oiler being placed at *G*, and oil holes in other places.



Figs. 1 to 3. Tool for Cutting Long Internal Keyways. Fig. 4. Slip Bushing for Use when the Hole in the Work is Larger than the Body of the Tool

In operation, the tool is used in an upright drill press and feeds into the work as in drilling. The body, of course, must be a neat fit for the hole in which the keyway is to be cut, to insure good work. When cutting keyways in a hole larger in size than the body, the bushing shown in Fig. 4 is used. This bushing is bored eccentric and has a shoulder for convenience in holding. When the tool is running hard, and shows a tendency to twist, a clamp may be put on near the top of the device until the guide key has passed into the cut portion of the new keyway.

Hamilton, Ohio. J. B. Haskell

CONVENIENCES FOR THE DRAFTING TABLE

Frequently the application of an inexpensive improvement or appliance to one's work will result in a saving of time and expense. No doubt every draftsman has experienced the inconvenience of lettering near the bottom of a large drawing which covers the entire drawing-board, without some means of supporting his elbow. Fig. 1 shows a drop leaf or wing, about 10 inches wide by 13 inches long, which is attached to the drawing-table, and provides a rest for the arm. When not in use it can be folded beneath the table out of the way, as shown by the dotted lines. This device has the further advantage of being adjustable to any position along the lower edge of the drawing-board, as it is made to slide on a rod *C*, thus allowing it to be placed in any convenient position.

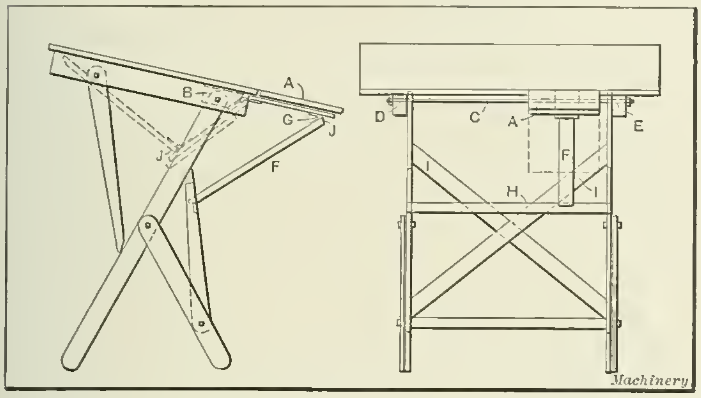


Fig. 1. Drafting Table provided with an Elbow Rest

The wing *A* is hinged to a block *B*, which slides on the rod *C*, the latter being made from cold-rolled steel and threaded on both ends, on which nuts are screwed. This rod takes the place of the bolts which were originally provided at *D* and *E* for holding the table together. A leg *F* hinged at *G* rests on the cross bar *H* and supports the outer end of the wing. When folded beneath the table, the wing is moved over near the side and allowed to rest on the braces *I* which hold it in place. The end *J* of the leg *F* is so trimmed that when the wing is folded, the opposite end of the leg will not project past the drawing-board and interfere with anyone passing. This wing *A* also serves the further purpose of providing a place to rest the points of the beam compass or other instruments when drawing large curves or circles, the centers of which would not come on the drawing-board.

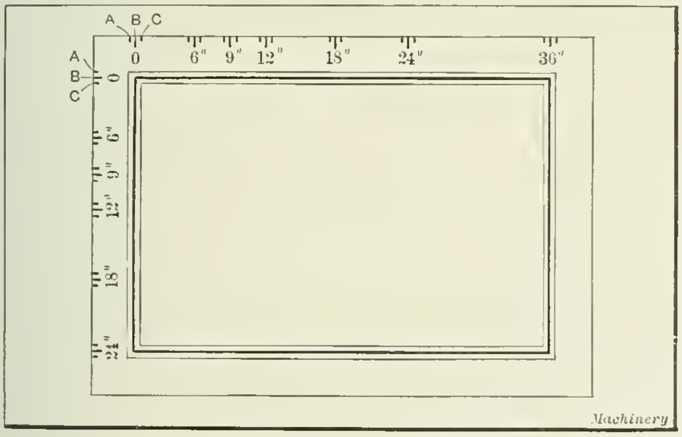


Fig. 2. A "Graduated" Drawing Board

Fig. 2 is a top view of what might be called a "graduated" drawing-board, the graduations being used to indicate the dimensions of standard drawings. Each graduation *A*, *B* and *C*, consists of heavy lines, of which *B* is longer than the other two. The graduation *A* indicates the trimming line of the sheet, *B* the border line, and *C* the drawing line of the limit for the drawing proper.

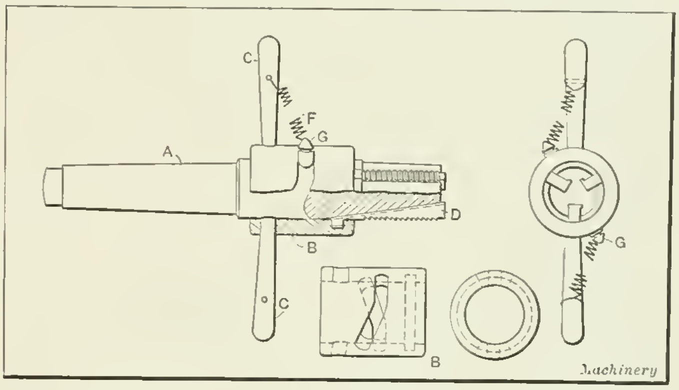
In use, the sheet is tacked to the drawing-board, and the border lines drawn, after which the trimming line and the inside or drawing lines are drawn in lightly with pencil so that they can be erased. The drawing lines *C* are simply to serve as a guide for keeping the drawing the proper distance away from the border line. The board shown in Fig. 2 is laid out for drawings from 6 by 9 to 24 by 36 inches. Of course, it is needless to say that any set of standard dimensions may be laid out as required. The advantage of this method lies in the fact that it does not necessitate measuring a drawing to see that it is of the correct size.

Aurora, Ill. E. J. G. PHILLIPS

A COLLAPSING TAP

The accompanying illustration shows a collapsing tap designed and furnished by a tap and die concern for the purpose of tapping a 1-inch Briggs standard pipe thread in cast iron, using a semi-automatic machine. The tap was designed to collapse on account of the desirability of withdrawing it without running out, thus decreasing the wear on the tap and increasing the production.

Referring to the illustration, *A* is the taper shank holder; *B*, the cam sleeve; *C*, the handle used as the knock-off; *D*, the blades of the tap; and *G*, a stud fastened to the taper shank holder, to which the spring *F* is fastened at one end, the other end being fastened to the handle *C*.



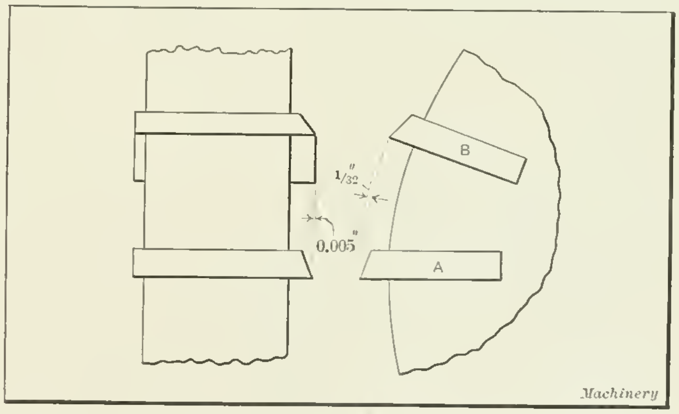
An Efficient Collapsing Tap

In operation, the handle *C* is held by the spring *F*, so that the blades *D* are drawn up on the taper and expanded to the correct size. The tap in action feeds in until the handle *C* strikes the stop, advancing the cam sleeve *B* through the action of the cam slot on the stud *G*, thus throwing the blades forward on the taper and collapsing the tap.

Hartford, Conn. F. CHARLES SCRIBNER

FACE MILLING CUTTERS FOR FINISHING

It is almost impossible to obtain a good finish when milling a rough surface with a face mill, without taking an extra finishing cut. This is not always permissible, because of the time consumed in re-handling the work. The roughness is the result of the cutting edges of the blades being nicked and burred, because of the comparatively heavy service required of them in removing the stock.



Method of Grinding the Blades of Face Mills to produce a Smooth Finish

It occurred to the writer that if some of the blades could be used only to take a light cut in clean iron, the difficulty would be largely overcome. This was accomplished by grinding the mill as shown in the accompanying illustration. Blade *A* is used for roughing. It projects 1/32 inch farther from the body of the mill than the finishing blade *B*, directly behind it, while at the same time it does not take as deep a cut as blade *B* by 0.005 inch. Every alternate blade is ground the same as *A*, and the remainder of the blades are ground like *B*.

It is evident that the scale and most of the stock will be removed by the roughing blades, while the finishing blades only take a light cut 0.005 inch deep, and hence keep a smooth edge and produce a good finish. This method of sharpening face mills does not take much longer than grinding the blades all the same, but it materially increases the number of pieces which can be milled before re-sharpening. R. W.

TOOLS FOR A TYPEWRITER FEED-FINGER

The front feed-finger of a Fay Sholes typewriter, shown a *A* and *B* in Fig. 1, is a piece of work which requires great accuracy in the tools, so much so that the methods of manufacturing it should be of interest. The blank as shown at *A*, was cut out by the punch and die shown in Fig. 2. This die is made sectional, that is, it is made of two pieces *A* of hardened tool steel, which are inserted in machine steel die-block *B*. This form of die construction permits of great economy in working out the shape, as the greater part of the stock can be removed with a milling cutter.

The stop in this die is of improved construction and varies from the finger stops usually made, which have a tapered hole reamed in them and swing on a pin let in from the side of the die. The tapered hole in the finger allows only for a small bearing on the pin, and the up, down and sidewise movement of the stop results in wear which soon destroys its accuracy as a locating point. The stop *C*, shown in Fig. 2, bears on a pin *D* which gives a bearing the full width of the stop. The pin *D* is held in a slotted disk *E*, which is located in a hole in the stripper, and is prevented from coming out by two round-head screws *F*, the heads of which overlap the disk. The disk *E* is made a turning fit in the hole and a good bearing is thus obtained.

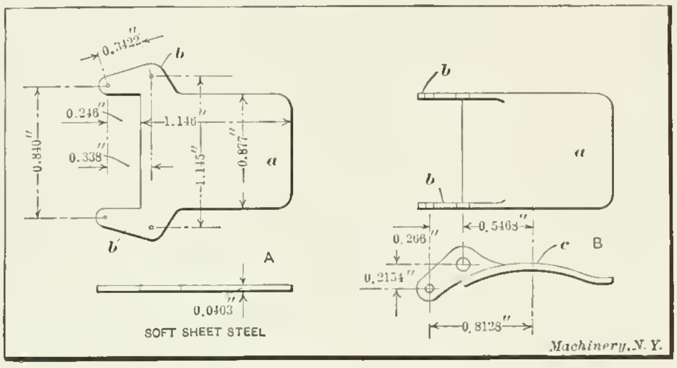


Fig. 1. Front Feed-finger for the Fay Sholes Typewriter, before and after Bending and Piercing

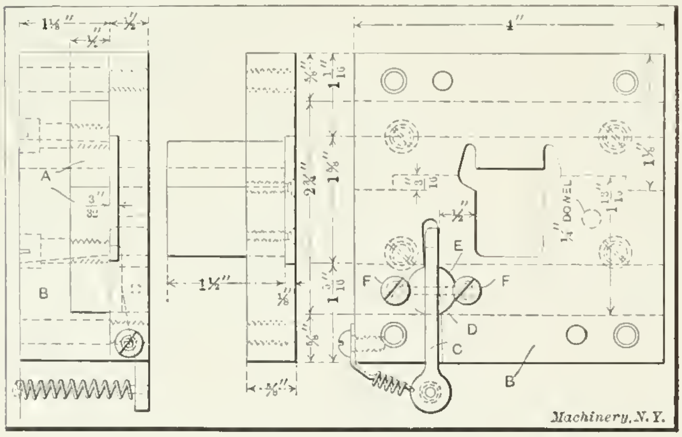


Fig. 2. Blanking Punch and Die

The punch and die for bending the typewriter feed-finger into the shape shown at *B*, Fig. 1, is shown in Fig. 3. The piece to be bent is located by the set edges *A* and rests on the pad *B*, the latter being shown in its "down" position. The part *a* of the spring, Fig. 1, is formed, and the ears *b* are bent at right angles, as shown at *B*, in this die. The pad *B* (Fig. 3) is raised by a spring-pressure device, and the piece is thus lifted out of the die after being bent. The punch *C* is cut away to allow the ears to lap beside it, as shown at *D* in the illustration.

As the location of the two pierced holes in the ears, shown at *B* in Fig. 1, required to be accurate in relation to the surface *c*, it was found impracticable to pierce them before bending, and on account of the shape of the work a rather elaborate locating device is used in the piercing die shown in Fig. 4. A swinging hinge *A* which turns on the pin *B* is used as a locating nest for holding the work while the holes are being pierced. The work is located between the gage-plates *C*, and one end bears against the stop-pin *D*, while the other end is held by the snap-catch *E*. The hinge *A* is closed against the die and the snap-catch *F* holds it in position. The two ears on the work fit into slots *G* cut in the die. The holes in the top ear are pierced by the punches *H* and the slugs from these holes precede the punches through the lower ear. This may appear to some as a rather unusual proceeding, but the method has been used with success in the Fay Sholes factory on different pieces requiring exact alignment between the holes; it has also proved superior to drilling for this purpose. When the piercing operation is completed the die is cleared by releasing the snap-catch *F*, when the swinging hinge *A* flies back owing to the tension of the spring *I*. The piece is then removed by releasing the small snap-catch *E*. Designer

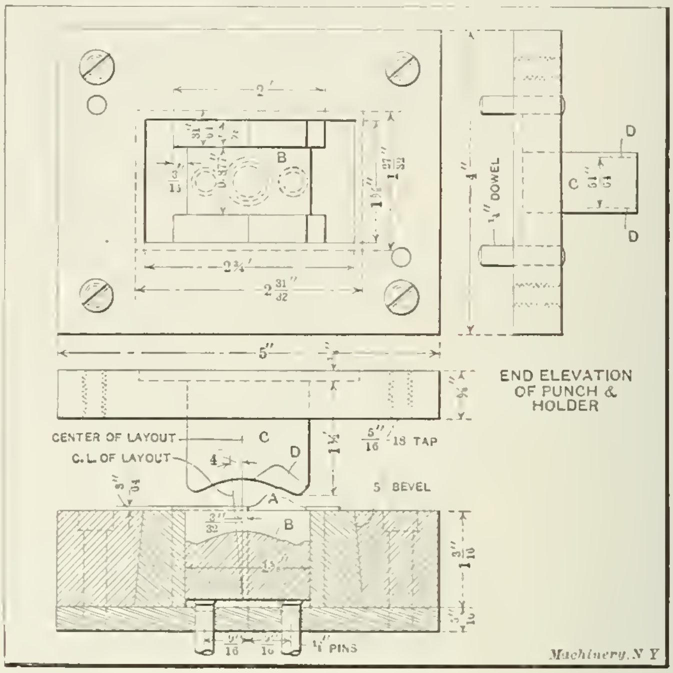


Fig. 3. Bending Punch and Die

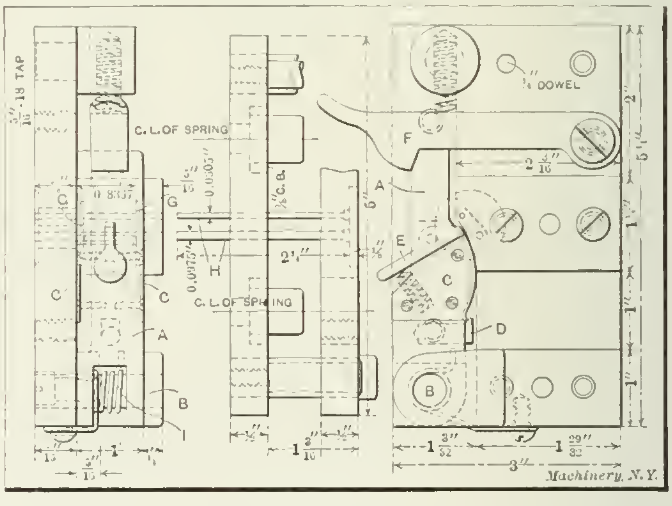
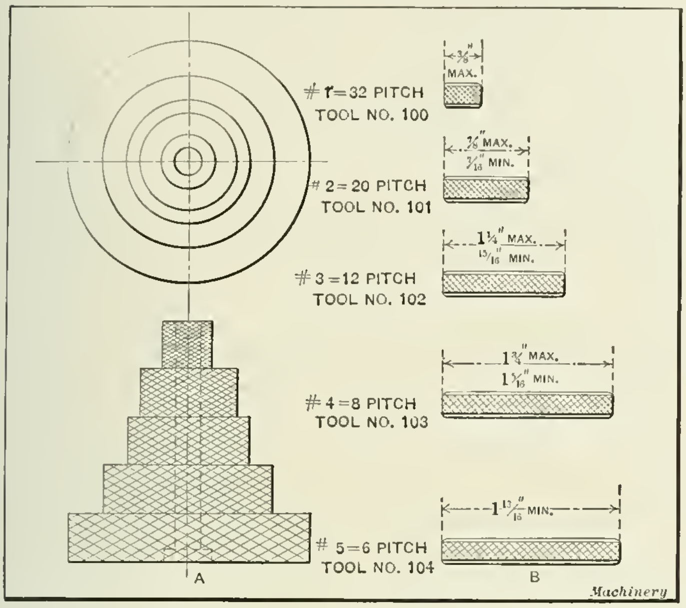


Fig. 4. Piercing Punch and Die, which embodies an Interesting Locating Device

KNURLING STANDARDS

Trouble is frequently experienced in factories where knurling operations are performed from having the wrong pitch of knurling applied to a given diameter of work. This trouble was overcome in one large factory by furnishing the heads of each department as well as the designers and draftsmen, with a blueprint upon which were designated the maximum and minimum diameters for which each pitch of knurling was applicable, giving the pitch of the knurling a number, and specifying the tool number of the knurls to be used.



Knurling Standards furnished to the Heads of the Various Departments, and Knurled Paper Weight given to Designers

On prints of manufacturing parts issued from the drawing-room, were specified the number denoting the pitch of the knurling required and the tool number of the knurls used to produce it. The standards furnished to the heads of the various departments are shown at *B* in the accompanying illustration and a paper-weight, which is given to each designer, is shown at *A*. This shows each step knurled, and the maximum diameter for that pitch of knurl.

Hartford, Conn. F. Charles Scribner

PRICES OF JOB WORK DONE ON MACHINE TOOLS

The article "Prices of Job Work Performed on Machine Tools," which appeared in the October, 1911, number of Machinery, engineering edition, opens up a subject which merits considerable discussion. In this article various hourly rates for work done on machine tools are quoted, varying from $0.20 to $1.50. Although not so stated, the writer assumes that, with a possible exception of the items given for the Rockford shops, the direct labor or time of the operator is included. A study of the various factors that enter into the question of maintaining and operating a machine tool will, the writer believes, lead to the conclusion that a more just and equitable rate for the machines involved should be devised, than the absurd flat percentage rate based on the direct labor so customary throughout the country.

To illustrate this the writer will outline the foundation of a machine rate based on his views. The ideas are not submitted with the opinion that they give a complete basis for the charge for machine tools, but rather with a hope that a discussion will be started on machine tool rates in general which will add useful information on this subject.

The machine rate is composed of two principal parts, the cost of the floor space that the machine occupies, and the cost of tools, supplies, power, etc., consumed by the machine. The first we will, for convenience, call building items, and the latter, machine items. All the factors entering into these items should be computed on an annual basis, which will make it comparatively easy to compute the hourly charge for each machine.

The building items should consist of the following factors:

1. Land, consisting of interest on the capital invested therein, the taxes, care of grounds, etc.
2. Buildings, consisting of interest on the capital invested, taxes, insurance, annual depreciation, care, watchmen, repairs, etc. In the case of a rented shop the foregoing items would be covered by the annual rent.
3. Fixtures, consisting of the interest on the capital invested in shafting, belting, motors, power plant, etc., and the depreciation, repairs, supplies and labor incident thereto.
4. Heat, being the interest on the capital invested in the plant, radiators, etc., and the depreciation, repairs, coal consumed and the necessary labor employed.
5. Light, consisting of the interest on the capital invested in dynamos, wiring, lamps, etc., and the depreciation, repairs, supplies, and labor employed.

In many shops the factors of power, heat and light are so closely interwoven that it is not practical to try to segregate them, and in this case they can generally be combined under one head without in any way departing from the principle involved.

The machine items should consist of the factors of interest and depreciation, repairs, stores, tools, superintendence, inspection, planning, and power consumed by the machine in question. To properly apportion these several expenditures over the machines concerned, the building items should be considered as a function of the floor space occupied by the machine. It is evident that there will be floor space in the shop that cannot be equitably charged against any individual machine—such as offices, aisles, stock rooms, etc. That occupied by a toolroom, inspection department and planning room, if any, should properly be charged under those respective heads, independent of the machine, as it is evident that these items might have no relation whatever to the space occupied by the machine. For instance, take the case of a large boring mill occupying 200 square feet of floor space and of a No. 3 horizontal milling machine occupying 75 square feet. It is evident from even a casual inspection that the milling machine will require a larger expenditure for tools, and also for inspection, as it requires about as much time to inspect a small piece as it does a large one; and in the time required to do a large job on the boring mill, several small jobs or pieces will be completed on the milling machine.

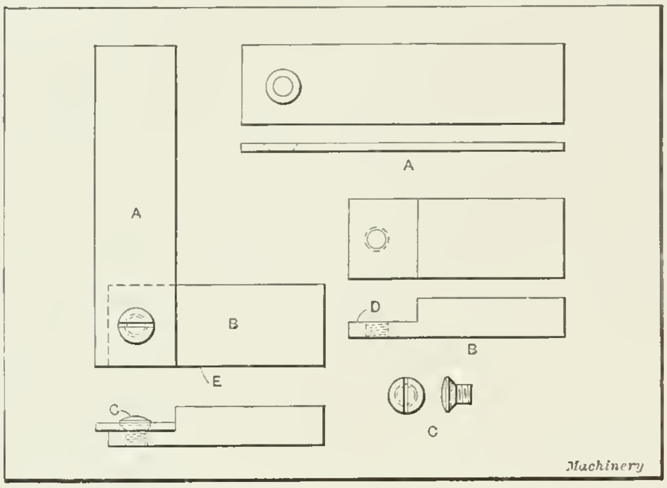
The space actually occupied by each machine should be measured and to it added sufficient space for the workman and the material being, and to be, worked on. To the sum total of the spaces thus used should be added the space occupied by the toolroom, inspection department and planning room, and the amount thus obtained should be taken as the total area of the shop instead of the area that would be obtained by computation from the actual dimensions of the shop. In this way the unoccupied space is spread uniformly over all the machines. The total of the building items divided by the computed area will give the annual cost per square foot of the shop space, and the cost thus obtained per square foot of floor space times the space occupied by any particular machine would be the proper charge per hour for that machine, exclusive of the direct labor. T. Covey

MAKING A HARDENED TRY-SQUARE

In the January, 1911, number of Machinery appeared a request for information regarding the making of accurate hardened try-squares, and in the March and April numbers, two articles were published describing the making and the means of testing such squares.

Another type of try-square which has been found reliable, is easily made, and possesses the advantage that it can be taken apart and trued up, is shown in the accompanying illustration, assembled and in detail. The hole in the blade *A* is drilled and countersunk slightly larger than the body of the screw *C*, and the position of this hole is off center, so that the head of the screw bears against one side of the countersunk hole, drawing the blade firmly against the stock *B*, The stock and blade are machined somewhere near the required size, the hole drilled and tapped in the stock, and drilled and countersunk in the blade. The blade and stock are then hardened as is also the screw *C*. The length of time for which the blade and the stock are allowed to season will govern the reliability of the square to a large extent.

After seasoning, the stock is ground square and parallel, care being taken to make the shoulder and face *D* as true as possible, using a square-cornered saucer wheel. The shoulder and face *D* are finished by lapping to get a true and dead smooth surface. The method of lapping and testing a try-square was described in the articles previously referred to. The blade is now ground square and exactly parallel, and finished by lapping. The stock and blade are then fastened together, and the outside edge of the blade and also the sides of it are tested for accuracy. The bottom face *E* of the stock is then ground and lapped dead parallel with the side.



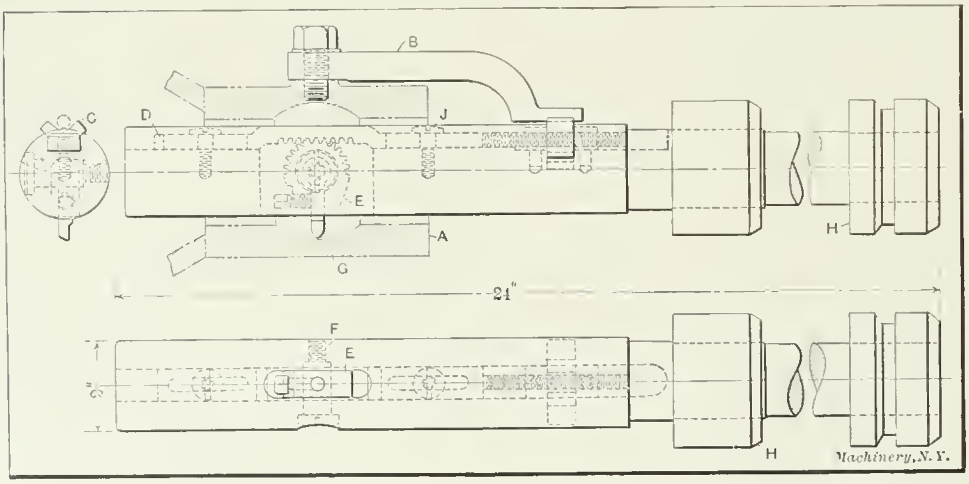
A Hardened Try-square which can be easily and cheaply made

If care has been taken in making the blade and stock, it will be found to be accurate when assembled. The sides of the blade will also be square with the stock, which is a feature usually absent in the ordinary square, when the blade is sweated in. A square of this description, if correctly made, is practically a knife-edge square, as both edges and sides of the blade are square with the stock, so that the corners of the blade can be used. If a knife-edge square is desired, it can be easily made in the same way. For ordinary machinists' use, this type of square can be finished on the surface grinder, producing a good hardened square at a much lower price than that at which they can be purchased.

Jethart

A SPHERICAL BORING-BAR

The accompanying illustration shows a boring-bar which was designed for boring a spherical recess 3 inches in diameter inside a cylindrical hole 2⅛ inches in diameter. The spherical recess had to be bored a given distance from the top face down in the cylindrical hole of the casting *A*. Casting *A* is held in a special fixture on a small vertical boring-mill table. After boring and facing the cylindrical hole in the usual manner, the boring-bar is inserted in the boring-mill head, and the arm *B* made fast to casting *A* by one cap-screw, placed in a tapped hole which was already in the casting.



A Spherical Boring-bar for Use in the Boring Machine

In operation, as the casting *A* is fastened to the boring-mill table, it revolves about the bar carrying the arm *B*, which engages with a star-wheel *C*, causing the latter to revolve one-quarter of a turn for every revolution of the casting. The star-wheel *C* fits snugly in a slot, and has a tapped hole in it. Fitting in the tapped hole in the star-wheel is the threaded end of the rack *D*. Since the star-wheel *C* is confined, as to side play, and the arm causes it to revolve, the result is the movement of the rack in a direction parallel with the center line of the bar. Rack *D* engages with tool-holder *E* on which are cut teeth of corresponding pitch.

This longitudinal motion of the rack causes tool-holder *E* to revolve on the central pin or shaft *F*, carrying with it the tool *G*. Tool-holder *E* is a snug fit in a slot in the bar, and also a running fit on the central shaft *F*. It is, therefore, obvious that these combinations of motion give a spherical recess. The rings *H* were shrunk on the bar, and are a snug fit in the boring-mill head. This was simply to keep the bar as light as possible. The screws *J* are to keep the rack *D* from rising out of the slot in which it slides. This is a rather unusual tool, but the principles involved may assist in the designing of a similar tool for a different purpose.

S. B. Rook

CUTTING AN ODD NUMBER OF CLUTCH TEETH

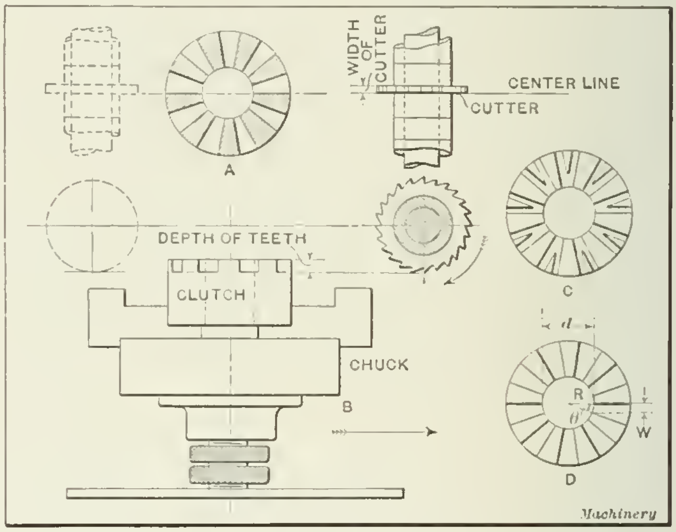


Diagram used in Setting Cutter to cut a Jaw Clutch having an Odd Number of Teeth

In a small shop where a variety of work came in, we at one time had to cut some jaw clutches. Both the milling machine hand and the foreman could not see why the draftsman called for an odd number of teeth. They had cut an even number of teeth before the firm established an engineering department, and they could not see the advantage of cutting an odd number of teeth. However, they went ahead and cut an odd number of teeth, but spoiled the work by using too wide a cutter. To avoid future mistakes like this, the draftsman prepared a diagram as shown in the accompanying illustration. The instructions given for cutting an odd number of teeth are as follows: Set the cutter to the inside of the center as shown at *A*, or in other words, set the outside face of the cutter in line with the center of the work. Then index the number of teeth desired and cut around twice, which will leave the clutch as shown at *C*. All that is necessary now is to cut away the remaining webs between the teeth. The widths of the cutter to use for cutting any odd number of teeth are obtained by the following formulas:

$$W = 2R\frac{\sin\theta}{2} \qquad \theta = \frac{360}{2N}$$

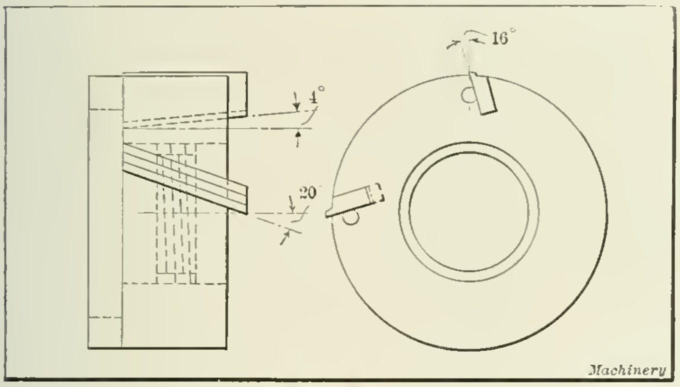
where

W = width of cutter,
R = radius of bore or $\frac{d}{2}$ (see D)
θ = included angle of tooth space,
N = number of teeth.

North Emporia, Va. George M. Meyncke

SETTING ANGLES FOR INSERTED-TOOTH HIGH-SPEED MILLING CUTTERS

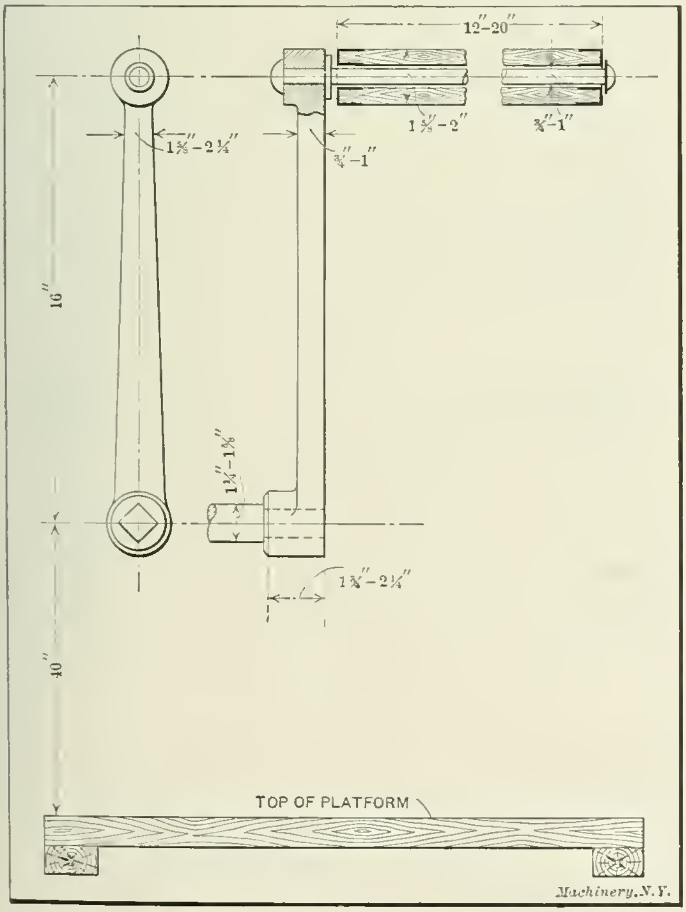
The accompanying illustration shows the angles at which the inserted teeth in high-speed milling cutters should be set to give good results. A cutter made as shown, 6 inches in diameter with 12 teeth and operated at 224 R. P. M., with a feed of 9¼ inches per minute, is doing excellent work, roughing and finishing forged copper in a vertical high-speed milling machine. Copper



Setting Angles for Inserted-tooth High-speed Milling Cutters for Heavy Duty

PROPORTIONS OF HAND-CRANKS

The accompanying illustration gives dimensions for hand-cranks as applied to hand-operated cranes, winches, etc. It will be seen that two sets of dimensions are given for the proportions, the larger dimensions being for cranks operated by two men, while the smaller are for cranks operated by one man. The distance from the shaft of the crank to the top of the platform on which the operator stands should be 40 inches as shown. The average force that one man can exert on a crank may be assumed to vary between 20 and 30 pounds. At intervals, as much as 40 pounds is a fair assumption. The circumferential speed varies usually from 20 to 40 inches per second. These values are based upon an 8-hour work-day. Cranks proportioned as shown have been used for a long time with entire satisfaction. F. J. B.

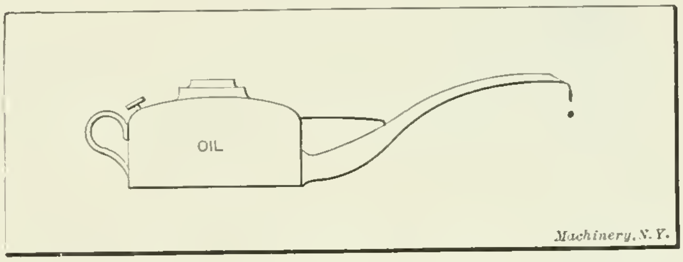


Proportions of Hand-cranks—Where Two Dimensions are given, the Larger is for Cranks operated by Two Men

FRICTION ELIMINATED

It was at one of the technical institutes in the north of England during the session just passed, that the head of the mechanical engineering department gave a two-hour lecture to a class of applied mechanics, students of the average age of eighteen, upon different devices, etc., for the reduction of friction. A few weeks afterward, the lecturer gave them for home work among other requirements the following: Sketch and describe fully any mechanical contrivance you know of for the elimination of friction.

This is the answer one of the students sent in: "The above sketch (see illustration) represents a contrivance which is made of tin, to hold a liquid called oil, the application of which is all that is necessary to make one part of a machine slide easily over another." A. Pierce



Friction Eliminating Device

PIERCING CAST IRON IN POWER PRESSES

The letter on piercing cast iron in power presses, which appeared in the September, 1911, number of Machinery, interested me very much, as we have been piercing cast iron for the past two years. The reason for piercing the holes was that the cast holes did not come accurate. The casting has a flange around it, but the part to be pierced is about 0.080 inch thick. Two holes are pierced about ½ inch apart, one of which is nearly square and the other round; the latter is about ⅝ inch from the edge of the casting. The castings are japanned before assembling.

We found that the shape and condition of the die did not make so much difference in regard to the cracking of the casting as did the shape of the punch. The dies used were perfectly flat on the top. If the punch is not backed off to within 1/64 inch of the cutting edge it will crack or break the casting nearly every time. The cutting edge of the die has been worn off and very few castings will crack or break as long as the punch is in good condition. The punches usually have to be ground three or four times to one grinding of the die.

The castings are usually good, but they vary; one batch will work fine and perhaps the next batch will cause all sorts of trouble. For instance, not long ago we ran through a batch which to all appearances was perfect; no crack was to be seen and they rang clear, but when taken out of the japanning oven every one showed a crack extending from the round hole to the edge of the casting. The piercing must have caused a slight strain, which was not sufficient to crack the castings until they were heated in the oven, for we found that by holding a casting over a blow-pipe, it would snap at a certain temperature. We are satisfied with the results, however, and hope this information may be of value to others. J. M. L.

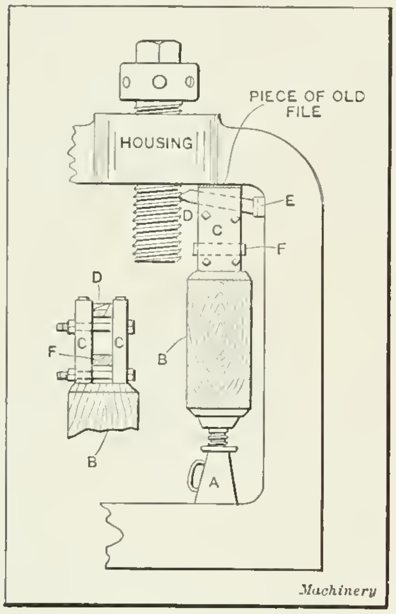
SHOP KINKS

PRACTICAL IDEAS FOR THE SHOP AND DRAFTING-ROOM

Contributions of kinks, devices and methods of doing work are solicited for this department. Write on one side of the paper only and draw sketches on separate sheets.

REDUCING THE UPSET ENDS OF ROLLER HOUSING SCREWS

We wanted to use, for another purpose, a pair of old roller housings that had seen years of hard service, and in which the adjusting screws had become rusted and upset on the ends. It was impossible to remove the screws without first reducing the enlarged ends, so that they would pass through the threaded holes in the housings. This was accomplished in the following manner:



A device was used, as shown in the accompanying illustration, consisting of a screw jack *A*, one 8-inch square hardwood block *B*, two cast-iron plates *C*, turning tool *D* and adjusting wedge *E*. The cast-iron plates *C* can be made either from a special pattern having the bolt slots cast in them or from stock pieces on hand in the shop. The iron wedge *E* is used for feeding and locking the tool and preventing it from chattering, while the two plates *C* are separated by a block *F*, the same width as the turning tool.

The tool *D* is set as shown in the illustration, and the adjusting screw is rotated by means of the regular wrench. In this way the enlarged end is reduced so that it will pass through the housing. The adjusting screws are 6½ inches in diameter with 4 threads per inch, thus requiring a rigid toolholder.

J. H. M.

FITTING A PULLEY QUICKLY BY FILING

To file a pulley quickly and have it run true when the hole is only a few thousandths small and when the pulley is held in place by a feather and set-screws, file only the upper half of the hole, *i. e.*, the half in which the keyway is cut. This does not require care, as removing 0.010 inch too much will not affect the truth of the pulley when tightened up.

Erie, Pa. A. N. Hammond

IMPROVED CALIPER GAGE

Every machinist and toolmaker has undoubtedly experienced some trouble in gaging parallel surfaces with a caliper gage, especially at the moment when the work is about to enter the jaws of the gage. If the gage is held so that the jaws are slightly inclined to the surfaces to be gaged, the piece will not enter the gage even if it should be several thousandths of an inch under size. This condition is indicated in Fig. 1.

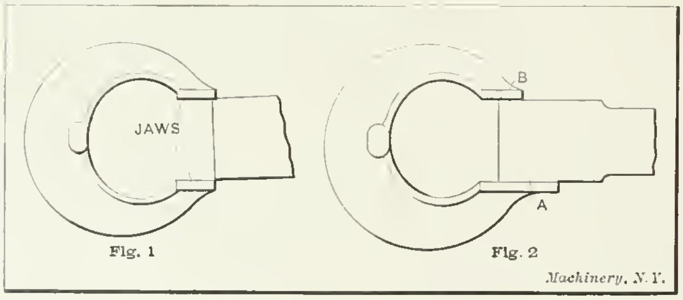


Fig. 1 Fig. 2

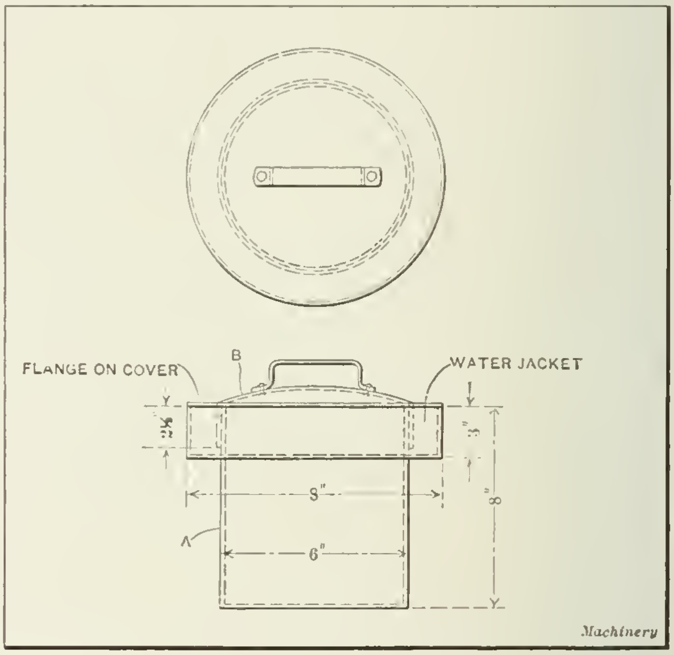
In Fig. 2 is shown a caliper gage which eliminates this difficulty and allows the gaging to be done quickly and accurately. When this gage is used, the long jaw *A* is held against one of the sides of the piece to be gaged and moved along it until the piece enters completely between the jaws, provided it is of the correct size or under size. If the piece is above the correct size it will be brought to a stop against the gage as soon as the short jaw *B* is reached.

Benjamin Brownstein

A GASOLINE CAN FOR THE SHOP

Gasoline in the machine shop is almost an absolute necessity for washing the oil and chips out of taps, dies and similar tools. In many factories, however, its use is prohibited not only because of the danger of fire, but also on account of the cost of the gasoline, which in a large factory amounts to a considerable sum in the course of a year. It is a well-known fact that 80 per cent of the gasoline that goes into the shop is lost by evaporation, it being allowed to stand around in buckets of various descriptions, some even without covers. It was to overcome this loss and afford better fire protection and incidentally to reduce fire insurance premiums, that the gasoline can shown in the accompanying illustration was made.

The body *A* is of the ordinary type, about 6 inches in diameter by 8 inches high, with straight sides. A water jacket is fastened to the outside of the body extending down about 3 inches from the top, and is made 2 inches larger in diameter than the body. The cover *B* is made to fit the body freely, and has a flange extending around the top edge to prevent dirt from getting into the water jacket, which is filled with water. This cover, when in position, forms a water seal through which no gas can escape.



To overcome the abuse to which such articles are subjected in the shop, each can was numbered and charged to the individual using it, according to the system in vogue. Once a week a boy empties, cleans, and refills the cans, and strains the dirty gasoline, and by so doing each man who requires gasoline always has a sufficient supply on hand, without leaving his work to procure it.

Lansing, Mich. E. H. Pratt

GAGING DIES

One shop in which I worked had a ring gage bearing the following inscription: "2¼-inch dies must go through this gage." I saw a man testing a lot of dies with it one day, and those that were a little large he drove through with a hammer. The gage said they *must* go through, so I suppose he was only following directions.

Mansfield, Mass. Lester P. Brown

NEW MACHINERY AND TOOLS

THE COMPLETE MONTHLY RECORD OF NEW DESIGNS AND IMPROVEMENTS
IN AMERICAN METAL-WORKING MACHINERY AND TOOLS

HAMILTON RELIEVING LATHE

The lathe shown in Fig. 1 has a relieving mechanism, which is built into and forms an integral part of the design, thus adapting the machine for all kinds of relieving operations, in addition to regular lathe work. Straight or taper taps and reamers and also straight or angular face mills up to 10 inches in diameter and with any number of teeth from two to sixteen, can be relieved. The lathe is not confined to outside relieving, but will also do inside work such as hollow mills, etc.

The relieving mechanism is driven from the back-gearing through change gears and a splined rod *A*, Fig. 2, which extends the full length of the bed, so that the lathe will handle work up to its maximum capacity between the centers. This shaft drives, through an intermediate gear, spur gear *B*, adjustably mounted on a slotted disk keyed to a bevel gear shaft; the latter drives cross-shaft *C*, which, in turn, operates cam *D*. This cam actuates the tool slide by imparting movement to cam link *E*, which bears against an adjustable block *F*. By means of this adjustable block, the throw is varied to suit the work, the position of the block being changed by turning screw *G*, which extends outside of the swivel. Any amount of relief from 1/32 to 5/16 inch can be obtained. Cam *D* is held against the link by a heavy spiral spring, the tension of which can be adjusted by turning a screw-driver screw. This spring insures positive action and eliminates looseness due to wear.

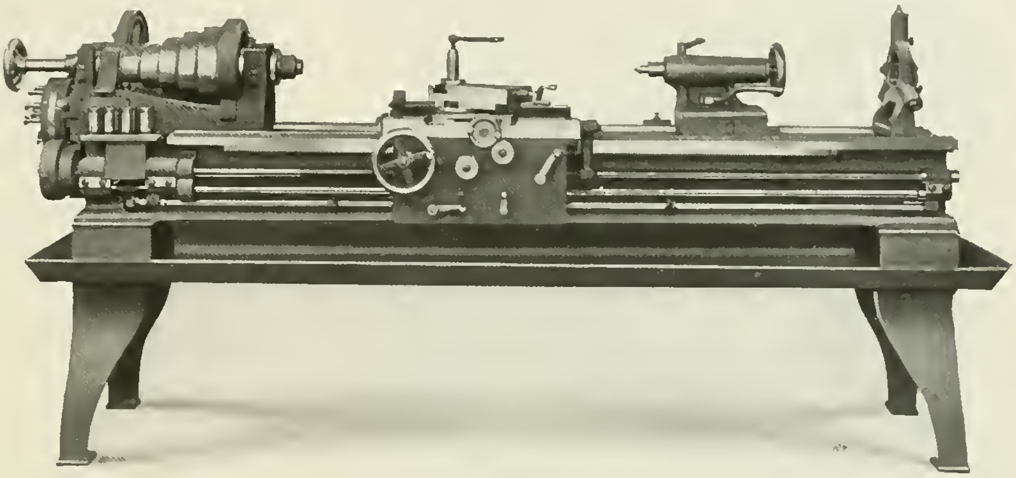


Fig. 1. Hamilton Lathe having Relieving Device incorporated in Design

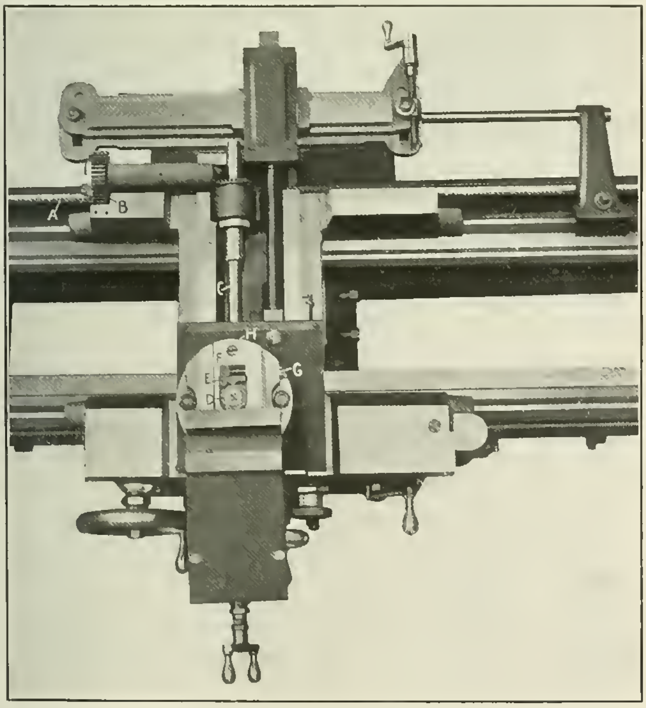


Fig. 2. Plan View of Carriage showing Relieving Mechanism

Gear *B* can be adjusted radially in order to set the work in such relation with the tool that the latter will "kick back" at the proper time. This adjustment is made by loosening two bolts, and it is a convenient feature, as the spindle can be turned by hand for adjusting the work, without changing the position of the cam. Three cams are furnished with each machine, one being double, one triple and one quadruple. These are sufficient for relieving sixteen numbers of teeth, varying from 2 to 16 inclusive. The cam is held in place by a screw and washer and can easily be changed by using a common screw-driver. When the lathe is not to be used for relieving, the short screw *H* should be removed and replaced by a longer screw which is supplied. This simple change converts the machine into a standard lathe.

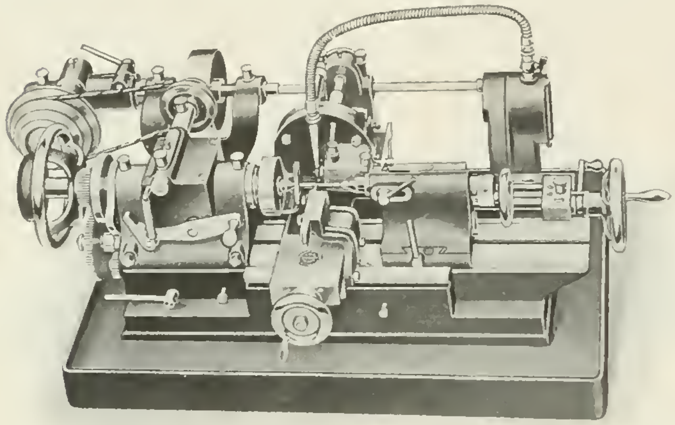
This relieving device is a development of the Hamilton Machine Tool Co., Hamilton, O. The regular 14- and 16-inch lathes built by this company are the only sizes being equipped with the relieving mechanism at present. These machines are furnished with or without taper attachments, and they are substantially constructed throughout. All shafts in the carriage run in hardened and ground bearings and are provided wih hardened and ground thrust washers. Both the cross-feed and compound-rest screws have double nuts for taking up wear, and the compound-rest base and swivel are equipped with taper gibs. A drawback collet attachment is furnished to take round stock up to 1 inch in diameter. The other features of this lathe are identical witn the standard Hamilton 14-inch cone-head pattern.

WALTHAM THREAD MILLING MACHINE

A thread milling machine for small precision work, made by the Waltham Machine Works, Waltham, Mass., was described in the department of New Machinery and Tools, December, 1910. An improved design of this machine is shown herewith. It is driven from a constant-speed shaft mounted in brackets attached to the rear of the machine. This shaft is connected, through worm-gearing, with another shaft mounted at right angles in a support or bracket at the left. This intermediate shaft connects by means of four-step cone-pulleys, with a worm shaft which drives a worm-wheel on the main spindle. These cone-pulleys are interchangeable and a total of sixteen speeds can be obtained by shifting the pulleys and belt. The support for the intermediate driving shaft can be adjusted longitudinally to facilitate shifting the belt or to secure the proper tension.

The right end of the constant-speed shaft is connected to a pump that supplies oil to the work-spindle through the flexible hose shown. This pump operates with the shaft running in either direction. The machine is mounted on a pan base of sufficient depth at the rear right-hand corner to hold a supply of oil. The oil, after it leaves the cutter, falls into a receptacle on the cross-slide from which a channel leads to the rear of the machine close to the oil reservoir. The pan base is inclined so as to return all surplus oil to the reservoir.

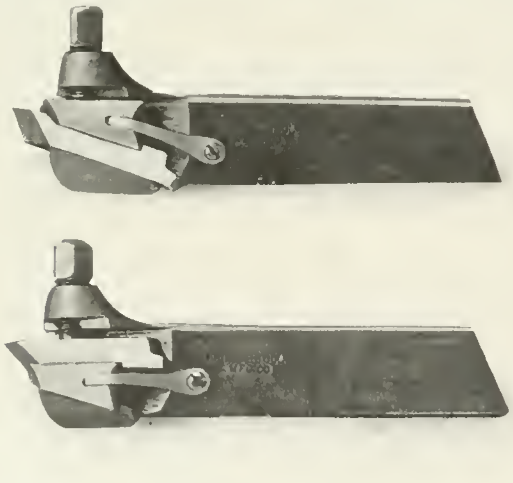
A clutch that is automatically released when the machine has reached the completion of the cut, is placed on the new machine directly on the work-spindle, and a large handwheel is provided on this spindle so that the carriage can be returned to the starting point by hand without disengaging the gearing. The gearing, however, can be disengaged, if desired, and the carriage returned by the handwheel on the right end of the lead-screw. The centers have been raised in the new model so that work three inches in diameter can be handled if the pitch of the thread is not too coarse. The bed has also been extended so that longer work can be held on centers, and the travel of the carriage is increased from 6 inches to 7¼ inches. Another size of this machine, which is 6 inches longer than the one illustrated, is also made. The tailstock has a cross-slide so that tapers too slight to be obtained by the taper attachment, can be cut, or the alignment of the centers can be rectified, if necessary.


Precision Thread Milling Machine, built by Waltham Machine Works

The compensating bar for varying the lead of the screw, is altered so that sufficient variation can be obtained to allow for shrinkage in hardening, etc. A pointer attached to the swiveling bar, reaches through to a graduated index on the front of the machine and shows the amount of increased lead that can be obtained. The bar can be swiveled by moving two thumb-screws at the front of the machine. The right-hand bearing of the lead-screw is threaded and this bearing can be rotated by a lever to change the location of the carriage in relation to the cut, thus making a fine adjustment for locating the cutter to work previously milled.

KRIEGER ADJUSTABLE TOOL-HOLDER

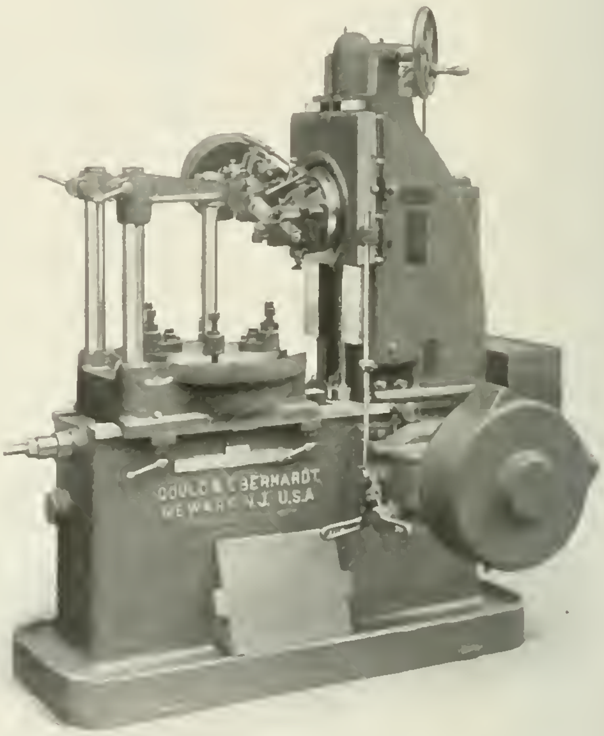
The Krieger Tool & Mfg. Co., 564-572 W. Randolph St., Chicago, Ill., has added to its line of tool-holders a type which permits the position of the cutter, in relation to the work, to be changed as required. The upper view in the accompanying illustration, shows the cutter in an angular or inclined position for turning iron and steel, and the lower view shows it set level for turning brass. As the illustration plainly indicates, these changes are effected by a tapered block, which, in one case, is placed above the tool and, in the other, beneath it. When the cutting tool is clamped in the holder in an inclined position, it is tilted sidewise, thus giving the top of the cutter side slope for turning iron or steel, and when it is set horizontally, as shown in the lower view, the top is level and in the proper position for thread cutting or turning brass, etc. The cutter is held firmly on all sides, regardless of its position.


Tool-holder arranged so that Cutter can be set in an Angular or Level Position

GOULD & EBERHARDT AUTOMATIC HOBBING MACHINE

Among the latest improvements embodied in the high-duty hobbing machines manufactured by Gould & Eberhardt, Newark, N. J., there is a single-pulley drive instead of the cone drive, ten changes of speed obtainable through gearing, and an automatic stop which disengages the entire mechanism of the machine when it has completed cutting a spur or helical gear.

The single driving pulley rotates at a constant speed and delivers the maximum power continuously. Previously it was necessary to reduce the speed of the cone-pulley when using hobs of large diameter, because the large hobs could not be run as fast as the smaller sizes. This reduction of the cone-pulley speed also decreased the driving power when it was most needed; that is, when using large hobs. The single-pulley drive, in conjunction with the speed-changing mechanism, also makes it unnecessary for the operator to shift the driving belt, which is always more or less dangerous.



Gould & Eberhardt High-duty Automatic Hobbing Machine for Spur and Helical Gears and Worm-wheels

As previously stated, there are ten changes of speed obtained by means of change gears, as against four changes with the cone-driven type. This range enables the operator to regulate the speed in accordance with the diameter of the hob or the quality of the metal being cut. When using small hobs, the speed of the machine can be increased, thus increasing the output without increasing the cut per tooth, as the feed per revolution of the blank remains constant. The speed is also governed by the kind of steel used in making the hobs.

The automatic stop mechanism enables the operator to set the cutter-slide trip-dog so that when the gear is finished, the entire mechanism of the machine will be stopped automatically with the exception of the driving pulley. This feature is especially valuable when cutting helical gears, as, heretofore, the operator has had to stop the machine by shifting the countershaft belt. This had to be watched closely to prevent the cutter slide from feeding down and jamming against the revolving table, but if the feed were disengaged before the hob had entirely cleared the gear, the hob would mill the teeth away, thus spoiling the work. With the present arrangement, if the feed is accidentally or otherwise disengaged before the gear is finished, the entire mechanism of the machine will be stopped and no damage done. This automatic arrangement makes the machine positively "fool-proof" at this point. It also enables the operator to feed up to a shoulder or line when cutting a helical or spur gear, and, as the cut is automatically stopped at the same point on every blank, there is the added advantage of making the work uniform. One man can also operate more machines having automatic stops, than is possible with the previous type.

A neat form of belt guard has been placed over the driving pulley, as shown. This guard can be adjusted to suit the angle of the belt and, if desired, it can be entirely removed without difficulty. All running gears of the machine are also enclosed with guards for the protection of the operator.

CINCINNATI SLOW-SPEED PLANER DRIVE

The planer illustrated in Figs. 1 and 2 is equipped with an electric variable-speed drive, having an additional slow speed arrangement for use when machining extremely hard castings, such as chilled rolls, etc. These slow speeds are also very useful when planing work of irregular shape or wide surfaces which are finished by a form tool requiring a comparatively slow speed.

The planer, which in this case is a 36-inch size, is driven by a 2 to 1 variable-speed motor, coupled directly to the top shaft. This shaft runs in ring-oiled bronze-bushed bearings and has keyed to it the regular "cut" and return pulleys *A* and *B*, Fig. 2. Any predetermined speed for the cutting and return strokes is obtained by adjusting the handles *C* and *D*, Fig. 1, on the controller. The drive, as far as described, constitutes the regular arrangement and gives cutting speeds ranging from 27 to 54 feet per minute and return speeds from 75 to 150 feet per minute. Any combination of these speeds can also be obtained. For example, the cutting stroke can be given a speed of 27 feet and the return a speed of 150 feet, or the cut can be increased to 40 feet and the return reduced to 100 feet per minute. Instead of varying both speeds, the return speed, for example, can be set to 100 feet and the cutting stroke can be varied as desired. These changes can be made instantly with the machine idle or operating on either stroke.

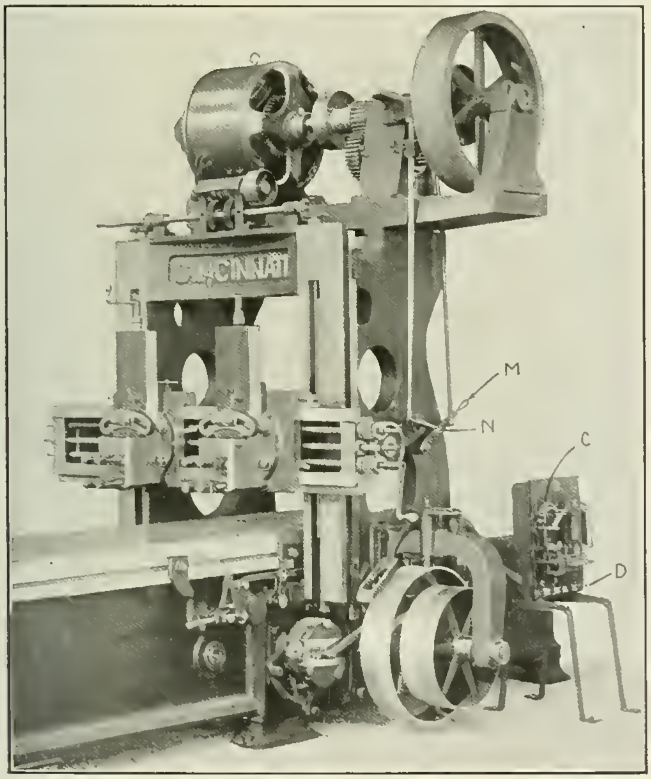


Fig. 1. Cincinnati Planer having Slow-speed Drive which can be engaged when necessary

The special slow speeds are obtained through back-gears. Referring to Fig. 2, pinion *E* is keyed fast to the top shaft and engages with gear *F*, which is keyed to the back-gear shaft carrying pinion *G*. The latter meshes with gear *H* which is keyed to the hub of pulley *J*, mounted loosely on the top shaft. By moving handle *N*, the driving belt is moved from pulley *A* to *J*, giving a slow speed to the planer driving pulley. A further speed reduction can then be made through back-gears on the left side. To change the planer from the slow to the regular speeds, it is simply necessary to disengage the back-gears by operating handle *K*, change the position of the reverse clutch handle *L* and shift the "cutting" belt from pulley *J* to *A*, handle *N* being provided for this purpose. If the planer is to be used on regular speeds for any length of time, the back-gears *F* and *G* can be disengaged by operating handle *M*.

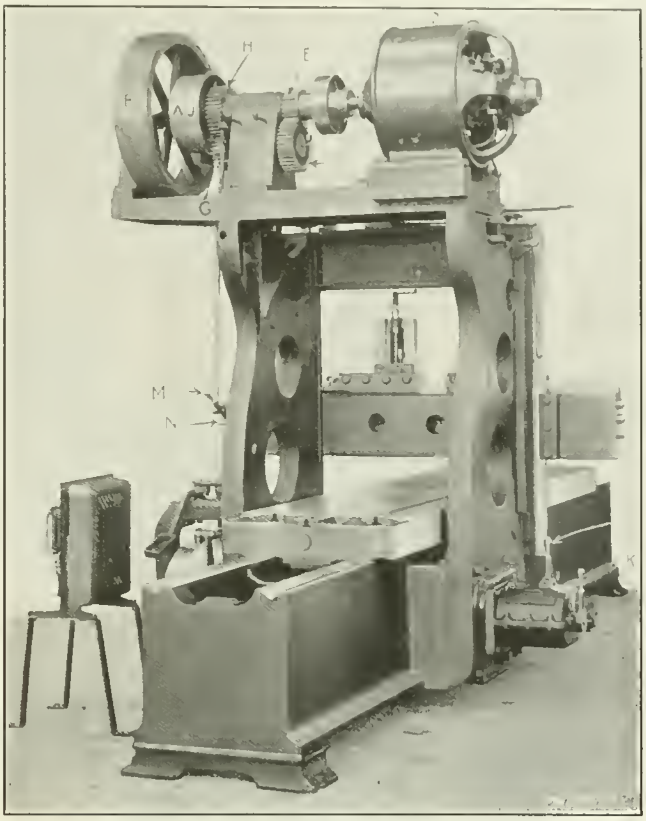


Fig. 2. Rear View of Planer having Slow-speed Drive

This makes a very flexible arrangement, as cutting speeds can be obtained, ranging from 1.6 feet to 3.2 feet with the back-gears, and from 27 to 54 feet per minute when driving in the regular way. This planer is built by the Cincinnati Planer Co., 3150-3152 Superior Ave., Cincinnati, O.

FOOTE-BURT FOUR-SPINDLE STAYBOLT DRILL

The staybolts which are used as supports between the inner and outer sheets of boilers often break entirely off or are cracked, doubtless because of the unequal expansion of the sheets and the resulting bending strains to which the bolts are subjected. One well-known method of detecting broken staybolts is by sounding them with a hammer, preferably when the boiler is under a slight hydrostatic pressure. When a bolt that is entirely broken is struck with a hammer, it gives a sound that is quite different from one that is solid, and in this way, bolts which are broken completely off can be detected with considerable certainty, by an experienced man. When there is only a partial fracture, however, the defective bolts are not found so easily and the hammer method is rather unsatisfactory. To do away with all uncertainty, locomotive boilers have been equipped for some years with bolts having small holes drilled centrally in the ends to a depth somewhat greater than the thickness of the sheet. When such a bolt becomes broken or is fractured as far as the central hole, water will be blown out through this hole and the defective bolt is discovered immediately.

The Foote-Burt Co., Cleveland, O., has designed a machine (which is illustrated herewith), especially for drilling these telltale holes in staybolts. This drill has four spindles with a power feed and sensitive drive, which, in connection with special chucks for quickly gripping and centering the bolts under the spindles, gives a very rapid production. Each spindle has three independent speed changes and two variations of power feed, as well as an automatic trip which disengages the feed when the hole has been drilled to the desired depth. By having an independent feed for each spindle, one operator can readily run all four spindles, thus obtaining a much larger output than would be possible with a single-spindle machine. The speed or feed of any spindle, can be instantly changed without affecting the other spindles. The drills run in bushings which insure starting them central with the work, and the chucks are accurately aligned central with each spindle. An oil pump with piping and a return tank, is provided so that oil and soda water can be supplied to the drills. This machine will drill to a depth of 3 inches, and has a capacity for drills up to 5/16 inch in diameter. Staybolts ranging from ¾ to 1¼ inch in diameter and with lengths varying from 3 to 15 inches, can be held in the chucks. The chucks and their supporting fixtures can be quickly removed from the table, so that the machine can be used for a variety of sensitive drill work.

Foote-Burt Four-spindle Machine for Drilling Telltale Holes in Staybolts

The distance from the spindle centers to the face of the column is 7½ inches and the spindles are 6½ inches apart. The maximum distance between the nose of each spindle and the top of the table is 36 inches, and the minimum distance, 4 inches. In addition to the power feed, the spindles can be fed by hand, and there is a quick return movement. The table is counterbalanced by a weight inside of the column. The weight of the machine is 1200 pounds.

LANGELIER SPECIAL SAWING AND DRILLING MACHINE

The accompanying views, Figs. 1 and 2, illustrate a machine built by the Langelier Mfg. Co., Providence, R. I., for sawing to length and drilling the two cross holes, simultaneously, in the Dobby chain lags that are used on weaving looms. The construction consists principally of a frame carrying a cross arm or rail on which the two saw crossheads are mounted. These crossheads are connected to a right- and left-hand screw in the cross arm, and, by means of this screw, the saw heads can be adjusted either in or out for lags of different length. This adjustment enables lags varying in length from 3½ inches to 11½ inches to be machined.

The drill heads are fastened to the saw crossheads, and they can be adjusted independently by means of "pull-and-push" screws. Each crosshead and the saw shaft bearing is cast integral with the table track. The table is of the push type and is constructed in three parts, there being an intermediate part for each of the different lengths of lags. On the inner end of this intermediate section there is a trough conforming to the shape of the lag, for accurately locating and holding it for the machining operations. The angular sides of this trough also act as a jig for drilling the two cross holes. Stops are provided for limiting the travel of the table in both directions, and there are means for automatically returning the table. On the narrow intermediate part, a special holding clamp is provided to prevent possible injury to the operator's hands when machining lags that are comparatively short. One of these clamps is shown in Fig. 2 on the left end of the table. The drilling spindles are driven by pulleys, as shown, which are connected by belt to an overhead countershaft, and the saws are driven by belts connecting with a floor countershaft at the rear of the machine, as shown in Fig. 1. The saw shafts are multi-shouldered and have babbitt metal cap bearings. These saws are 6¾ inches in diameter.

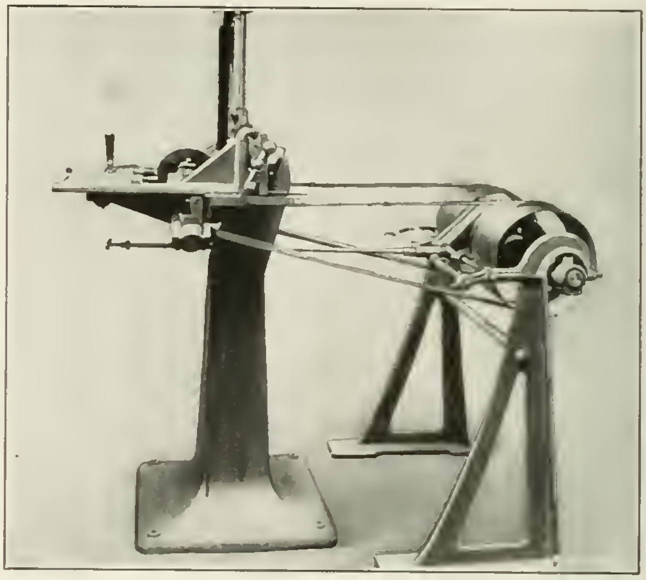


Fig. 1. Side View of Langelier Sawing and Drilling Machine for Dobby Chain Lags

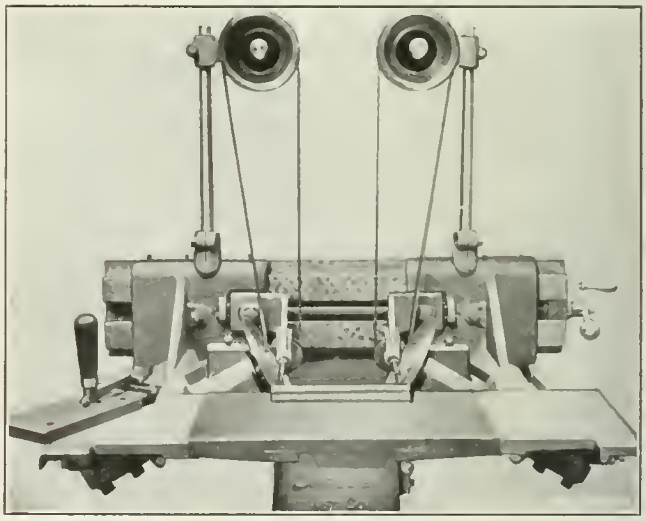
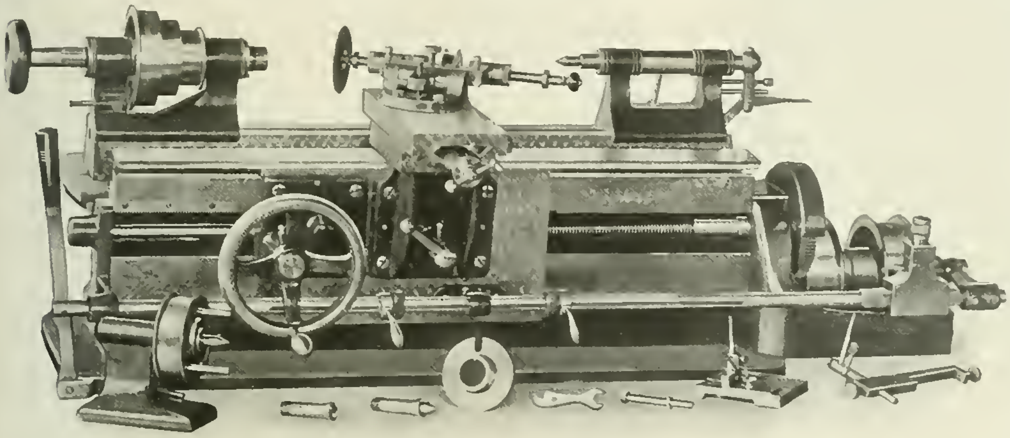


Fig. 2. Front View of Langelier Machine

HARDINGE UNIVERSAL GRINDER

A recent addition to the line of precision tools manufactured by Hardinge Bros., 3133 to 3141 Lincoln Ave., Chicago, Ill., is shown in the accompanying engraving. This new product is a universal grinder designed to do all kinds of internal and external grinding, on work up to 7 inches in diameter and 18 inches long, and it is especially applicable to the grinding of cutters, reamers, end-mills, saws, and other tool-room work of a varied nature, requiring a high degree of accuracy.

The base of this machine has mounted on it a swiveling bed which enables the grinding of tapers, and as this table is designed to carry the Hardinge dust-proof bench-lathe heads, the latter can be used interchangeably. This application of bench-lathe heads to the grinder is an important feature as it makes possible the use of various attachments which greatly increase the range of the machine. Any lathe head varying from the No. 3 size, having a capacity of ½ inch through the draw-back collet, to the No. 7 size, inclusive, with a capacity of 1⅝ inch through the collet, can be applied to the grinder. It should be mentioned in passing that the spindles and journals of these lathe heads are protected from emery or other abrasive material by felt rings and dust caps, which seal the bearings. The angular position of the bed is shown by a steel plate inserted in the base on the left side. This plate is graduated to 10 degrees on each side of a central zero line, and as the graduations are on a circle 36 inches in diameter, accurate readings can be taken. This means of obtaining accurate angular adjustment is desirable in order that fine tools, such as reamers or cutters, having a slight taper or angle, can be ground accurately to the angle required. The angular position of the bed is changed by unlocking two hand nuts, which are easily reached by the operator when in front of the machine.



Hardinge Universal Grinder

The wheel spindle is mounted on a slide which is not directly operated by the cross-feed screw, but is carried by a lower slide, as the illustration shows. The upper slide is secured to the lower one by knurled screws at the side; by simply loosening these screws, the operator can move the grinding wheel rapidly to and from the work. When a fine adjustment is desired, the lower slide is moved by the handle in front, which is provided with an accurate micrometer dial. The base carrying the grinding spindle can be set to any angle, as it is graduated to 360 degrees. These graduations are on a beveled edge, so that they can be read easily and accurately. The traverse spindle is hardened and ground and runs in adjustable journals, which are protected with felt rings similar to those in the bench-lathe heads, and special oiling facilities are provided to insure good lubrication. In each end of the spindle there is a standard taper hole, so that the wheel can be placed on either end as required.

The carriage, containing the compound slide and grinder head, is mounted on the front of the base, and the top bearing surface is carefully protected from grit by a shield which is plainly shown in the illustration. This carriage has an automatic feed in either direction, the reverse movement being obtained by shifting the vertical lever seen at the extreme left. This lever is connected by a shaft with a clutch located between the feed pulleys which are driven by open and cross belts. Feed-control stops are provided for automatically disengaging the feed at any predetermined point. These feed-stops are located on the reverse shaft, and are provided with knurled nuts giving a micrometer adjustment. The power feed is engaged by a lever at the center of the carriage, which operates a split nut, and the wheel to the left is used for hand operation.

Some of the attachments used on this grinder are also shown in the illustration. To the left, a "dead-center" head for external work or quills is shown, and to the extreme right, there are two forms of stop fingers for cutter grinding. One of these stops is designed for straight face cutters and the other for cutters having spiral teeth. This equipment, in connection with the bench-lathe heads, which enable the use of draw-back chucks, wheel chucks and closers, and independent and universal chucks, adapts this machine to a wide range of work. The countershaft provided with the grinder is arranged to give variations of speed and is so constructed that the work or grinding wheel can be stopped independently of the main drive.

ROCKFORD HORIZONTAL DRILLING, BORING AND FACING MACHINE

A horizontal drilling, boring and facing machine, built by the Rockford Drilling Machine Co., Rockford, Ill., is shown in Fig. 1. This latest design is equipped with a direct motor drive, the motor being mounted on an extension of the machine base, thus forming a complete unit. An important advantage incident to this construction is that the machine can be conveniently picked up by a crane and carried to any part of the shop where it might be required.

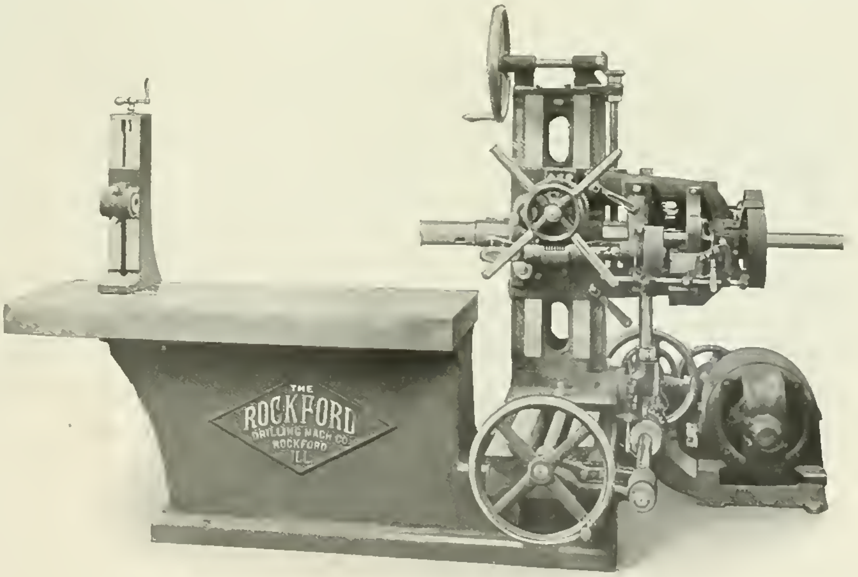


Fig. 1. Rockford No. 2 Motor-driven Horizontal Boring and Facing Machine

The motor is of the direct-current variable-speed type and it drives through gearing, as shown in the rear view, Fig. 2. On the main horizontal driving shaft there are two sliding gears, either of which can be engaged with intermediate gears that connect with the driving pinion of the motor. By means of this back-gearing, a ratio of 5 to 1 is obtained.

The machine has, in addition to the positive geared drive, a positive geared feed, giving variations ranging from 0.005 to 0.060 inch per revolution of the spindle. The amount of feed for any position of change gears is shown by a pointer and index plate, and the changes are made by handles conveniently located on the saddle. There is also an automatic trip for disengaging the feed, which operates at any point within the full travel of the spindle sleeve without the use of trip dogs on the sleeve. A detailed description of this feeding mechanism was published in July, 1911, in connection with a description of a belt-driven machine of the same type. The spindle has a vertical travel on the column or vertical head, of 18 inches, and the column has a maximum lateral movement of either 12, 24, or 36 inches, the distance being varied to suit individual requirements.

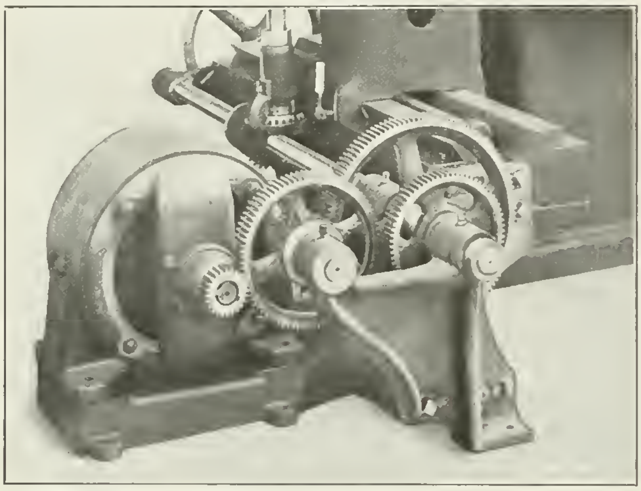


Fig. 2. Rear View showing the Motor Drive and Back-gears

AUTOMATIC CONTROLLERS FOR MOTOR-DRIVEN MACHINERY

The Electric Controller & Mfg. Co., of Cleveland, O., has recently brought out a line of automatic controllers, designed especially to give the utmost convenience in the control of motor-driven machinery. The advantage of convenient control and its effect on production is universally recognized, and these controllers were designed to provide such a control for starting, stopping or reversing motor-driven machine tools or other electrically driven machines.

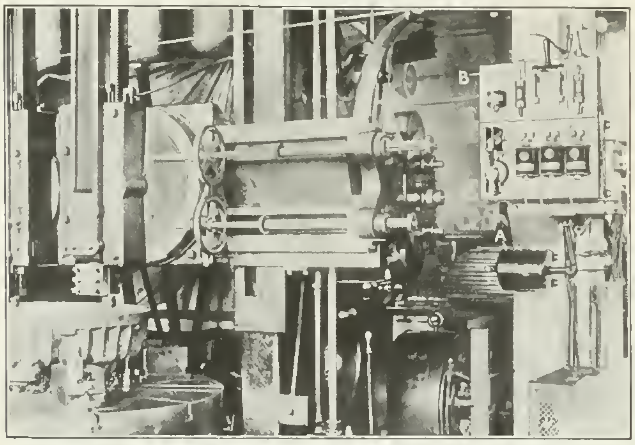


Fig. 1. Electric Controller & Mfg. Co.'s Automatic Controller applied to Boring Mill

The controller consists of a small operator's switch and an accelerating unit, and it is built in three types to secure, first, non-reversing and dynamic braking; second, reversing without dynamic braking; and third, reversing and dynamic braking. In each type, four different forms of accelerating units are available, which vary in their design from a simple train of accelerating switches up to a unit having a fused service switch, a train of accelerating switches, and complete circuit breaking features. The accelerating unit automatically accelerates or retards the motor through the action of series-wound accelerating switches, which act not only as switches but as current limit relays as well. When the current in the winding of one of these switches exceeds a predetermined value, the switch locks open and cannot close until the current is reduced to the proper value.

Fig. 1 shows one of these automatic controllers installed in connection with a large boring mill. The operator's switch is located at *A* and the accelerating unit at *B*. The method of mounting one of these operator's switches on a shaper is shown in Fig. 2. When the operator's switch is thrown to the running position, current flows through the motor, all of the starting resistance, and the coil of the first series-wound accelerating switch. As the motor accelerates, the current drops, and when it reaches the correct value, the first accelerating switch closes, cutting out part of the starting resistance. The succeeding accelerating switches operate similarly, ultimately cutting out all of the starting resistance and putting the motor "across the line." By throwing the operators' switch to its original position, the motor is disconnected from the line and, consequently, stops. Different positions of the handle of different types of operator's switches, provide for drifting, reversing, or rapid stopping by dynamic braking.

Dynamic braking is secured by a change of connections, made by the operator's switch. All the starting resistance is first inserted in series with the armature; the motor is then quickly and evenly brought to rest by automatic dynamic braking, the accelerating switches, in this case, acting as "decelerating" switches by cutting out the resistance step by step, as the current generated by the motor, decreases due to the slowing down of the motor.

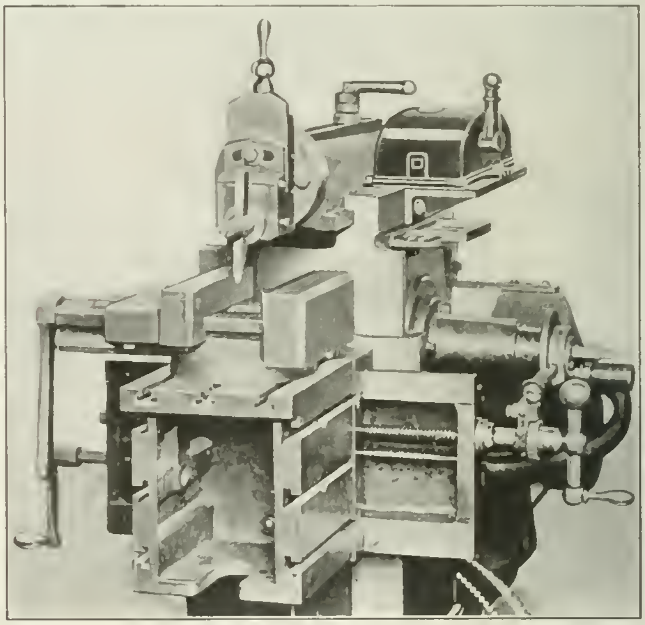


Fig. 2. Operator's Switch mounted on Shaper

The manufacturers claim the following important advantages for this automatic controller: It limits the accelerating and retarding current at all times to a safe value; it accelerates and retards the motor in the minimum safe amount of time, and automatically varies the time of acceleration and retardation, depending upon the load which the motor has to start and stop; it provides the best conditions for good commutation; it limits all mechanical strains on the motor and driven machinery by limiting the current both in starting and stopping; it obviates the necessity of mechanical clutches on many motor-driven machine tools; it adds very materially to the safety of an installation, because, in case of accident, the motor can be stopped quickly; it inherently provides no-voltage protection, for, if the voltage fails, the switches drop open, and upon the return of voltage, they automatically close in their regular order, again accelerating the motor to full speed.

HARDINGE AUTOMATIC LOCKING FOOT-TREADLE

Three styles of an automatic locking foot-treadle, which are intended for all small belt-driven machines requiring a treadle shifter, are shown in Figs. 1 and 2. The belt is shifted to the tight pulley by the downward movement of the treadle, which operates a bellcrank lever that is connected with the countershaft by a wire. After the treadle is pressed down, it is locked by the upward pull of the wire leading to the countershaft, and in order to unlock it for stopping the lathe, it is simply necessary to press down the heel part of the treadle. The lock for the running position enables the operator to remove his foot from the treadle, except when starting or stopping, and the action is as easy as though there were no locking feature.

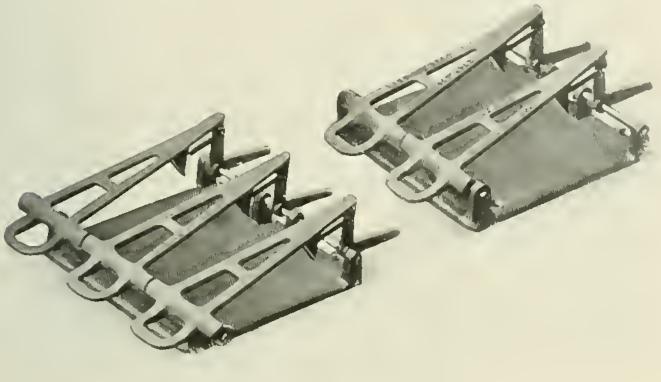


Fig. 1. Hardinge Foot-treadles in Locked Position

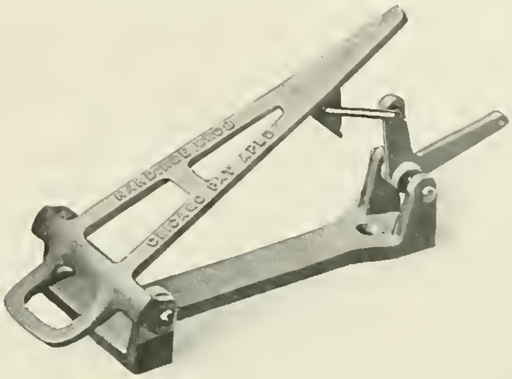


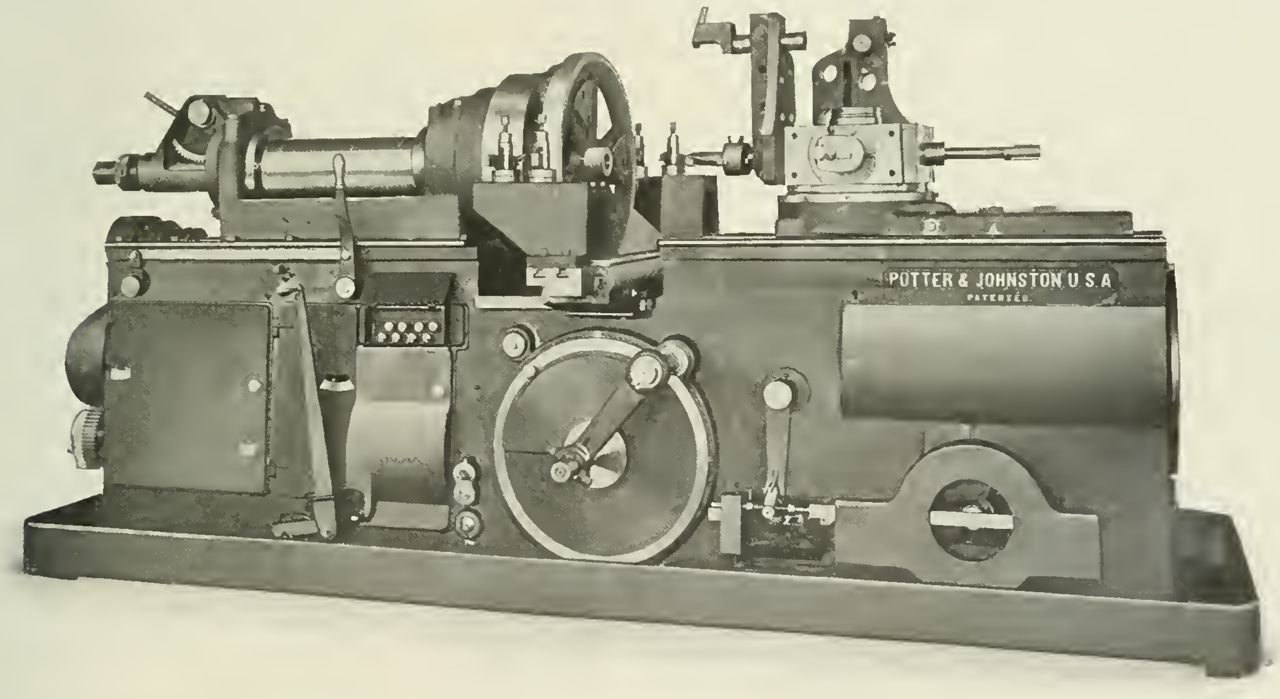
Fig. 2. Treadle in Raised or Unlocked Position

The advantage of this device will be thoroughly appreciated by the users of bench lathes or other machines which are set in motion by means of treadle shifters, because this improved design makes it unnecessary for the operator to stand with one foot on the treadle and sustain his entire weight on the other, as with devices used heretofore. The treadles shown in Fig. 1 are in a downward or locked position, while the single type illustrated in Fig. 2, is unlocked. The general arrangement of this improved treadle and its locking feature is clearly shown in the engravings, so that further description is unnecessary. This treadle is manufactured by Hardinge Bros., 3133 to 3141 Lincoln Ave., Chicago, Ill., for one-, two-, and three-speed countershafts, and it will be furnished regularly with the bench lathes built by this company.

POTTER & JOHNSTON AUTOMATIC CHUCKING AND TURNING MACHINE

The Potter & Johnston Machine Co., Pawtucket, R. I., has brought out a new automatic chucking and turning machine, known as the No. 7-A model. This latest design is of the same general construction as the Nos. 5-A and 6-A models, but it has increased capacity and power and is especially adapted for the manufacture of motor truck parts, such as chain sprockets, brake drums, hubs, pistons, cylinders, flywheels and similar work in this and other lines. The accompanying illustration shows the machine set up for turning the large rear sprockets of motor trucks. As is well known, all the cutting operations are performed automatically by these machines, and one workman can operate from two to six machines, the number depending on the nature of the work.

The headstock of the No. 7-A model can be adjusted along the bed, within certain limits, to suit the length of work being machined. All speed changes are obtained through gearing enclosed in the base, and the spindle has four automatic and five hand speed changes, the latter of which are obtained through change gears, thus giving a total of twenty spindle speeds. These speeds vary in geometrical progression from 5½ to 163 revolutions per minute. The spindle is driven by a gear attached to the chuck or faceplate, thus eliminating torque. The speed clutches are powerful friction clutches, which drive the heaviest work and, at the same time, absorb all shock when changing from one speed to another.



Potter & Johnston No. 7-A Automatic Chucking and Turning Machine

There are four automatic changes of feed, including a threading and reaming feed, and six hand changes. Any variation of speed within the range of the machine can be obtained through change gears, which are regularly furnished. All the automatic changes of speed and feed are actuated by revolving cams, and as the changes are practically instantaneous, they can be made at any part of the cutting stroke.

The cross-slide is provided with front and rear tool-blocks, each of which carries two toolposts. This slide is adjustable longitudinally along the bed and is of a very strong construction. The turret has four stations upon which tools may be mounted, and with each machine an outfit of turret turning tool-holders, stems and cutters is furnished. The turret is advanced, returned and revolved automatically, and as these movements are performed at a high constant speed, little time is lost in changing from one operation to another. When the turret slide has advanced to the point where the tools begin cutting, a slower feeding motion is automatically engaged. A 21-inch, three-jawed scroll chuck, having a standard set of jaws, is supplied. This chuck is equipped with a pilot bushing to receive pilot bars for supporting the turret tools. An oil pump and piping, with an oiling arrangement through the turret, is also furnished when the material to be machined requires a lubricant. As the machine has a single-pulley drive, the application of a motor is very simple. The bracket for the motor is bolted to the base and the drive is through a pinion and gear which is substituted for the regular driving pulley. A constant-speed motor is recommended. By means of change gears, the variations of speed and feed common to the belt-driven machines are obtained with the motor drive.

The general dimensions of the No. 7-A automatic are as follows: Swing over the bed, 29 inches; swing over the cross-slide, 21 inches; travel of the cross-slide each way, 7 inches; turning limit with a standard turning tool (diameter), 21 inches, and with a special tool, 29 inches; diameter of holes in turret, 2½ inches; depth, 4½ inches; distance from center of turret hole to top of slide, 4¾ inches; maximum turret slide travel, 21 inches; length of turret slide travel which permits the supporting and piloting of turret boring tools, 10 inches; diameter of spindle bearing, 7¾ inches; maximum diameter which will pass through the spindle, 6 inches.

SAXON SURFACE GRINDER

The J. A. Stowell Co., Leominster, Mass., is now manufacturing an improved design of the Saxon surface grinder, which appears, as far as can be judged from a study of the illustration, to be a very simple and durable machine. There are comparatively few parts in the design and the machine is heavily constructed to absorb all vibrations and facilitate the rapid production of precision work.

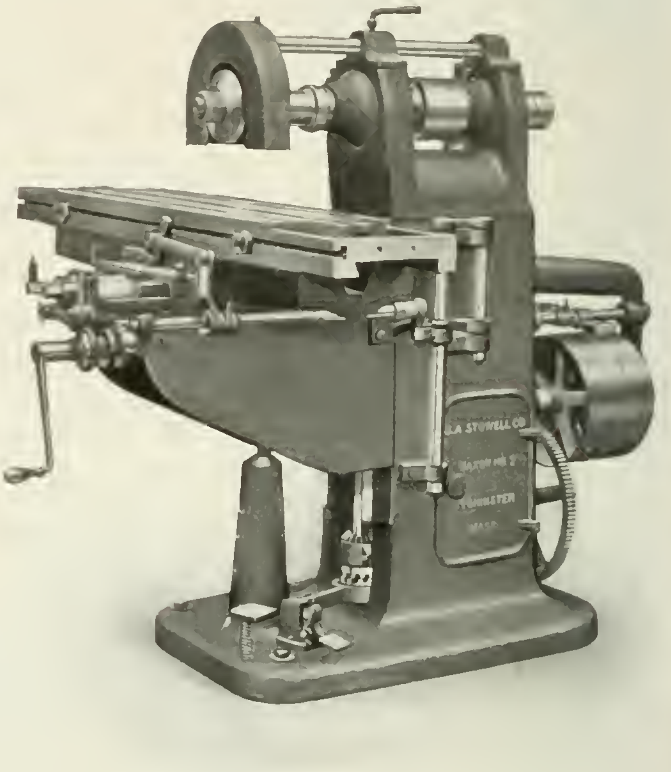
The grinding-wheel spindle is driven from an overhead countershaft which also drives the table reciprocating mechanism by open and cross belts operating on pulleys at the rear of the column. The shaft carrying these pulleys drives, through spur gearing giving a large speed reduction, a lower horizontal shaft which connects through bevel gears with an intermediate vertical shaft shown at the front of the column in the illustration. This vertical shaft, in turn, imparts movement to a horizontal shaft mounted in the knee and carrying a gear which meshes with a rack on the under side of the table.

The stroke of the table is controlled by trip dogs at the front which, through the connections shown, operate a reversing shaft at the side of the knee. This reversing shaft, in turn, connects through a suitable mechanism with belt shifters at the rear. The table can also be reversed at any point by means of the hand lever attached to the front end of the reversing shaft. The starting or stopping of the table is controlled by a foot-treadle, through the medium of a clutch, which engages or disengages the vertical intermediate shaft with the driving bevel gears at its lower end.

The transverse feeding motion for the table is derived from the rack gear shaft in the knee, which drives, through a friction clutch, a shaft having a slotted disk on the outer end, connected by a short rod with a ratchet mechanism, operating a feed-screw shaft at the left. The slotted disk gives the necessary feed variations, and the automatic feed occurs at each end of the stroke. The direction of the feeding movement can be reversed by simply turning the feed pawl. The table can be shifted longitudinally, transversely, or vertically by the crank handle shown, which fits the three adjusting shafts. The vertical adjustment is shown by a dial graduated to thousandths of an inch.

The bearing surfaces of this machine are large and are protected by dust guards. The guards at the ends of the table and above the front of the knee were detached from the particular machine illustrated in order to give a better view of the mechanism. The spindle is of crucible steel, accurately turned and ground, and runs in bearings of ample dimensions. The bearings are provided with fiber thrust collars and adjustment for eliminating lost motion, and they are self-oiling as well as dustproof. All handles and levers for controlling the various motions are operated from the front or working position. A water attachment is furnished with this grinder when desired. This attachment, however, reduces the working capacity 1½ inch in width and the same amount in height.

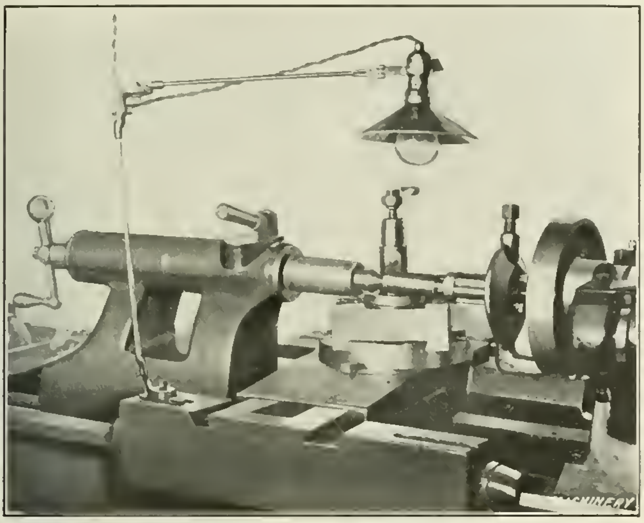
This grinder is built in two sizes known as Nos. 2 and 3. The smaller size has a capacity for work 36 inches long, 10½ inches wide and 12 inches high, and the larger size, for work 45 inches long, 12 inches wide and 10 inches high. Each size takes a 12- by 1½-inch wheel. The diameters of the respective spindles are 2 and 2¼ inches; and the maximum distance from the top of each table to the spindle center, 18 inches and 16 inches. The rate of the table travel is 16 feet per minute for both sizes. The dimensions of the bearings are 8½ and 7 by 2 inches, and 10 and 9 by 2¼ inches, and the complete weights, 1900 and 3000 pounds, respectively.



Surface Grinder built by the J. A. Stowell Co.

ADJUSTABLE LAMP BRACKET

The lamp bracket shown attached to the rear of a lathe carriage in the accompanying view has a universal adjustment which enables the light to be directed where it is most needed. The importance of this feature will be appreciated particularly by all machine tool operators. This same bracket can also be attached to the wall and is applicable not only to machine shops, but to drafting-rooms, etc. The bracket is equipped with universal joints formed by disks and so arranged as to give both horizontal and vertical movements. Between each pair of disks there is a friction washer, and the amount of friction can be regulated by screws and lock-nuts which keep the friction uniform at any desired tension. The arms are of solid steel and the disks are of malleable iron and machined to form a good bearing for the friction washers. The lamp itself can be quickly removed from the bracket when desirable, as it is held in place by a spring clamp. These brackets are plated by an electro-galvanizing process giving an aluminum finish which is rustproof and pleasing to the eye. The bracket is made in several different styles so that it can be attached to the ceiling, floor, bench, etc., and all of these, except the one intended for bench or desk use, are 30 inches long, thus giving a total range of 5 feet. This bracket is manufactured by the McCrosky Reamer Co., Meadville, Pa.


Adjustable Lamp Bracket for Shops or Drafting-rooms

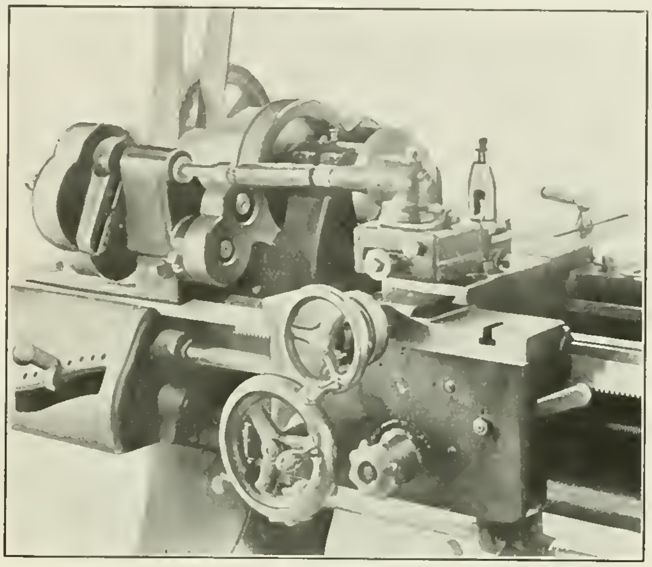
RELIEVING ATTACHMENT FOR SENECA FALLS LATHES

The Seneca Falls Mfg. Co., 330 Water St., Seneca Falls, N. Y., has brought out a new relieving or backing-off attachment for use on the 14- and 16-inch, quick-change, tool-room lathes built by this company. The tool-slide is attached to the cross-slide of the carriage, in place of the compound rest, and it will operate at any angle through an arc of 180 degrees or 90 degrees each way from the center of the carriage. The lower part swivels on the cross-slide the same as a compound rest, and the upper part, containing a pair of driving bevel gears, swivels on the lower part to permit the free working of the driving shaft which is connected to the driving mechanism by universal joints. The stroke can be adjusted while the machine is in motion, to give any amount of relief from 0 to ¼ inch, the amount being indicated by graduations on the adjusting knob.

The driving mechanism is attached to the bed in front of the headstock, and receives power from the large spindle gear. The number of strokes per revolution of the work is governed by change gears. A set of gears is furnished giving twenty-two variations, including all numbers from two to sixteen, and even numbers from eighteen to thirty.

The attachment may be so easily and quickly disconnected, that it does not interfere with the regular operation of the lathe. The tool-slide is removed by loosening a binding screw (a patented device that is much quicker and easier to operate than the regular T-bolts), pulling out a splined shaft from the driving mechanism, and then throwing the driving gear out of mesh with the headstock gear.

This attachment can be used in connection with the taper attachment and micrometer cross-feed stop, and also with the power cross and longitudinal feeds. Special cams can be used for turning elliptical and other irregular shapes.


Relieving Attachment applied to Seneca Falls Tool-room Lathe

BRISTOL RECORDING INSTRUMENT

The semi-transparent smoked chart recorder made by the Bristol Co., of Waterbury, Conn., is an instrument that is fundamentally simple in its construction and extensively used, but there has been a demand for a recorder in which the record is made with ink. To meet this demand, the frictionless ink type recording instrument, shown in Figs. 1, 2 and 3, has been developed. This recorder is designed to parallel, as nearly as possible, the simplicity of the smoked chart type. It will accurately record fractions of milli-volts and is adapted for use as an electric pyrometer. This instrument has been thoroughly tested in practical service and is the result of several years experience with an original patented design of frictionless ink recorder, having a hinged electrical movement carrying a retaining receptacle for the marking fluid, which extends over the path of the recording tip and is provided with means for periodically making contact with the source of the marking fluid and the chart.

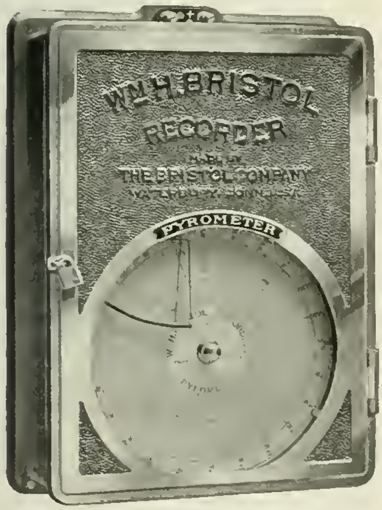


Fig. 1. Bristol Recorder ready for Operation

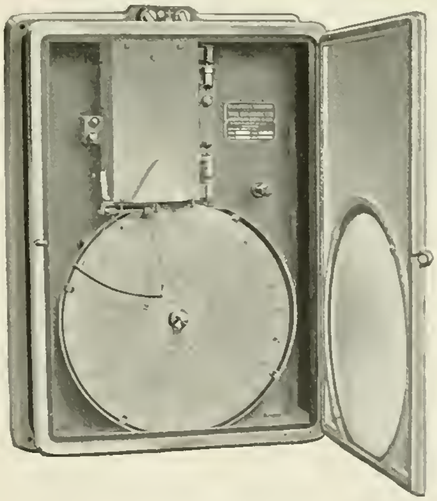


Fig. 2. Interior View showing Galvanometer Movement

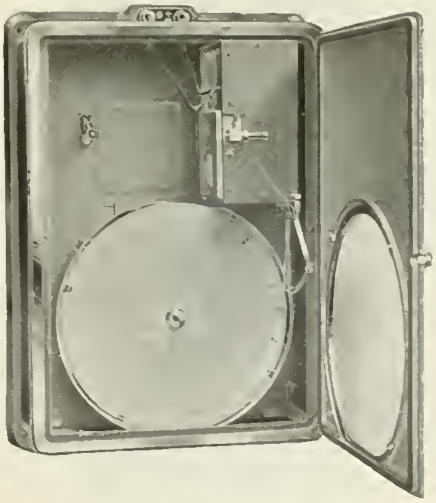
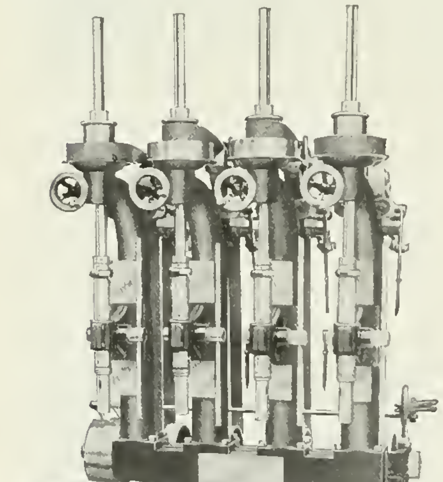


Fig. 3. Electrical Movement swung to One Side for Inserting Chart

Fig. 1 shows the recorder ready for operating, and Fig. 2 is an interior view showing the galvanometer movement case hinged to the back of the instrument and carrying the inking pad in front of the recording arm. Fig. 3 shows the sensitive electrical movement swung to one side, for convenience in removing the record and inserting a new chart. A capillary gold tube, open at both ends, is carried at the end of the recording arm and at right-angles to the surface of the chart. The inking pad is suspended from the electrical movement case and is curved to correspond with the arc described by the end of the recording arm. When the movement is swung back into its operating position, as shown in Fig. 2, the recording arm can swing free, thus accommodating itself to the position corresponding to the delicate current which is to be measured. The clock which revolves the chart at the desired speed also automatically presses the inking pad toward the chart every ten seconds, thus bringing one end of the capillary tube into contact with the chart, and the opposite end, simultaneously into contact with the inking pad. A fine dot of ink is left on the chart and the capillary tube is replenished with ink from the pad. The recording arm thus carries a constant supply of ink, and its perfect balance, which is a very important feature, is always retained.

The electrical movements used in these recorders are made especially for the purpose by the Weston Electrical Co. Although the most important applications of these instruments have been as pyrometers, they are also used for electrolytic research, as recording voltmeters and recording shunt ammeters.

HIGH-SPEED DRILLING MACHINES



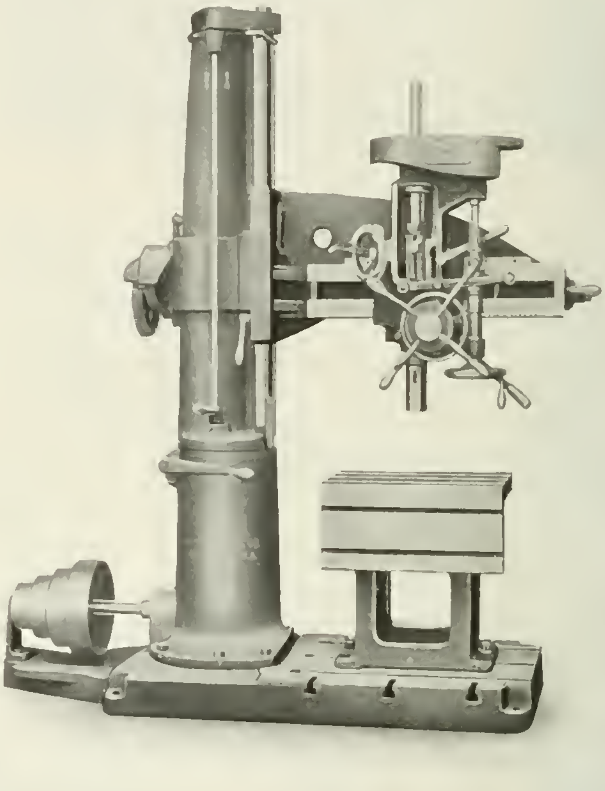
High-speed Drilling Machine built by the Guarantee Machine Co.

The Guarantee Machine Co., Grand Rapids, Mich., is manufacturing the design of high-speed ball-bearing drilling machine shown in the accompanying illustration. These machines are made with any number of spindles from one to six, inclusive. The spindle driving cones have two sets of adjustable ball bearings and there are ball bearing thrusts for the spindles. The countershaft at the rear also runs on ball bearings. The idler pulleys on this machine are arranged to rise simultaneously, so that the belts are kept in line with the proper cone step. To change the spindle speed from low to high requires no adjustment other than to raise the idler pulleys, the idler brackets being arranged to allow the idlers to track on either cone without adjustment on the part of the operator. Speed changes are made by means of a lever within convenient reach. Four changes are available, ranging from 450 to 1400 revolutions per minute, with a countershaft speed of 600 revolutions per minute. The idler carriage has an adjusting screw and handwheel located at the front of each head, to take up the stretch of the 1½-inch endless belts, when necessary. The spindles are driven by two splined keys, and have a feed of 6 inches. The sliding heads also have a vertical movement of 8 inches. The spindle bearing in the quill is 10 inches long, and there is an adjustable stop-collar attached to the quill. The table has a 10-inch bearing on the face of the column, and is gibbed to compensate for wear. The three-, four-, five- and six-spindle machines are equipped with raising screws for the table, and the one- and two-spindle sizes can be provided with these screws if so ordered. The belt-shifting device requires a forward movement instead of a side motion, and it can be placed between any of the upper columns.

SIMPLEX 31- AND 36-INCH RADIAL DRILLING MACHINES

The radial drilling machine illustrated herewith is intended particularly for repair shops or other places where a machine of simple construction is preferable to a more complicated and expensive design. It is built by the Dreses Machine Tool Co., Cincinnati, O.

The column revolves on a roller bearing and is clamped in a fixed position by a single handle. The spindle has a ball thrust bearing and is started, stopped, and reversed by the well-known three-bevel-gear arrangement and a friction clutch. This clutch is operated by a lever seen on the right-hand side under the arm. There is an automatic stop and graduated depth gage, and a quick-return movement controlled by the four handles shown. The feed is all-geared and has four changes which can be made while drilling. A speed and feed plate is attached to the head for the convenience of the operator. The head is traversed along the rail by a rack and spiral pinion arrangment, and it is clamped by a single lever seen above the rail. The table is separate from the column which makes it available for the full horizontal traverse of the spindle. A swinging or tilting table with or without a worm movement can also be furnished.

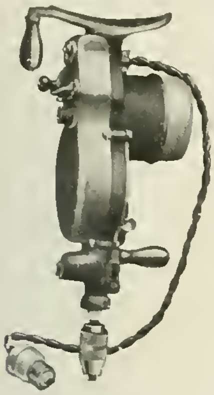


Simplex Radial Drill built by Dreses Machine Tool Co.

Some of the principal dimensions of the 31- and 36-inch sizes are, respectively, as follows. Maximum distance between spindle and base, 51 inches and 58 inches; traverse of head on arm, 21 inches and 26 inches; traverse of arm on column, 32 inches and 38 inches; minimum distance between column and spindle, 10 inches for both sizes; traverse of spindle, 12 inches for both sizes, maximum diameter of circle the center of which can be drilled, 63 inches and 73 inches; pipe tap capacity for both sizes, 2 inches; standard tap capacity, 1¼ inch; capacity for drilling in solid cast iron, 2½ inches; capacity for drilling in solid steel, 1¾ inch. These machines are also furnished with a speed variator or motor drive.

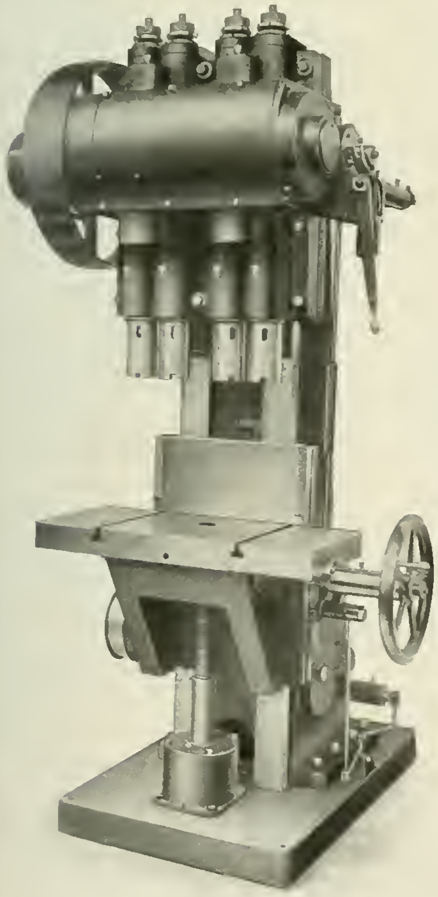
TEMCO ELECTRIC DRILL

The portable electric breast drill shown herewith has a capacity for drills up to ¾ inch in diameter and it weighs complete 12½ pounds. The driving motor is wound for either alternating or direct current, and a combination winding for either current (of the same voltage) can be furnished if desired. This winding, however, is recommended only when the drill is to be used in various places where the current may change. The motor is reversible, which is convenient when the drill breaks or sticks; this feature is also advantageous for tapping. The switch for starting, stopping or reversing the motor is encased, which excludes all chips and protects the hands of the operator. A single lever on the outside, that is insulated from the current-carrying parts of the switch, serves to control the switch. This lever is spring-seated when in the "off" position, so that the arc is broken the same as in a "snap" switch. This feature increases the durability of the switch points and insures certainty of movement to the operating lever, which is located beneath the handle that extends from the breast-plate, and within easy reach of the thumb and finger. When it is desired to tighten the drill chuck, the spindle can be locked against rotation by swinging it to a right-angle position where it is locked by jaws on the main frame. This drill is manufactured by the Temco Electric Motor Co., Leipsic, O.


Electric Breast Drill

BAKER BROTHERS CYLINDER BORING MACHINE

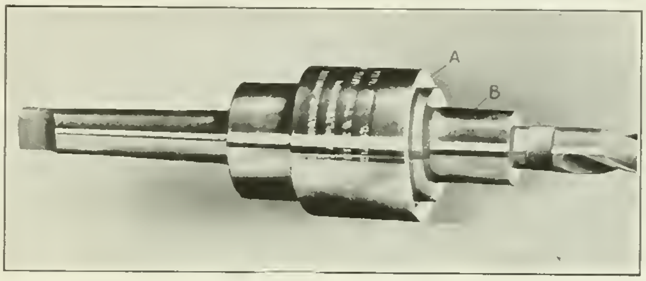
A cylinder boring machine of recent design, built by Baker Bros., Toledo, O., for the rapid boring of automobile cylinders *en bloc*, is illustrated herewith. In the design of a machine of this type, it is very important to secure a powerful but smooth-running drive with the close center distance required between the spindles. On one of these machines, having four spindles, the center-to-center distance between adjacent spindles is 4 inches and the drive is sufficiently powerful to rough-bore a block of four cylinders 3¾ inches in diameter and 10 inches deep, in one and one-half minute and finish it in one minute. The usual operations in their successive order are rough-boring, "straighten" boring, and finish-reaming. This powerful drive is secured by eliminating friction as far as possible. The horizontal shafts are all provided with Hess-Bright annular bearings, and the vertical shafts with "high-duty" roller bearings. The thrusts are all taken on ball bearings. The drive is through a simple train of spur and bevel gears. The gears are all made of high-grade steel and hardened. The friction losses are said to be so slight that the entire gear train with the four spindles, each having a ratio of 15 to 1 from the primary drive, can be easily turned backward by applying a lever two feet long to the end of one of the spindles. In order to align the spindles perfectly, they are provided with bronze taper bearings with provision for adjusting in case of wear.


Baker Cylinder Boring Machine

The action of this machine in operation is semi-automatic. After a cylinder is chucked, the starting lever, shown at the upper right-hand side of the machine, is thrown in; this engages the driving clutch, thus starting the spindles and feeding mechanism. The table feeds up with the work until the proper depth is reached, when it automatically trips, the spindles stop revolving, and a quick-return feed is engaged which backs the work away from the cutters and stops when the latter are clear. The entire feeding train contains hardened gearing and shafts running on annular ball bearings with thrust bearings where needed. The table is gibbed on the inner part of the column ways, and there is large ratio between the width and length of the bearing surfaces, thus insuring accurate alignment and freedom of operation.

QUICK-CHANGE DRILL CHUCK

The Machine & Tool Mfg. Co., Cleveland, O., has brought out a type of drill chuck known as the "quick-change chuck." This chuck is intended for use in upright drills and in screw machines or horizontal boring mills. It is very simple and easy to operate, and sockets can be quickly changed without stopping the machine by pushing back the outer sleeve *A* which allows the socket *B* to fall out (when in a vertical position) or be removed; a new socket can then be inserted in its place, after which the outer sleeve drops down by gravity and holds the socket in place. The chucks and sockets are made of a special grade of steel which is selected for its toughness and wearing qualities. All parts are hardened and ground, insuring accuracy and durability. The chucks are said to be very accurate, and it is claimed that no dirt can enter to interfere with the operation, as all parts are enclosed. These chucks are made in three different sizes.



"Quick-change" Drill Chuck

NEW MACHINERY AND TOOLS NOTES

Reamer: McCrosky Reamer Co., Meadville, Pa. Adjustable reamer made with either right- or left-hand spiral cutting edges. The 2-inch size has an expansion of approximately 3/32 inch, and the adjustment is easily effected.

Drilling Machine: Newton Machine Tool Works, Inc., Philadelphia, Pa. Special three-spindle drilling machine designed to drill and tap, simultaneously, the three cored holes in motor contactor pole-pieces. It has a capacity for drills up to 1¼ inch and for taps up to 1 inch in diameter.

Foot-power Grinder: Carborundum Co., Niagara Falls, N. Y. Grinder operated by a one-foot treadle which imparts rotary movement to a vertical, spirally grooved shaft connecting at the top with a horizontal spindle, having carborundum wheels at each end. The grinder has ball bearings and weighs 68 pounds.

Lathe: Von Wyck Machine Tool Co., Cincinnati, O. Engine lathe having a gear box at the headstock end giving three feed changes, and a gear mechanism in the apron giving five additional changes for each variation obtained with the first box referred to, thus making a total of fifteen rates of feed. This number can be extended for either finer or coarser feeds by the use of change gears.

Tap Grinder: Bicknell-Thomas Co., Greenfield, Mass. Tap grinder with capacity for sharpening taps up to 1½ inch in diameter. The tap being ground is held between centers and it is swung past the face of the cup-wheel. The spindle is driven from a countershaft bolted to the rear of the column. A wheel for general grinding operations may be mounted on the opposite end of the spindle. This machine is sold exclusively by the Wells Bros. Co., Greenfield, Mass.

Ring Wheel Chuck: Gardner Machine Co., Beloit, Wis. Ring wheel chuck for all types of disk, vertical, edge, face and knife grinders. The special features claimed for this chuck are lightness, simplicity of construction, perfect running balance, minimum overhang, and safety in operation. They are built in six sizes for abrasive rings varying from 12 to 24 inches in diameter, and can be interchanged with the regular disk wheels.

Portable Grinder: Ransom Mfg. Co., Oshkosh, Wis. Portable emery grinder consisting of a wide-tired two-wheel truck, carrying a stiff tube about 8 feet long, on one end of which the grinding wheel is mounted. Attached to the same tube on the opposite side of the axle there is a motor which is connected to the wheel by a long belt. A five-horsepower motor is used and it is located so as to counterbalance the weight of the grinding wheel.

Center Drills: J. T. Slocomb Co., Providence, R. I. Combination center drills consisting of a variety of sizes arranged in sets in a nicely finished wooden box. There are eight sizes in all, so that the proper size for a great variety of work is always at hand. All of the Slocomb combination center drills now manufactured are made of semi-high-speed steel, which increases their productive capacity. These combination drills are so well known and widely used that the drill itself is familiar to practically all mechanics, and need not be described.

Spring Dies: National-Acme Mfg. Co., Cleveland, O. This company is placing on the market an improved spring die having S. A. E., (formerly A. L. A. M.) vee and United States standard threads. Dies of special pitch and shapes can also be supplied to order. This company has made, for several years, large quantities of spring or prong dies for use in its "Product department," and now has a fully equipped die department for the manufacture of these spring dies and also the self-opening die-heads and chasers previously described in the June, 1911, number.

Bench Drills: Hisey-Wolf Machine Co., Cincinnati, O. Attachment in the form of a base, column and cross arm for converting hand or breast drills into a machine of the bench type. The cross arm, which is adjustably mounted on the column, has a fixture for holding the drill, and there is a table on the column having vertical and radial adjustment. Portable electric sensitive bench drill, the spindle of which is driven through friction disks. This form of drive makes the tool very handy for small tapping operations, as the motion can be quickly reversed by shifting the driven disk across the center of the driver. This tool is made for either alternating or direct current.

Rack and Gear Cutters: Standard Mfg. Co., Bridgeport, Conn. Worm-gear- and rack-cutting machines, intended for standard work. The rack-cutting machine has power feed, an automatic index and a hand return. It will take work up to 8 inches in width and will automatically cut racks 22½ inches in length, and longer if the work is re-set. The slide carrying the cutter spindle, rises as soon as the cut is completed and clears the blank on the return stroke, indexing at the same time. An automatic stop renders the mechanism idle when the rack is completed. The worm-cutter has a master worm which feeds the work beneath the cutter. This machine is said to be very rapid in its operation.

Horizontal Boring Machine: Barrett Machine Tool Co., Meadville, Pa. Horizontal machine for boring and facing, simultaneously, steam, gas, gasoline, pump and locomotive cylinders. The boring-bar is 5 inches in diameter and has a continuous feeding movement in either directon of 48 inches. It is driven through worm-gearing of the Hindley type which imparts a smooth steady motion. There is a quick-change feed-box, giving feeds varying from 1/32 to 7/16 inch per revolution of the bar. The two facing arms are mounted on the ends of sleeves and are driven by friction. These arms can be started and stopped at will, and when not in use, they do not interfere with the rotation and travel of the bar. The machine is furnished with either a belt or motor drive.

Riveter: Grant Mfg. & Machine Co., 80 Silliman Ave., Bridgeport, Conn. Motor-driven riveter of the spinning type composed of two parts, one of which consists of a cast-iron frame suspended from the ceiling by tie-rods and containing the motor and spindle, while the other is in the form of a pedestal which is bolted to the floor. This arrangement permits the work to be placed in the most convenient position for riveting. Unlike the regular line of riveters built by this company, this machine is operated by a hand lever so located that it does not interfere with the work, but is easy of access for the operator. This machine is especially adapted for riveting automobile bodies, hoods, fenders and other light work which is bulky or irregular in shape. The riveting spindle can be driven by belt or direct by a motor.

Square Hole Milling Machine: R. K. LeBlond Machine Tool Co., Cincinnati, O. Combination milling machine especially adapted for cutting square holes. This machine is of the same general construction as the No. 2 plain type built by this company, and can also be used for regular milling work. The operation of the square-hole attachment is similar in principle to other devices which have been designed for this class of work. A triangular-shaped drill revolves in a stationary master guide which resembles a regular drill chuck. This guide or chuck is fastened directly to the column of the machine. This method of mounting the stationary guiding member is an important improvement over other devices in that it gives the rigidity necessary to withstand the side thrust and eccentric jarring motion of the cutter. The cutter receives its motion from a driving member which allows it to "float" or travel around the square opening formed by the jaws of the stationary master guide or chuck. When the drill is in operation, it describes a movement similar to that obtained with a "three-cornered box cam," which causes the three lipped drill to form a square hole. Holes of any depth within the length of the drill and capacity of the machine can be formed, and a neat square bottom is left in "blind" holes. As it is advantageous, when cutting square holes in tough material, to previously drill a round hole, the machine is provided with an appliance for operating ordinary twist drills. The square-hole attachment can be removed quickly when it is desired to use the machine for regular milling work.

* * *

DRAFTSMEN AND DESIGNERS

The following extract from a letter written by an experienced machine designer to a young man just entering the drafting-room, who had been asking for advice, may be of interest to young men in general who look forward to drafting work as the ultimate goal of their ambition.

"As you are young at the business, perhaps I had better explain the term "draftsman" to you. This term has a very wide meaning and includes anyone, from a man who can make a drawing to scale from a free-hand sketch, to a man who can design as well as draw a printing press, for instance. The first one is a draftsman pure and simple, while the second one is a designing draftsman, who can do things the first man never heard of. Properly designated, the first man is a draftsman, while the second is a designer. This distinction, however, is not usually made except in salary, and anyone working on drawings (not tracings) is known by the general term of draftsman.

"A designer must be a specialist, because neither you nor anyone else will ever know how to design anything, even in a very limited field, and there is no known rational method of design which can be studied in the same way as we can study mathematics or physics.

"The following may give you an idea of salaries. A draftsman's salary runs all the way from $50.00 to $150.00 per month. A detailer gets from $50.00 to $100.00 a month, the figure depending upon the man's ability and experience. A salary of about $110.00 per month calls for a man who can make the simpler designs for a detailer, the latter in that case getting perhaps about $60.00 a month. A salary of $125.00 per month calls for a man who can design anything in his line expected of a man in a drafting-room. If he receives $150.00 per month he must be able to look after the designing and detail work of men working under him."

* * *

Tests made by Arthur D. Little, Inc., chemists and engineers of Boston, Mass., indicate that a great deal of money is wasted on lubricants because "good brands" are bought at any price. In one case an analysis of the cylinder oil for which a plant was paying 65 cents per gallon showed that, although a good oil, it was no better for the purpose than oils for which many large corporations are paying as low as 25 cents per gallon. A thoroughly good oil can be bought to rigid specifications at prices less than one-half of those usually charged for cylinder oils known by some special name. The saving thus accomplished is obvious.

* * *

Coes Wrench Co., Worcester, Mass., advertised a draftsman's eraser, belt or lace knife in MACHINERY, 1902. Recently an order was received for same from a party that enclosed a clipping of the original advertisement and referred to its date. This case is only one showing that the useful life of an advertisement in a valued journal is not limited merely to a few weeks or months.

A QUESTION IN SHAPER DESIGN

The article on the quick-return motion of the Stockbridge shaper, published in the October number, does not, in our opinion, properly set forth the merits of a plain slotted crank as compared with the more complicated quick-return mechanism previously described. Will you allow us to point out some of the objectionable features of this mechanism as applied to the back-geared crank shaper?

Fig. 1 shows the construction of our simple quick-return mechanism. It will be noted that there is but one bearing surface for the bull-gear as compared with ten bearing surfaces in the complicated quick-return mechanism which will be referred to later. The single bearing surface is that of the bull-gear hub in the column. This journal is hardened and ground and has a self-oiling device giving flooded lubrication which prevents it from wearing elliptical. It should be noted that the gear teeth are radial from a point within the bearing, to reduce the overhang as much as possible, and that the hub is very long to offset the overhang.

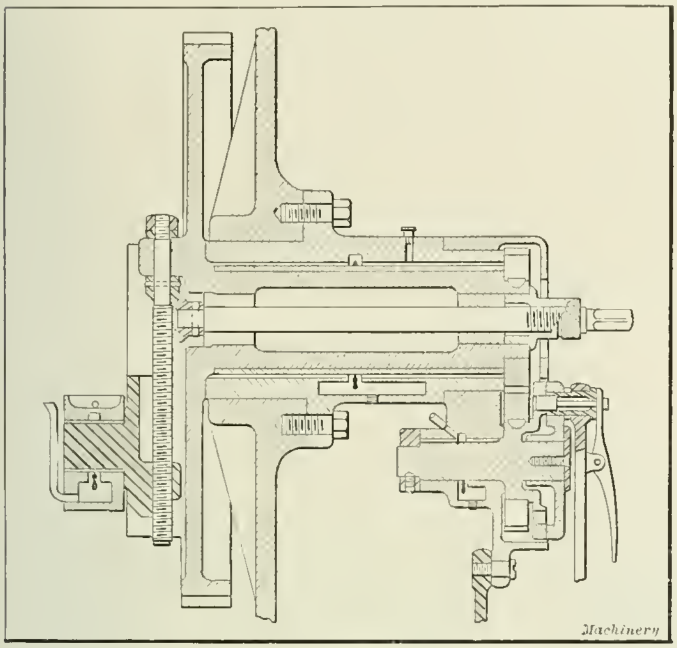


Fig. 1. Bull Gear and Crank of Queen City Shaper

Fig. 2 shows the four principal parts of the crank mechanism previously illustrated, and Fig. 3 is a reproduction of the assembled sectional drawing shown in the original article. The ten bearing surfaces, all of which are in action while the tool is cutting, are as follows: No. 1 runs in the column and corresponds to the center hub bearing of the simple quick-return mechanism, but although this bearing must take the full thrust of the cut, it is comparatively short. The other bearing surfaces are numbered so that the journal and its bearing can be easily located, the journals being indicated by Nos. 2, 3, 4, etc., and the corresponding bearings by 2_1, 3_1, 4_1, etc. No. 10 is in contact with a flange on the column.

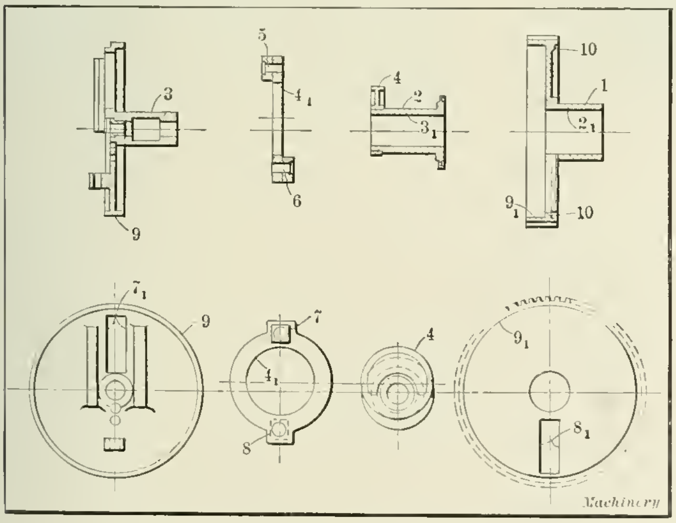


Fig. 2. Principal Parts of Mechanism illustrated in Fig. 3

Is it necessary to point out that these nine extra bearing surfaces increase friction and wear? It should also be noted that two of these bearings are flat rubbing surfaces (7 and 8) which act as a brake, and some of the radially moving parts are placed close to the periphery of the bull-gear, which is more objectionable from the standpoint of friction increase, than a well designed hub bearing. We should like to refer right here to your most excellent and timely editorial in the October number, entitled, "Complicated vs. Simple Machine Designs."

We freely admit that the quick-return mechanism illustrated in Fig. 3, does bring about the desired effect, in that it has a very quick return and an even cutting speed, but, at what a sacrifice of simplicity and loss of power! Reference is made to some tests published in the November, 1909, number of MACHINERY. While looking up these tests, which show the horsepower required for removing metal, please refer to the tests published in the March, 1909, number of MACHINERY, and compare the horsepower required to remove about four times the amount of metal. These two tests are compared on page 37 (advertising section) of the December, 1909, issue of MACHINERY.

Let us ask if an even cutting speed is desirable in planing? If so, why is Mr. Powell of the Powell Planer Co. so enthusiastic over his accelerating cut planer? Furthermore, it has been shown time and again that a quick return, in planing, is not nearly so important as the speed at which the cut can be taken. If the quick return is so important, why the variable speed planer with a constant return? The accelerating motion of the shaper is especially valuable, in that it reduces the shock of the tool when entering and leaving the work. The real question at issue is, how much work can be produced in a given time and at what expenditure of power? We claim that a shaper with the simple quick return, will not only take a much heavier cut or the same cut at a much higher speed, but it will make more full cycles of the ram per minute.

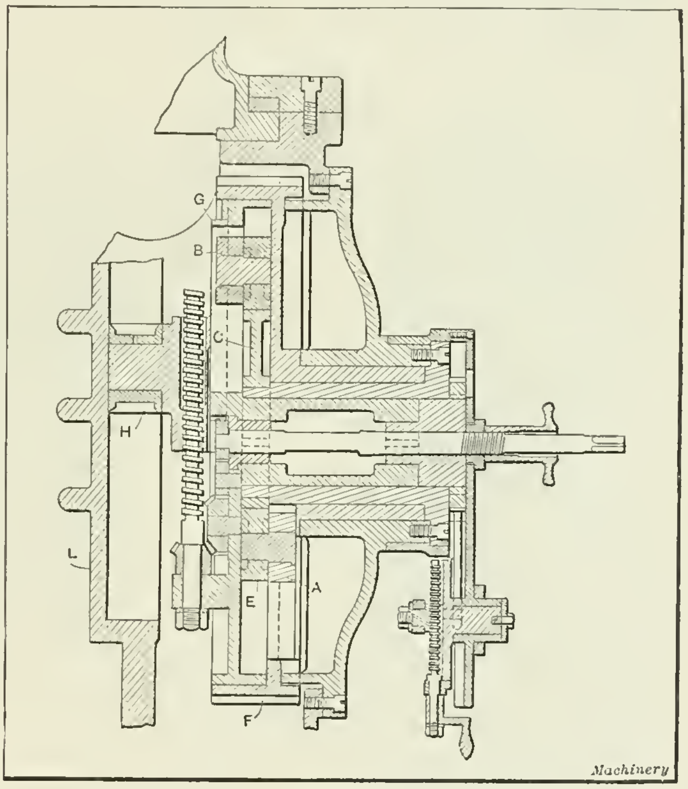


Fig. 3. Crank Mechanism of Stockbridge Shaper

Cincinnati, O. QUEEN CITY MACHINE TOOL CO.

[The article referred to in the foregoing criticism was not published in order to exploit the advantages of the quick-return mechanism which was the subject, but rather to analyze the motion; in other words, the article was more on kinematics than machine design. The movement obtained with the Stockbridge quick-return mechanism is, in our opinion, preferable to that derived from a plain slotted crank, as far as the motion itself is concerned, but any advantage resulting from a more constant cutting speed or quicker return than is imparted by a plain crank may, of course, be more than offset by the additional complication required. A gradual acceleration at the beginning of a cut is, no doubt, desirable in that it diminishes the shock. The advantage of this feature, however, is obtained in a somewhat lesser degree with a shaper having a constant cutting speed, because the accelerating period extends through a greater part of the stroke than would be required for tool clearance. After the cut is started, there is no reason why the velocity should vary. With the accelerating cut planer, the impact between the tool and the work is reduced by a slow start at the beginning of the cut; the speed is then increased but it remains constant for practically the entire cutting stroke. The question is: Are the disadvantages of the variable speed and slower return of a plain crank, great enough to warrant the addition of a more complicated mechanism that will give a constant cutting speed and a quicker return? We do not know.—Editor.]

* * *

SCIENTIFIC MANAGEMENT OF ARSENALS

According to newspaper reports, the War Department is making an investigation with a view to the introduction of scientific management at the army arsenals. The system has been tried out in the arsenal at Watertown, N. Y. As an example of the working of the system and of the results achieved, the following is abstracted from a report of Major-General Crozier, chief of the Bureau of Ordnance. A certain mold under the day wage system had taken 53 minutes to make, while a time study indicated that the molds could be made in 24 minutes each. A premium was, therefore, offered for every minute under 50 minutes in which the mold was made, and a workman was put at the task, following the suggestions given by the expert employed. This workman made the molds at an average of twenty minutes each. The castings from the molds so made could not be distinguished from the old ones. At one time, it is reported, this man did a whole day's work at the rate of one mold every fifteen minutes, and he once was observed to complete a mold in ten minutes. When these molds were produced in 53 minutes each, the labor cost, including helper and all other charges, was $1.17 each. When they were made in 20 minutes, the cost of each was reduced to 54 cents. There was thus a saving of 63 cents on each mold, and the net daily saving as the result of one man's work in this particular case was $15.10. When the molds were made at the rate of 53 minutes each under day wages, the molder's pay was $3.28 a day; when made in 20 minutes, the molder earned $5.74 a day.

THE SPHINX VALVELESS GASOLINE MOTOR

By R. W. HUTCHINSON, JR.*

After the design of internal combustion motors appeared to have been standardized and a type in which poppet or mushroom type valves formed an indispensable part had been adopted, the design was revolutionized a couple of years ago by the placing on the market of an engine somewhat erroneously known as a valveless motor. In place of poppet valves the new type of motor employed sliding or rotary sleeves uncovering ports in the cylinder walls. It is generally conceded that this sliding valve type of motor has the advantage of silence, especially at low engine speeds, and that at these speeds it develops greater power than the average poppet valve motor. It has the disadvantage, however, of greater complication, higher cost, and the absence of "foolproofness" found in the standard poppet type motor. A type of engine known as the "Sphinx" motor, which has all the advantages of the slide valve type, together with the best features of the poppet valve engine, has recently been developed. In this engine a split ring having a sufficient reciprocating motion within the cylinder to cover and uncover the intake and exhaust ports in the cylinder walls, is made use of.

The accompanying illustrations show various views of this engine. Fig. 2 shows a single cylinder type in which *A* is the intake port and *B* the exhaust port. At *C* is shown the split ring which regulates the inlet and exhaust at *M* and *N*. It will be seen that the cylinder differs from the usual poppet valve type by having no outstanding chamber to receive the valves. Down one side of the cylinder near the head of the casting are the two ports, and on the opposite side is a camshaft housing cast integral with the cylinder. The cylinder head is separate, and the spark plug is mounted in the center of the head, which is the best possible position. The split sliding ring consists of a gray iron casting having a length of face of 1½ inch for a motor of 4-inch bore and 5½-inch stroke. As shown in Fig. 4, this ring is provided with a hollow spindle or bearing block for receiving the rocker arm. The depth of the ring is greater around the hollow spindle than at any other point, this increased depth being necessary in order to cover the slot through which the rocker arm is passed from the outside to the inside of the cylinder. This slot in the cylinder wall is never uncovered. By means of a bell-crank *H* and an ordinary type of camshaft, as shown at *E*, Fig. 1, the necessary reciprocating motion of the ring is obtained to insure the different phases of a four-cycle motor.

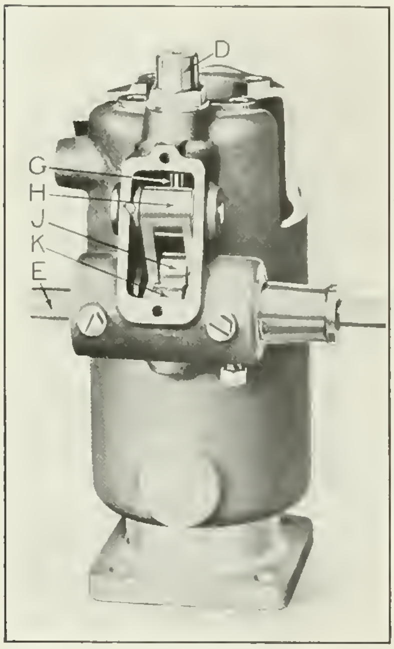


Fig. 1. Side View of Cylinder of Sphinx Gasoline Engine

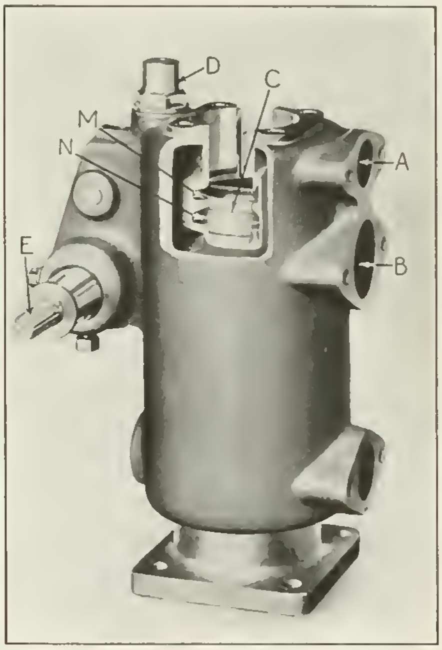


Fig. 2. Cylinder with Part of Metal cut away to show Sliding Ring

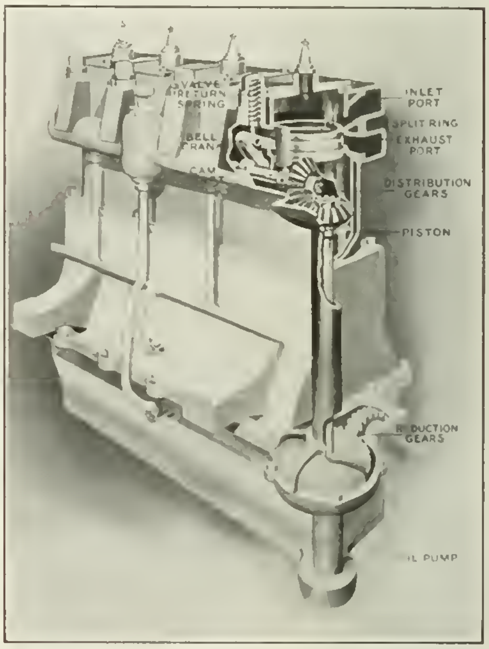


Fig. 3. Four-cylinder Engine shown partially in Section

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*Address: Care of Sphinx Motor Co., Room 2006, 30 Church St., New York.

One of the most valuable features of this motor is the large valve area obtained without the complication attending the use of large diameter poppet valves. In an investigation of specific designs it was found that the Sphinx motor had port areas of more than twice the areas of motors with poppet valves, for engines of equal bore and stroke. The walls of the sliding ring are in direct contact with the water jacketed walls of the cylinder, and work under practically the same favorable conditions as piston rings. As shown in Fig. 4 the short arm of the bell-crank carries a roller. This roller *J*, Fig. 1, is in constant contact with the face of cam *K* on shaft *E*. As the boss of the cam lifts the roller, the ring is raised. The return of the ring is obtained in practically the same way as in the case of a poppet valve, namely by means of a coil spring as indicated in Fig. 3. The housing for this spring is shown at *D* in Figs. 1 and 2.

The serious objection made to motors of the sleeve or rotary valve type—that in the case of defective lubrication the valve mechanism would seize and probably ruin the engine—is not applicable to this motor. If the spring should be unable to return the ring to its normal position, the exhaust port would merely be left open, and this would be far less serious a matter than the breakage of a valve or the seizing of a valve stem in its guide.

The walls of the cylinders are cooled all the way up to the head, but the head itself is not water-cooled. The lubrication is taken care of in a satisfactory manner. All the main bearings receive their oil supply under pressure, and the crankshaft is bored out to allow a supply of lubricant to reach the connecting-rod ends. The oil thrown out from the bearings is sufficient for proper lubrication of the cylinder walls.

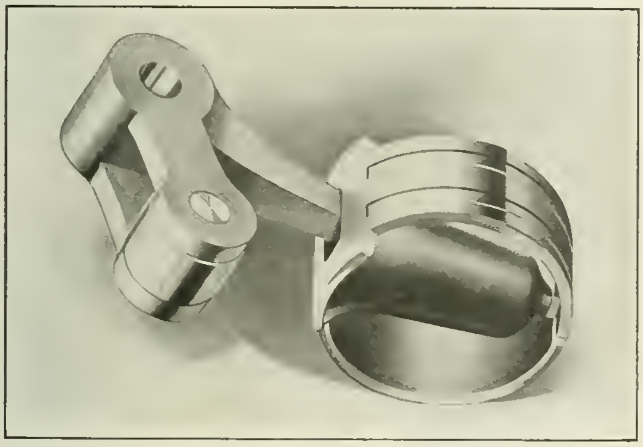

Fig. 4. Sliding Ring and Bell-crank

Rotation of the camshaft can be obtained in several ways, one of these being by means of a vertical shaft at one end of the engine, as shown in Fig. 3. This shaft is driven from the main shaft by means of helical gearing and engages the camshaft by means of bevel gearing. On the lower end of the vertical spindle is the oil pump, drawing its supply of lubricant from the base of the crank chamber. The motor is practically silent in operation, as there are but one pair of bevel gears and no valves causing a tapping noise as they come into contact with their seats, nor any tappet rods striking the ends of the valve stems. The motor will remain silent after long use, there being practically no parts which will cause noisy action as the result of wear.

The nature of the ports and the design of the split ring allow the valves to open quickly and to remain with the maximum of opening for a long period. On the 4 by 5½-inch four-cylinder type, the exhaust is closed at the upper dead center. During the first 60 degrees the opening of the intake port has attained an area of approximately 2.3 square inches. It is gradually increased until the maximum of about 2.6 square inches is obtained at 90 degrees. The intake port now gradually closes until it is completely closed at 18 degrees after having reached the lower dead center. The exhaust opens 32 degrees before the lower dead center is reached, obtains its maximum opening at the lower dead center, and is closed at the upper dead center.

CRAMER PROCESS FOR HARDENING HIGH-SPEED AND CARBON TOOL STEEL

An interesting process for hardening steel, especially high-speed steel has been developed by Cramer & Longo, 933 East Ave., Belvidere, Ill. The method is cheaper than the methods ordinarily employed, and the results obtained are remarkable. As the process has not yet been fully covered with patents, detailed information is not yet available, but some of the interesting results obtained deserve to be mentioned. Formed tools for screw machine work, for example, can be hardened without any distortion and can be put to work without polishing or grinding after hardening. Even the cutting edge can be sharpened before hardening, so that the tool can be placed in the machine where it is to be used immediately after coming out of the hardening bath. As a notable example, it is stated that a hollow ground razor had been hardened by this method and used for shaving without stropping. Another advantage of the process is that it does not require a skilled mechanic to accomplish good results, but any man of ordinary ability can acquire enough experience to turn out good work in a few days.

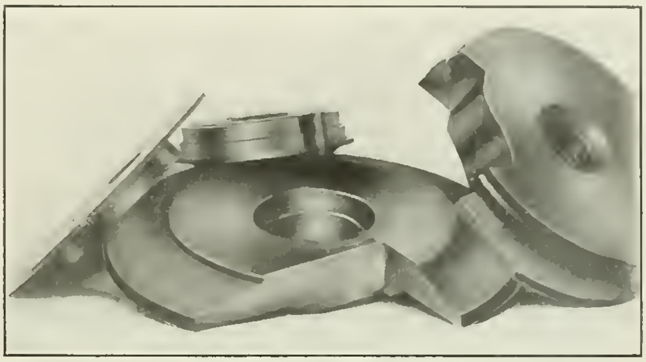

Fig 1. Forming Tools hardened by the Cramer Process. No Sharpening after Hardening is required

The accompanying illustrations Figs. 1 and 2 shows some examples of work that has been hardened in this manner. The screw machine forming tools shown in Fig. 1 were put to work immediately after having been hardened, as was also the milling cutter shown in Fig. 2.

It would seem that this method would be of considerable value in making it possible to use high-speed steel satisfactorily for keen-edged tools which cannot be ground after hardening, such as taps, dies, knurls, etc. In the past, the great difficulty with these tools has been that on account of the high heat to which high-speed steel must be heated in order to be properly hardened, the delicate edges of the tools were fused before the remainder of the tool had acquired the proper hardening heat. With a method where regrinding of the tool is obviated, this difficulty is entirely avoided. It would also seem that the process would be of great value for hardening steel gears, as there is no distortion of the hardened object, and the present difficulties of automobile concerns with regard to the distortion of hardened gears are well known. The process promises to mark one of the epochs in the hardening of steel.

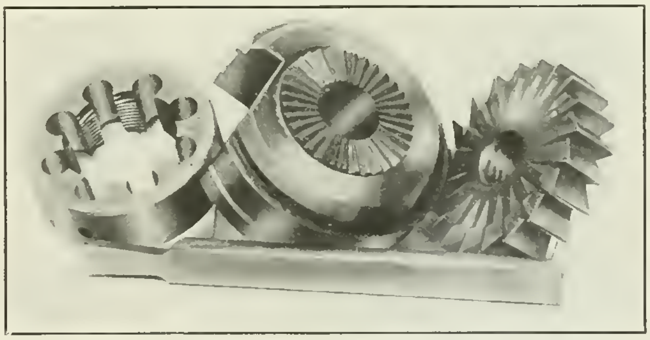

Fig. 2. Other Examples of Work hardened by the Cramer Process

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More than one-third of the gold production of the world came from Transvaal in 1910. The United States contributed about 20 per cent of the total, and Australia, 14½ per cent.

POINTS IN THE OPERATION OF THE "LO-SWING" LATHE

The "Lo-swing" lathe, manufactured by the Fitchburg Machine Works, Fitchburg, Mass., was described in MACHINERY in the November, 1905, issue. Improvements upon this design have been later described in the September, 1907, and the May, 1909, numbers. In June, 1909, an article entitled "Operations performed on the Lo-swing Lathe" was also published, giving a description of the methods used in turning work adapted to be machined on this lathe. In the present article therefore, it is not proposed to describe the machine itself, but to give a few points with relation to its operation, in order to indicate how the highest efficiency may be obtained by the use of a machine of this type.

As may be remembered from the description previously published, the "Lo-swing" lathe is adapted for the turning of shafts, axles, and similar work, not exceeding 3½ inches in diameter. The usual cross-slide is eliminated, and the adjustment of the tools is obtained by a micrometer adjusting screw bearing against the end of the tool, which is itself placed in a heavy tool-holder. This construction reduces vibration at the cutting point, and permits higher speeds and greater depth of cut. The main feature in addition to this is the facilities provided for "multiple" turning, that is, the turning of a number of diameters simultaneously, and it is in cases where the work must be turned on centers to several different diameters or tapers that this machine has a decided advantage over the engine lathe.

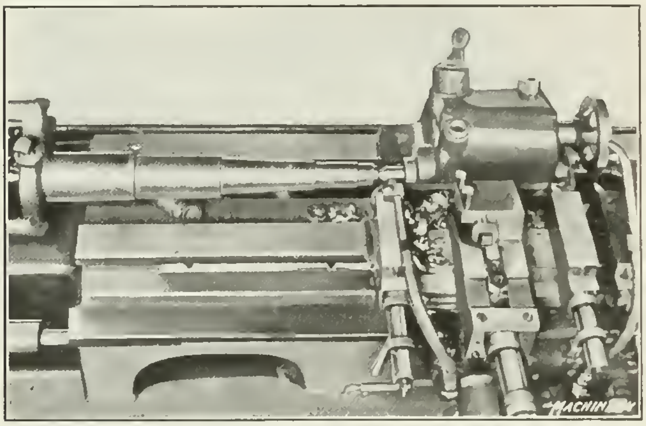


Fig. 1. The "Lo-swing" Lathe in Operation, with Carriage slid by Tailstock

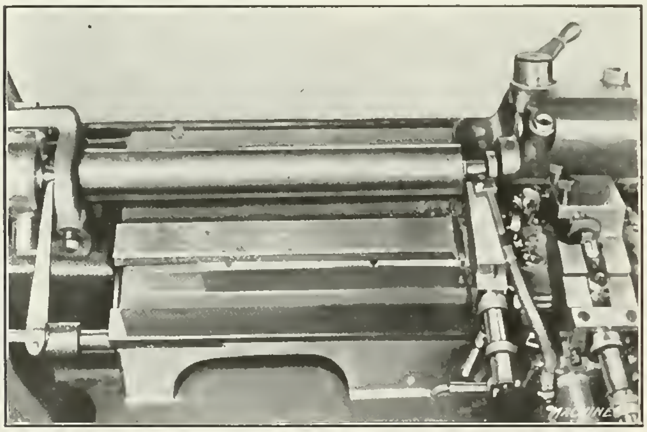


Fig. 2. The Indicator in Use

The tailstock is of the over-hung construction, being cut away at the front, thus permitting the carriage to slide by to facilitate removal of the work without disturbing the adjustment of the tools. This feature is illustrated in Fig. 1. The carriages accommodate from one to six tools each. The stop-rod on the lathe, with its stop-collars, engages projecting pins on the carriages which, in turn, throw out the carriage feed. In Fig. 2 an indicator is illustrated which is located upon an arm that swings from the end of the stop-rod. In cutting off work and centering, there are apt to be slight variations either in the length of the pieces or in the depth of the centering. Variations of either kind would result in differences in the finished work; therefore, when a piece is placed upon the centers, this indicator arm is thrown up to the position shown in Fig. 2. The bearing end of the indicator is placed against the end of the work, and by means of a small lever on the stop-rod, it is adjusted until the indicator needle is central. This adjustment is accomplished by means of a coarse-pitch thread in the left-hand bearing of the stop-rod. It will be seen that in this way all pieces are turned with relation to the end face of the work, and if, as is often necessary, the work is reversed on the centers and turned from the opposite direction, the indicator is brought into play again, being used against the nearest shoulder left by the previous operation.

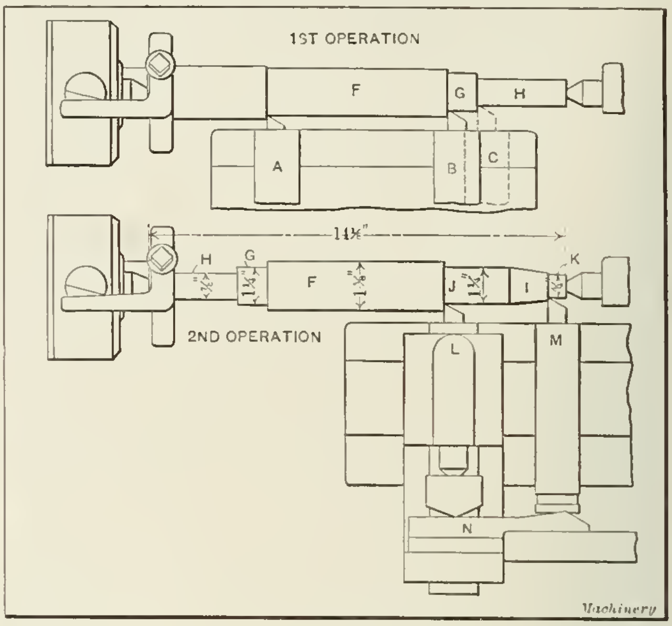


Fig. 3. Arrangement of Tools

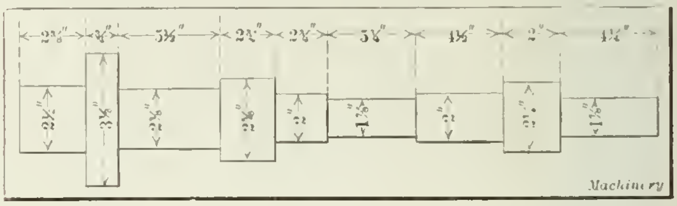


Fig. 4. Example of Work done in the "Lo-swing" Lathe

Setting up and Starting a Job of Multiple Turning

When it is required to set up the lathe for a new job, templets must first be made for the tapering parts of the work. These templets are used in connection with the taper attachment, and are made from steel ½ inch thick. Templets are also made for curves or other irregular sections that must be produced. The templets may be made to turn the work partly straight and partly tapered, as indicated by the diagrammat-

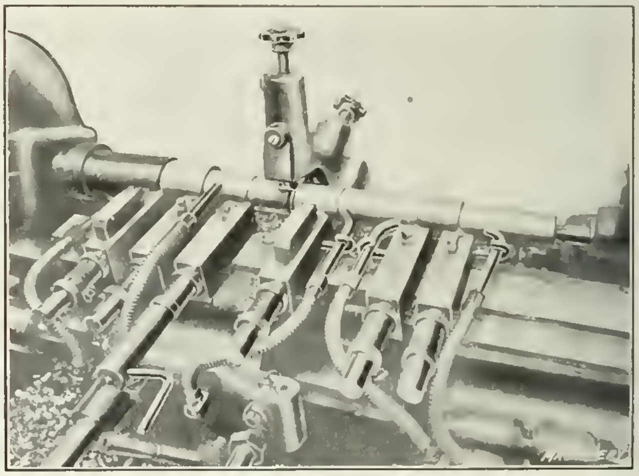


Fig. 5. Work shown in Fig. 4 being turned

ical view in Fig. 3. According to the nature of the work, one or both of the carriages will be required.

Fig. 3 illustrates clearly the way in which an average job of multiple turning is done. In setting up the tools for the first operation, the tools *A* and *B* are located on the first carriage at the exact distance apart that the shoulders must measure on the finished piece; then a stop-collar is located on the stop-rod at the proper place to throw out the feed of the forward carriage at the exact point where the first shoulder must be located with relation to the end of the bar. The tools must also be located by means of the individual micrometer adjustments provided for each tool, so as to turn each portion to its proper diameter. The rear carriage is finally set up with a single tool adjusted to turn section *H*. The stop-collar for the rear carriage is located on the stop-rod to throw out the second carriage feed when section *H* has been turned to the proper length. All the shafts to be turned pass through this operation, and then the machine is set up as shown in the lower view in Fig. 3 for the second operation.

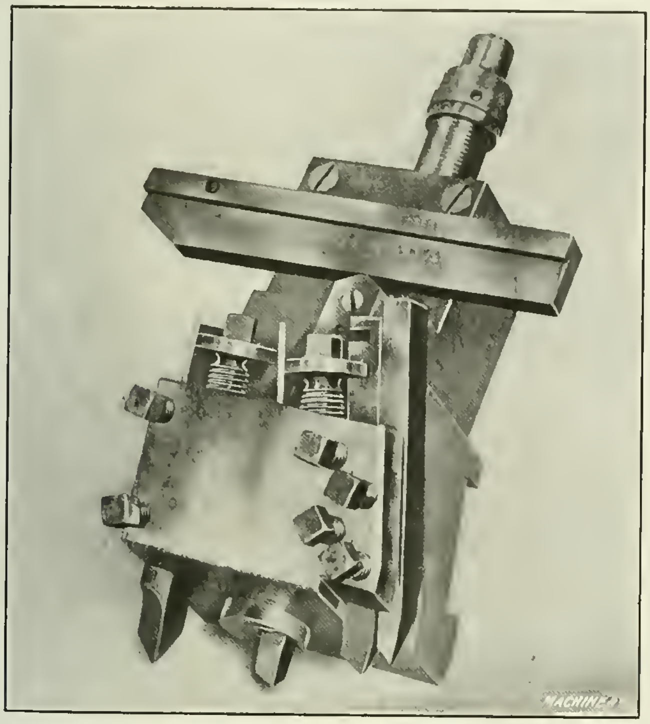


Fig. 6. Special Form of Tool Block

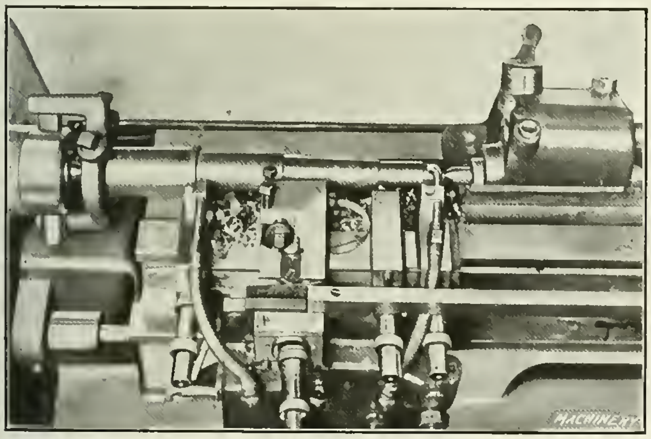


Fig. 7. Tool Arrangement for an Average Piece of Work

In this case the forward carriage only is used and the taper cutting attachment is brought into action. The templet *N* guides tool *L* in turning sections *I* and *J*. Tool *M* is adjusted on this carriage to turn part *K*. The shafts are now all finished by this operation, the automatic measuring device previously referred to being used against the shoulder of section *G* to obtain accurate results.

In turning a piece such as shown in Fig. 4, it would be impossible to obtain square shoulders on the recessed portions without a previous "necking" operation, which consists in taking a square cut to form such shoulders as are at the ends of the recesses. Two tools are used in "necking," the cutting end of the tools being similar to the points of ordinary cutting-off tools.

Often when work is slender, and especially when heavy cuts are to be taken, it is advantageous to spot a central section to receive the steadyrest; in some cases a longer section is turned and the follow-rest used, the same as in an ordinary engine lathe. The piece shown in Fig. 4 is turned from a machine-steel forging of 0.65 per cent carbon steel. The tools used for turning this piece are shown in Fig. 5.

A special tool used in the lathe is shown in Fig. 6. In addition to the taper cutting attachment and the extra tool shown at the left, this special tool block carries two additional tools at the right. The reason that a special tool block is not used for these tools is because of their close spacing, which necessitates that the tools be held in the same tool block with the tool for the taper turning.

One of the most important features is an ample supply of cutting compound for cooling the tools. This is supplied by means of a pump within the head of the machine whence the compound is pumped to supply a pipe for each carriage. From these supply pipes, metal-cased flexible tubes convey the lubricant to the cutting points. The flow from each of these branch pipes is controlled by valves. This arrangement is clearly indicated in Fig. 5. Fig. 7 shows an illustration of an average turning job, of the type for which the machine is adapted, being carried out on the lathe.

* * *

MODERN WELDING METHODS

On account of the wide interest in modern welding methods, the monthly meeting of the American Society of Mechanical Engineers, held November 14 at the Engineering Societies Building, New York, was devoted to the presentation of papers and discussion on the autogenous, electric, and thermit processes of welding. Representatives of both the makers and users of apparatus for welding by the processes mentioned participated in the discussion. The subject was introduced by Mr. H. R. Cobleigh of the International Steam Pump Co., New York, who dealt principally with apparatus for oxy-acetylene and oxy-hydrogen welding. The origin and principles of the various processes were referred to, and illustrations of the development of the blow-pipe and apparatus for autogenous welding were shown.

Mr. G. E. Pelissier of the Goldschmidt Thermit Co., New York, presented a paper on "Thermit Welding" followed by a series of moving pictures showing the work of welding rail joints under ordinary working conditions on the street. In the application of the thermit process two distinct methods are employed. In one case the heat of the chemical reaction of the burning thermit is utilized for obtaining a welding temperature of the parts which are then forced together. In this case the process involved is that of butt-welding. This method is chiefly applied for welding pipes, tubes and small rods. Pipes from 1 to 6 inches in diameter, and rods up to 2 inches in diameter can be advantageously welded by this method. The strength of the welded section is from 80 to 90 per cent of the strength of the solid pipes or rods. In the other method, used for large work particularly, the ends of the pieces to be united are not forced together, but are merely fused and united by the molten metal resulting from the reaction of the burning thermit which amalgamates with the molten metal of the ends to be welded together. In the first method mentioned the ends are filed or machined carefully to fit. In the second method, again, the parts are not brought close together, but a space of ½ inch to 2 inches is allowed for the free flow of the thermit metal. The faces of the metal may then be rough, and molds are used around the parts to be welded.

"Electric Arc Welding" was treated in a paper by Mr. C. B. Auel of the Westinghouse Electric & Mfg. Co., East Pittsburg, Pa. The three processes dealt with were the Benardos, Salvianoff, and Zerener. The latter process, which consists in using two carbon electrodes for producing welding heat in the parts to be welded, and which has sometimes been called the electric blow-pipe method, is not used at all in the United States, and only to a very limited extent abroad. The Benardos process is perhaps most commonly used, and consists in using one of the objects to be welded as one electrode, while the other electrode is of carbon. In an endeavor to prevent the formation of hard welds sometimes produced by the Benardos process, Slavianoff substituted a metal electrode for the carbon, this metal electrode usually being of the same material as the metal welded. Considerable attention is required with regard to some details when using this method. In welding iron or steel, the electrodes should be of soft iron from ⅛ to ¼ inch in diameter and about 12 inches long. The current should be of from 125 to 175 amperes with 25 to 30 volts across the arc. The length of the arc is usually from 1/8 to 3/16 inch, while in the Benardos process the arc is from 3/4 to 1 inch long. The Slavianoff process is used where the strength of the weld is of importance.

The Benardos process has several advantages over other processes. It is cheaper and permits more rapid work, and is especially used for rough, large work where appearance and strength are not of prime importance. Mr. Auel stated that the oxy-acetylene and oxy-hydrogen processes are superior to the Benardos electric process in the average strength of welds and in the smoothness of finish, but these advantages are, in the majority of cases, obtained only by higher cost.

A great number of the men connected with the companies manufacturing welding outfits participated in the discussion. However, a detailed review of the papers presented has not been deemed necessary as the various processes have been completely treated in the columns of MACHINERY during the past years.* The possibilities of these various welding processes have hardly been taken advantage of to the extent that seems practicable and economical. The processes are by no means limited to repair work, as is very commonly assumed, but are revolutionizing many practices in regular manufacturing.

* * *

MATTER REDUCED TO THE MOLECULE

In a paper on "Deflocculation" read by Dr. E. G. Acheson, of Niagara Falls, N. Y., the well-known inventor of carborundum, Acheson graphite, etc., before the London Society of Chemical Industry, the theory and practice of deflocculation was dealt with in an interesting manner. One of the particular points of interest brought out by Dr. Acheson was that lamp-black treated by his method would produce an indelible printing ink. At the close of his address Dr. Acheson made a most radical claim to the effect that his process reduces matter to the molecule. An article on deflocculated graphite appeared in the July, 1907, number of MACHINERY.

* * *

DECISION IN MOLDING MACHINE PATENT CASE

The United States Circuit Court of Appeals has handed down a decision in the patent infringement suit brought by the Tabor Mfg. Co., Philadelphia, Pa., against the Mumford Molding Machine Co., Plainfield, N. J. The patents involved covered improvements in molding machinery. Judge Lanning did not sustain the contention of the plaintiff, but decided that there was no infringement on any of the patents under consideration.

PERSONALS

George L. Spence has been appointed sales manager of the Pratt & Cady Co., Hartford, Conn.

G. P. Blackiston entered into the employ of the United Steel Co., Canton, Ohio, as advertising manager, on November 1.

E. G. Acheson, of Niagara Falls, N. Y., read a paper on "Deflocculation," on November 7, before the London Society of Chemical Industry.

F. H. Meyers has been appointed assistant superintendent of the Standard Welding Co., Cleveland, Ohio. Mr. Meyers has for many years been in the employ of this firm.

A. B. Enbody has been appointed assistant master mechanic of the Lehigh and Susquehanna division of the Central Railroad of New Jersey. Mr. Enbody will be located at Mauch Chunk, Pa.

Charles Churchill of Charles Churchill & Co., Ltd., London, England, recently spent a month in this country, principally visiting his friends and relatives. He sailed for home on the *Lusitania* on November 29.

Coker F. Clarkson, secretary and general manager of the Society of Automobile Engineers, New York, sailed with a party of automobile engineers for Europe on the *Mauretania* on November 1. Automobile plants in England and on the Continent will be visited.

Charles E. Hague has been appointed representative in charge of the Philadelphia office of the Best Mfg. Co., of Pittsburg, Pa. His office will be located at 1510 Land Title Bldg., and he will have charge of Eastern Pennsylvania, and the Baltimore and Washington territory.

H. N. Anderson, chief engineer of the Speedwell Motor Car Co., Dayton, Ohio, resigned December 1. Mr. Anderson gave up his position in order to give his entire time to his process of rolling teeth in steel gear blanks while hot. See MACHINERY, November, 1910, for description of the process.

Robert Grimshaw, who represents the National Association of Manufacturers in Germany, has had the Foster pressure regulators introduced on the cars of the Roumanian State railways, and the first lot of these is being built in Austria under the patents of the Foster Engineering Co., of Newark, N. J.

A. M. Welch, who was employed with the Studebaker Co., of South Bend, Ind., for about eight years, and who for the past year has been manager of the commercial car department of the H. H. Franklin Mfg. Co., of Syracuse, N. Y., has entered the employ of the Stevens-Duryea Co., of Chicopee Falls, Mass., for which company he will take up territorial work.

George Walworth Hayden has been elected president of the Pratt & Cady Co., Hartford, Conn. Mr. Hayden, who has been in the valve business for twenty-three years, having started in this work with the Crane Co., of Chicago, Ill., entered the employ of the Pratt & Cady Co. two years ago as general manager.

Frank L. Sessions has been made superintendent of the Standard Welding Co., Cleveland, Ohio. Mr. Sessions graduated from the Worcester Polytechnic Institute in 1889. He is a member of the American Society of Mechanical Engineers and of the American Institute of Electrical Engineers. His extensive experience in handling complicated manufacturing problems thoroughly equips him for his present duties.

Ralph E. Flanders was married on November 1 to Miss Helen Edith Hartness, a daughter of James Hartness, the president of the Jones & Lamson Machine Co. of Springfield, Vt. Mr. and Mrs. Flanders will continue to live in Springfield, where a house has been built for them, and Mr. Flanders will continue to give his attention to the work of the Fellows Gear Shaper Co. with which he is connected. Many of our readers will remember Mr. Flanders' work as Associate Editor of MACHINERY for a number of years, and especially those who are personally acquainted with him will join us in congratulations.

* * *

OBITUARIES

Francis B. Wilson, treasurer of the Jewell Belt Hook Co., Hartford, Conn., died at his home, 132 Jefferson St., after a long illness, on November 6, aged fifty-six years.

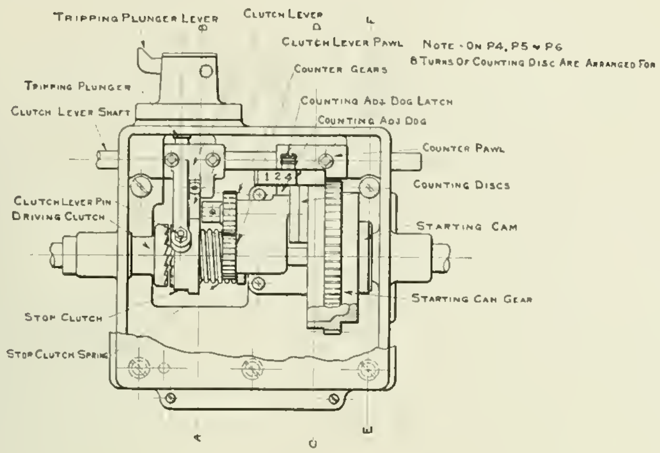
C. L. Rice, a pioneer in the mill supply business and one of the oldest members of the Dodge Mfg. Co.'s selling force, died as a result of a street accident in Chicago, Ill., November 3, aged eighty-nine years.

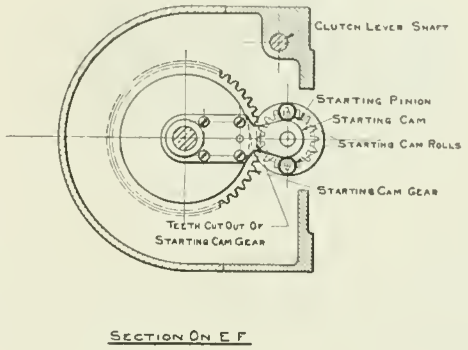
Thomas Fitzsimons, one of the original incorporators of the Novelty Mfg. Co., Waterbury, Conn., and for a number of years actively connected with it, died at his home, 83 Cherry St., Waterbury, Conn., November 5, aged seventy-three years.

T. F. Salter, manager of the sales and engineering departments of the Standard Roller Bearing Co., of Philadelphia, Pa., died very suddenly at his home in that city on Wednesday, October 25, at the age of thirty-five years. Mr. Salter was a member of the American Society of Mechanical Engineers and of the Society of Automobile Engineers.

The following articles previously published in MACHINERY on the oxy-acetylene process and the apparatus used for same may be referred to: "The Oxy-Acetylene Process and the Steel Car," May, 1911; "Goodyear Oxy-Acetylene Equipment," December, 1910; "Dangerous Oxy-Acetylene Apparatus," May, 1910; "Autogenous Welding Equipment for Light Work," July, 1909; "Autogenous Welding as a Means for Repairing Cylinders," April, 1909, engineering edition; "The Application of Autogenous Welding to Automobile Repairs," December, 1908; "Autogenous Welding," November, 1908, engineering edition; "Oxy-Acetylene Process of Metal Cutting and Autogenous Welding," October, 1908; "Autogenous Welding," July, 1907, engineering edition; "Acetylene Gas for Welding," September, 1906, engineering edition. The principles and application of electric welding and machines for doing work of this kind have been treated in the following articles previously published in MACHINERY: "Point and Ridge Method of Electric Welding," September, 1911; "Toledo Spot Welding Machines," June, 1911; "Electric Butt-Welding," October, 1910, engineering edition; "Electric Welding of Copper, Brass and Aluminum," March, 1910, engineering edition: "Toledo Electric Welding Machines," September, 1909; "Electrical Welding," February, 1909; "Electric Welding of Dissimilar Metals," July, 1908; "Some Examples of Electric Welding," April, 1908. The thermit process has been dealt with in the following articles: "Welding a Large Crankshaft with Thermit," July, 1910; "Novel Use of Thermit," February, 1908, engineering edition; "Thermit Repairs of Steamship Stern Frame and Rudder Post," December, 1907; "Thermit Welding of Locomotive Frames," August, 1905; "The Thermit Process," March, 1903; "The Use of Thermit for Repairing," March, 1903.

To cut accurate gears quickly, special features must be embodied in the indexing mechanism

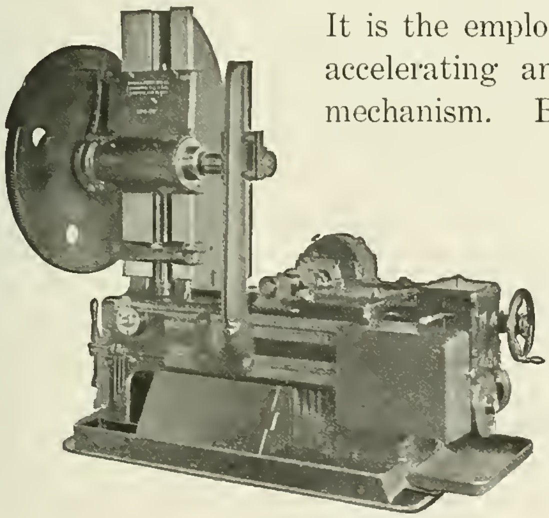




B & S AUTOMATIC GEAR CUTTING MACHINES

The accuracy of gears is almost sure to be impaired if they are cut on a machine the indexing mechanism of which operates with a shock.

Two methods can be used to prevent this. The first method is to run the index mechanism at a very slow rate of speed, thus securing accuracy at the sacrifice of time and at a great expense.



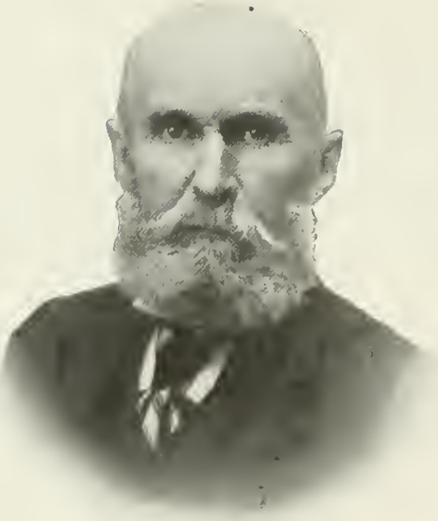
The other method is just as sure and more economical. It is the employment of a machine equipped with an accelerating and retarding motion of the indexing mechanism. By such means the indexing begins slowly, increases to a rapid rate, and then gradually comes to a stop. This does away with all shock, obviating inaccuracies due to this cause.

This is an exclusive B & S feature.

There are many other excellent features, all of which are explained in a circular, mailed on request.

BROWN & SHARPE MFG. CO.

PROVIDENCE, RHODE ISLAND, U. S. A.



RICHMOND VIALL

Richmond Viall, superintendent of the Brown & Sharpe Mfg. Co. since 1878, and one of the most widely known and highly esteemed men in the machinery industry, died at the Newport Hospital on November 9, from a paralytic stroke, in the seventy-seventh year of his age.

Mr. Viall was born in Barrington, R. I., December 16, 1834, and descended from one of the oldest New England families, which came to this country from England. Receiving his early schooling in East Providence, to which town his father had moved, he left at the age of seventeen to become a jeweler's apprentice. After remaining in the employ of Briggs, Hough & Stone for four years he went to Attleboro, Mass., in 1857, and worked at his trade until the Civil war broke out. Then for two years he engaged in the manufacture of cavalry sabres.

On January 6, 1863, Mr. Viall entered the employ of J. R. Brown & Sharpe as a screw machine operator, working for an average day's pay, and in a little less than a year he became foreman of the department, with thirty-seven men under him. In 1872, when the plant was moved to its present location, Mr. Viall assumed charge of the department devoted to the manufacture of the Willcox & Gibbs sewing machines, and six years later became superintendent of the works, a position which he held until his death. Although he retired from active work in 1902, he retained his interest in the company almost to the end. Taking hold of the superintendent's work in 1878, immediately after the panic, Mr. Viall found a world-wide demand for the company's product which was being supplied with a force reduced to less than 200 men on account of the financial depression. As the effects of the panic wore away the force of employes began to increase, and upon his retirement in 1902 more than 2000 men were on the pay-roll, and the floor space had increased to 360,000 square feet, or 8½ acres.

Many factors have contributed to the growth of the Brown & Sharpe Mfg. Co. One was the inventive genius of Joseph R. Brown, coupled with his high standard of workmanship, which has always been maintained; another was the far-sighted policy consistently adhered to by Lucian Sharpe, a man of unusual business ability; a third was Mr. Viall's personality. Not only was he qualified to superintend the practical operations of a large shop, but his democratic spirit, keen insight into human nature, and loyalty, all united to fit him in an unusual degree for the business he helped to expand. He was not a great mechanic in the ordinary sense, but he possessed executive ability and sterling integrity, and to these qualities must be attributed his remarkable and successful life.

In his work Mr. Viall fully realized the value of cooperation, and there was no more striking example of this than his willingness to work with his foremen and give each man credit for what he accomplished. He never allowed petty jealousies to disturb him or to arise among his men. He insisted upon honesty and dependableness among his foremen, and no man was chosen for this position unless he had these characteristics. It was Mr. Viall's opinion that the dissatisfaction and unsettled feelings which sometimes arise in the shop are caused in a great measure by unfair rivalry and by misunderstandings between the foremen and workmen. Accordingly he emphasized the law of mutual helpfulness, in the belief that cooperation increases the value of both skilled and unskilled workmen, and also tends to unify and harmonize shop life. Mr. Viall's reputation for giving careful directions as to the manner in which his instructions were to be carried out was such that there was never any doubt in the mind of the recipient as to the right course to follow.

No record of his life would be complete, however, without mention of his kind and sympathetic nature. He was always mindful of the welfare of his men and often visited them, searching out those whom he thought might need his help. It has been said that he was imposed upon many times, but he preferred to be imposed upon rather than injure anyone. And when he made a mistake and found that somebody had suffered through his error he sought out and apologized to the injured person. Mr. Viall's associates in business, those who knew him personally, and the thousands of men who have been at one time or another under his care, and who are to be found all over the world, will remember him with affection and admiration.

Mr. Viall was married in 1859 to Eliza M. Cole. Four children were born to them; one of them, William A. Viall, now being the secretary of the Brown & Sharpe Mfg. Co.

CHARLES H. PHILLIPS

Charles H. Phillips, well known to the machinery trade of the East, died on November 3 at his home in Providence, R. I., at an age of seventy-eight years. Up to two years ago, Mr. Phillips was in the employ of the Brown & Sharpe Mfg. Co., at which time he had been with this company more than forty years. For twenty-two years he represented the Brown & Sharpe Mfg. Co., as salesman in the Eastern territory.

Born in Taunton, Mass., in 1832, Mr. Phillips received a common school education and then became an apprentice at the Mason Machine Co., of Taunton. Here he obtained his fundamental training as a mechanic, and after eleven years, in 1856, he entered the employ of the firm of J. R. Brown & Sharpe, as the Brown & Sharpe Mfg. Co. was then known. After one and one-half year he became contract-foreman in the old Burnside Rifle Works, where he was very successful in manufacturing the old Burnside and Springfield rifles. After having been with this firm nine years, he again entered the employ of the Brown & Sharpe Mfg. Co., in 1867, as contract-foreman of the milling machine department. This position he held when he began to make trips representing the company twenty-four years ago. He was very successful as a salesman, and his success was due as much to his honesty in his dealings with his customers as to his loyalty to his firm. Outside of his work his chief interest was centered around his church, and he was actively engaged in that work almost up to the time of his death. He was also a member of the Odd Fellows. He is survived by four children, two sons and two daughters.

* * *

COMING EVENTS

December 5-8.—Annual meeting of the American Society of Mechanical Engineers in New York. Calvin W. Rice, secretary, 29 W. 39th St.

December 5-8. Annual meeting of the National Gas and Gasoline Engine Trades Association at the Hotel Hollenden, Cleveland, Ohio. An exhibit of accessories will be an important feature of the convention. Albert Stritmatter, secretary, 224 E. Seventh St., Cincinnati, Ohio.

January 6-13.—Passenger automobile exhibition, Madison Square Garden, New York.

January 10-17.—Combined passenger and commercial car exhibition, Grand Central Palace, New York.

January 15-20.—Commercial vehicle exhibition, Madison Square Garden, New York.

January 18-20.—Annual meeting of the Society of Automobile Engineers in New York. Coker F. Clarkson, general manager, 1451 Broadway, New York.

January 27-February 3.—Passenger automobile exhibition, Coliseum and First Regiment Armory, Chicago, Ill.

February 5-10.—Commercial vehicle exhibition, Coliseum and First Regiment Armory, Chicago, Ill.

May 14-17.—Sixth annual convention of the Master Boiler Makers' Association at the Fort Pitt Hotel, Pittsburg, Pa.

June 12-14.—Annual convention of the American Railway Master Mechanics' Association at Atlantic City, N. J.

June 17-19.—Annual convention of the Master Car Builders' Association at Atlantic City, N. J.

September 2-7.—Sixth congress of the International Association for Testing Materials at the Engineering Societies Building, 29 W. 39th St., New York. One of the important functions of this association is to establish standard specifications for materials used in manufacture and construction. The cooperation of engineers and others who are engaged in the purchase and use of the raw materials of the trades, is requested. The annual dues are $2, with no initiation fee. Mr. H. F. J. Porter, secretary, 1 Madison Ave., New York.

SOCIETIES AND COLLEGES

MARYLAND AGRICULTURAL COLLEGE, College Park, Md. Catalogue 1911-1912, giving a complete review of the college courses, entrance requirements, expenses, etc.

SOCIETY OF RAILWAY CLUB SECRETARIES, 95 Liberty St., New York. Index of papers and subjects discussed by railway clubs from May 31, 1910, to May 31, 1911.

COME AND SEE US IN OUR NEW PLANT

THE CINCINNATI MILLING MACHINE COMPANY

THE PLANT DRAWN TO AN EXACT SCALE

OUR new plant is only 40 minutes from the hotel district. It contains 275,000 square feet of floor space exclusive of power house, which makes it the largest milling machine manufacturing plant in the world. The buildings have been planned for the most efficient handling and routing of materials, and provide ideal factory conditions as to lighting, heating and ventilation. Our equipment has been especially selected and tooled up for manufacturing in large quantities. Many important parts are made on machines designed especially for individual operations.

These things are not possible in the shop producing a smaller volume. They enable us to produce very much better machines and give you bigger value for the price.

We devote all our time and energy to the design and manufacture of Milling Machines and Milling Cutter Grinders. By this specialization and this concentration of effort on the part of a corps of men especially trained in this line of work, we are able to produce machines of the highest quality as to design, materials and workmanship.

THE CINCINNATI MILLING MACHINE CO.

CINCINNATI, OHIO, U. S. A.

American Museum of Safety, 29 W. 39th St., New York. Safety leaflet No. 2 on foundry safeguards, showing some safety devices for preventing accidents to the molder.

American Brass Founders' Association. Bulletin No. 10, containing list of new members elected, review of important articles in the engineering press, and a review of patents of interest to brass founders.

University of New Mexico, Albuquerque, N. M. Bulletin No. 61 entitled "How the Curriculum of the Secondary School Might Be Reconstructed." The bulletin contains 25 pages, 5¼ by 7½ inches, and includes considerable matter of interest to those engaged in educational work.

NEW BOOKS AND PAMPHLETS

Electrical Accidents in Mines, Their Causes and Prevention. Miners' Circular No. 5. 10 pages, 6 by 9 inches. Published by the Department of the Interior, Washington, D. C.

Farming Possibilities of the Delaware, Maryland and Virginia Peninsula. 52 pages, 5½ by 7¾ inches. Illustrated with halftones. Published by the Pennsylvania Railroad, Philadelphia, Pa.

Pennsylvania Railroad at the American Land and Irrigation Exposition in New York, November 3-12, 1911. 38 pages, 4¼ by 6¾ inches. Published by the Pennsylvania Railroad, Philadelphia, Pa.

Annual Report of the Chief of Bureau of Manufactures to the Secretary of Commerce and Labor for the Fiscal Year Ended June 30, 1911. 16 pages, 6 by 9 inches. Published by the Department of Commerce and Labor, Washington, D. C.

Constructive Railway Policies. 30 pages, 6½ by 9½ inches. Published by the Railway Business Association, 2 Rector St., New York.

This pamphlet is bulletin No. 9 of the Railway Business Association and reviews the constructive railway policy of several of the states of the Union in 1911.

Alcoholism in Industry. By Wm. H. Tolman. 40 pages, 4½ by 7 inches. Published by the American Museum of Safety, New York. Price, 10 cents.

This is one of a series of manuals of safety published in the interest of the prevention of accidents. The present booklet deals with some European methods of preventing such accidents as are due to the use of alcoholic beverages by industrial workers.

Mechanical World Pocket Diary and Year Book for 1912. 330 pages, 4 by 6 inches. Published by Emmott & Co., Ltd., 65 King St., Manchester, England. Price 6d.

This is the 25th edition of the *Mechanical World's* popular handbook, containing the usual information arranged in convenient form for ready reference. A number of new features have been introduced. The section on steam turbines has been partly rearranged and considerably extended, and information is also included on indexing on milling machines; verniers and micrometers; roller bearings; helical springs; cutters for milling spiral gears; speed calculations, etc. The number of illustrations has been increased.

The Copper Hand-Book. By Horace J. Stevens. 1902 pages, 6 by 9 inches. Published by the author, Houghton, Mich. Price, $5.00.

This book is the tenth annual edition of a hand-book which is considered a standard authority on the subject of copper and copper mines. It covers all the countries in the world and lists and describes over 8000 copper mines and copper mining companies. In addition there are twenty-four miscellaneous chapters treating on copper from different viewpoints, there being chapters on the history, geology, chemistry, mineralogy, metallurgy, brands and grades, and alloys of copper. A chapter of statistics containing about forty tables covering copper production, prices, dividends, etc., is included. The book is sent by mail prepaid to any address without advance payment, and subject to return after a week's inspection.

Wood-Turning, Woodworking Machines and Patternmaking. By George H. Resides and Hugo Diemer. 117 pages, 10½ by 7¾ inches. 169 illustrations. Published by the McGraw-Hill Book Co., New York. Price, $1.50.

This book is intended as a text-book for university, college and technical high school shops, and for apprenticeship courses. The aim of the book is to present principles, descriptive matter and exercises so as to develop the students' ability in woodworking, and in its application in the manufacturing industries and in patternmaking. Chapters are contained on the wood lathe and its equipment, methods for sharpening tools are shown and described, and a number of exercises for producing special objects are given. The book reviews the ordinary woodworking machines found in the regular pattern shop, and deals specifically with patternmaking and subjects relating to this trade.

Bearings and Their Lubrication. By L. P. Alford. 235 pages, 6 by 9 inches. 131 illustrations. Published by the McGraw-Hill Book Co., New York. Price, $2.50.

In the preface of this book the author states that the reason for its publication has been to present the underlying principles involved in the design of all classes of machine bearings, and to show modern practice in the construction and application of important commercial types. The book contains a great deal of data useful to the designing engineer. Many of these data have never before been published, and many of the experiments and researches quoted are from European sources not generally available to American readers. The treatment is divided into two parts, one dealing with bearings with sliding contact, and one with bearings with rolling contact. The data given for coefficient of friction of journal, collar, step and guide bearings are very complete, and will be found the more useful as these data are often difficult to obtain.

Thermodynamics of the Steam Turbine. By Cecil H. Peabody. 282 pages, 6 by 9 inches. 103 illustrations. Published by John Wiley & Sons, New York. Price, $3.00.

The author of this book is professor of naval architecture and marine engineering at the Massachusetts Institute of Technology, and the book contains a systematic treatment of the thermodynamics of the steam turbine, especially prepared for students in technical schools. Constructive details are considered as far as they are necessary for a proper understanding of thermodynamic computations. The methods explained are in general those accepted by steam-turbine designers, although certain methods have been devised by the author in such cases where new methods would lead more rapidly or precisely to the desired end. The chapters of the book are headed as follows: Introduction; Steam-Nozzles; Jets and Vanes; Simple Impulse Turbines; Pressure Compounding; Velocity Compounding; Pressure and Velocity Compounding; Reaction Turbines; Accessories; Effect of Conditions; Marine Steam Turbines.

Maximum Production in Machine Shop and Foundry. By C. E. Knoeppel. 365 pages, 5 by 7½ inches. Published by the *Engineering Magazine*, New York. Price, $2.50.

This book is based on three series of articles originally published in the *Engineering Magazine*. The machine shop and factory are considered so closely related that the problems concerning the two are assumed to be best studied together. The information is based upon the author's personal experience. The foundry, particularly, is given close attention, because in the past it has been noted for less systematic methods and it still offers great possibilities for improvement in management and methods. The chapters of the book are headed as follows: The Two Great Forces in Manufacturing; Importance of Efficient Organization; The Elements of Accounting and Management; Maintenance, New Construction and Reconstruction; Systematic Processing, Assembly, and Erection; Efficiency in the Use of Materials and Time; Better Deliveries—More Satisfied Customers; Scientific Management in the Foundry; Foundry Organization and Management; Foundry Production and Its Details; Efficient Despatching in the Foundry; Handling Shop Details; Importance of Correct Burden Apportionment; Elements of Foundry Production Costs; Apportionment of Foundry Costs to Production; Cost Apportionment in Various Classes of Foundries.

CATALOGUES AND CIRCULARS

General Electric Co., Schenectady, N. Y. Leaflet describing electric glue pots.

American Oxhydric Co., Milwaukee, Wis. No. 5 of the leaflets entitled "Oxhydric Sparks."

Strong, Carlisle & Hammond Co., Cleveland, Ohio. Circular of Frankfort furnaces, showing three types and giving general dimensions.

Duff Mfg. Co., Pittsburg, Pa. Folder illustrating the constructional features of Duff-Bethlehem hydraulic jacks, and comparing this design with designs of other types.

American-Swiss File & Tool Co., 24 John St., New York. Booklet entitled "The Lady from Paterson—A True Story." The little story teaches the lesson that home products may be as good as or superior to those imported.

Challenge Machine Co., Inc., 5116 Springfield Ave., Philadelphia, Pa. Folder illustrating and describing Challenge grinders. A number of different types are illustrated and general specifications are given, together with price list.

Erie Forge Co., Erie, Pa. Photograph of the company's open-hearth furnace in operation, giving an idea of the facilities this company has for manufacturing carbon and alloy—such as nickel and chrome-vanadium—steel.

H. W. Johns-Manville Co., 100 William St., New York. Booklet entitled "The Roof Everlasting," describing the asbestos fire-proof shingles manufactured by the company. Complete data of size, weight, cost, etc., and method of application, are included.

Bristol Co., Waterbury, Conn. Folder showing Bristol recording thermometers, voltmeters, wattmeters, electric time recorders, electric pyrometers and differential pressure gages. Brief references to the general use of the various instruments are included.

Morse Chain Co., Ithaca, N. Y. Pamphlet entitled "A Modern Power Transmitter," describing the Morse silent-running high-speed chains and showing installations where this chain is employed. An interesting comparison between rope drive and chain drive is included.

Ingersoll-Rand Co., 11 Broadway, New York. Bulletin No. 4003 on "Little Giant" rock drills. The bulletin contains a table of this type of drill, giving the principal dimensions. A sectional view of the machine is shown, and also illustrations of several machines at work on the Panama Canal.

Charles A. Stickney Co., St. Paul, Minn. Circular describing Stickney worm-gear pump jacks. One feature of these is that the frame of the jack encases the gears so that the operator is protected from injury, and, in addition, an oil receptacle is formed which thoroughly lubricates the gearing.

Walworth Mfg. Co., Boston, Mass. Circular descriptive of the advantages of the genuine Stillson wrench which has been manufactured by the company for over forty years. These wrenches are made in sizes from 6 inches to 18 inches with wood handles, and from 10 inches to 48 inches with steel handles.

Kerr Turbine Co., Wellsville, N. Y. Bulletin No. 20, dealing with the improvements made in Kerr turbo-blowers and turbo-pumps, especially intended for gas plant service. Bulletin No. 22, describing and illustrating installations of turbo-generator sets for lighting, with special reference to independent lighting plants.

Fitchburg Machine Works, Fitchburg, Mass. Circular entitled "The Lo-swing Lathe" describing the general details of the lathe and showing work produced on same. The description is profusely illustrated with halftones and line engravings and gives a comprehensive idea of the design and capacity of the Lo-swing lathe.

Vulcan Crucible Steel Co., Aliquippa, Pa. Booklet giving information about the company's products in vanadium steels, referring to the forging and heat treatment of alloy steels, in general, and when used for casehardened products and for gears and tools. Directions are also given for heat treating Wolfram high-speed steel and Vulcan special vanadium steel.

Peterson Engineering Co., Hudson Terminal Bldg., New York. Bulletin No. 56 on Economy elevator guide lubricators describes a new method of lubricating elevator guides. The method consists in applying a thin layer of grease exactly where the shoes bear on the rails. The grease is applied for every trip of the car. Different types of lubricators suitable for steel and wooden rails are described.

Reynolds Pattern & Machine Co., 101-103 Third Ave., Moline, Ill. Circular describing the improved Reynolds automatic screw-driver with magazine feed for wood or machine screws. These screw-driving machines are built in several different types, including four standard types, one radial and one gap column type, and also a type with an auxiliary drill spindle. The machines are fitted with tight and loose pulleys for belt drive.

Westinghouse Electric & Mfg. Co., East Pittsburg, Pa. Leaflet No. 2373 describing No. 303–A box frame interpole motor manufactured by the company. Particular stress is laid upon the fact that the motor is equipped with axle-bearing dust guards, which greatly prolong the life of the bearings and gears. Leaflet No. 2374 gives specifications and brief descriptions of the parts of the company's railway motor No. 310–C.

American Blower Co., Detroit, Mich. Hand-book of information on blowers and exhausters for forges and furnaces. The little hand-book, comprising 24 pages, is intended to enable prospective purchasers to select the proper size and type of blower or exhaust fan for their requirements. The information covers blowers for ordinary blacksmith forges, for heating furnaces, for plates and rivets, and for melting furnaces, as well as exhaust fans for removing smoke, gases, fumes, etc.

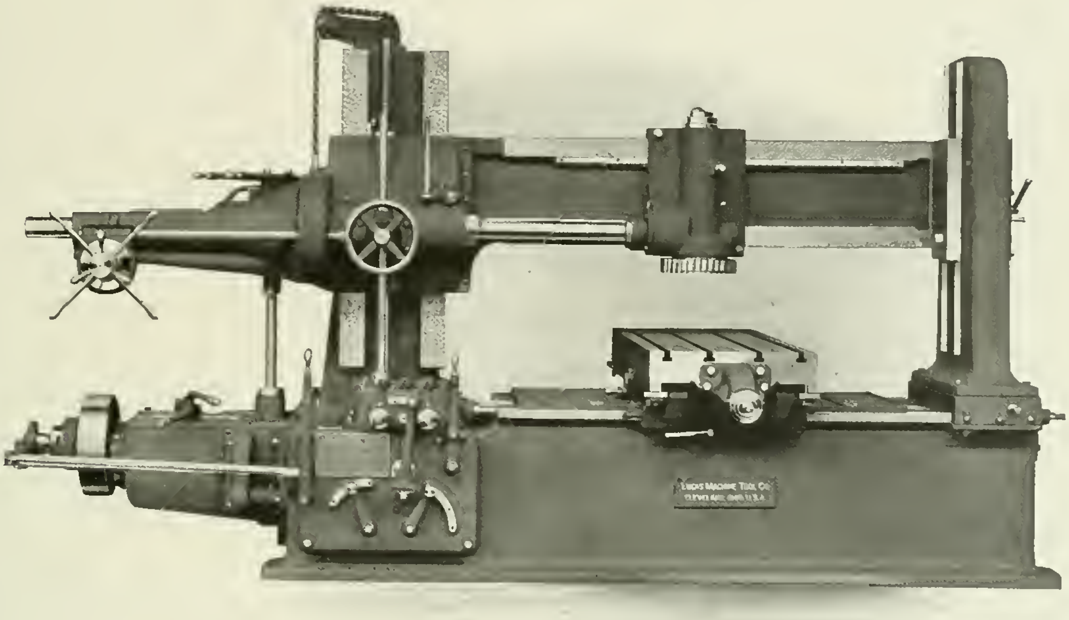
Norman W. Henley & Son, 132 Nassau St., New York. Circular advertising pads of paper ruled at certain angles adaptable for drawing objects in isometric perspective or projection. By using paper ruled in this manner drawings in isometric projection can easily be made by anyone who has even elementary understanding of the principles involved. The paper is sold in pads of 40 sheets, 6 by 9 inches and 9 by 12 inches. It is also sold in loose sheets, 12 by 18 inches.

Tate, Jones & Co., Inc., Empire Bldg., Pittsburg, Pa. Catalogue of furnaces for heating, forging and welding. The subject of furnace

Can you imagine any job of boring, drilling or milling that cannot be done on this machine?

THE No. 32 "PRECISION" BORING, DRILLING and MILLING MACHINE

with VERTICAL MILLING ATTACHMENT



Power feeds with quick returns in every direction. Same number of feeds and same amount of feed wherever applied. Interlocking feed system; impossible to get in more than one feed at the same time, or to get in any feed not wanted.

ALL feeds **started** and **returned** by quick power **motion** by ONE lever.

Lucas Machine Tool Co., NOW AND ALWAYS OF **Cleveland, O., U.S.A.**

AGENTS—C. W. Burton, Griffiths & Co., London. Alfred H. Schutte, Cologne, Bruseels, Liege, Paris, Milan, Bilbao, Barcelona. Schuchardt & Schutte, Berlin, Stockholm, St. Petersburg, Copenhagen. Donauwerk Ernst Krause & Co., Vienna and Budapest. Overall, McCray, Ltd., Sydney, Australia. Andrews & George, Yokohama, Japan. Williams & Wilson, Montreal.

efficiency is dealt with, and various types of tool dressing furnaces, blacksmith forges, rivet forges, pipe bending furnaces, bolt heading furnaces, flue welding furnaces, rod heating furnaces, and forging furnaces of various sizes, are illustrated and described. Line engravings are used in many cases to show the actual construction of the furnaces.

Slater, Marsden & Whittemore Co., Beloit, Wis. Catalogue No. 7 on punches, shears, bending rolls, and woodworking machinery. A line of combined power punches and shears is illustrated and specifications given. The catalogue also shows and describes the company's make of alligator shears, back-geared power splitting shears, boiler-makers' lever punches, lever splitting shears, hand bench punches, lever punches and lever shears, swing cut-off saws, combination rip and cut-off saws, and bending rolls.

Ingersoll-Rand Co., 11 Broadway, New York. Catalogue describing "Imperial Type X" duplex steam-driven compressors, showing several views of the machine and its details, and containing tables of standard sizes and capacities. The air cylinders have water-jacketed barrels and heads, the latter being hooded for the admission of clean air. The smaller compressors, up to 16-inch stroke, have overhung cylinders, but on the larger sizes the air cylinders are supported on a foot-piece resting upon a sole-plate on the foundation.

Shepard Electric Crane & Hoist Co., Montour Falls, N. Y. Bulletin No. 504 illustrating and describing Shepard monorail traveling hoists designed for the economical handling of any material used for manufacturing. The hoist may be used in connection with grab buckets, lifting magnets, cars, slings, etc. One lumber yard reports that the reduction in the cost of handling lumber and other wood products is 41 per cent, and another lumber company reduced the cost of handling 1000 feet of lumber from $1.20 to $0.12 by the use of these electric traveling hoists.

Cincinnati Electrical Tool Co., 650-652 Evans St., Cincinnati, O. Catalogue of "Peerless" portable electric drills, reamers and grinders. The complete line of these tools, as manufactured by the company, is illustrated and described, and important dimensions are tabulated. The catalogue covers fifty-two 6 by 9 pages, and includes portable electric drills of various types and sizes, portable reamers, Scotch radial drills, portable toolpost grinders, portable bench grinders, floor grinders with one and two wheels, internal grinders, portable aerial grinders and buffers, and portable electric blowers. All the tools described are air-cooled.

C. H. Caton & Co., Ltd., Keighley, England. Loose leaf catalogue illustrating the line of machine tools manufactured by the company, including horizontal boring machines, radial drilling and tapping machines, plain milling machines, combined milling and slotting machines for locomotive cylinders, heavy duty slotting machines, double-head slotting machines, rack driven planers, special drilling and tapping machines for locomotive wheels, combined multiple radial drilling and milling machines, cylinder boring and facing machines, vertical turning and boring mills, and engine lathes. The machines are well illustrated; a general description is given, and the most important dimensions included.

National Twist Drill & Tool Co., Detroit, Mich. Catalogue No. 7 of twist drills, reamers, milling cutters and special tools. The catalogue contains 160 pages, 5 by 7½ inches, and gives general dimensions and price list of the large line of different types of tools manufactured by the company, comprising twist drills, straight-fluted drills, special drills, machine bits for wood, oil-tube drills, hollow drills, center drills, countersinks, sockets and sleeves, drill chucks, mandrels, reamers of all types, solid and built-up counterbores, solid and inserted blade milling cutters, end-mills, and special cutters. A number of useful tables are also included, and the catalogue is conveniently arranged for reference.

Brown & Sharpe Mfg. Co., Providence, R. I. Series of six booklets on grinding and grinding machines, containing many practical points that are of interest to foremen and workmen employed in grinding rooms. The titles of the various booklets give an idea of their contents. They are as follows: "In the Shops where B. & S. Grinding Machines are Built;" "Rigid Machine Tool Construction — Its Value in Grinding Machines;" "Accurate Grinding is Largely Due to Alignments of Machine;" "Features that adapt B. & S. Machines to Commercial Grinding;" "Points About Grinding Wheels and Their Selection;" "Why Independent Speeds and Feeds are Essential in Grinding Machines." The booklets are well illustrated with halftones and line engravings.

General Electric Co., Schenectady, N. Y. Bulletin No. 4860, giving a brief outline of the fundamental principles of electro-metallurgy and its principal applications. The bulletin is intended to aid prospective buyers in the selection of proper apparatus for work of this character. Bulletin No. 4883, describing the construction of Curtis steam turbine generators. This bulletin contains a detailed description of the steam turbine parts, and shows installations of steam turbine generator sets. Bulletin No. 4885, describing Thomson watt-hour meters, designed for accurately measuring the power used by relatively small consumers. Bulletin No. 4886, devoted to the advantages of electric power in coal mine operation. Bulletin No. 4889, describing commutator grooving machines. Bulletin No. 4891, showing a series of illustrations of electric railway equipment. Bulletin No. 4894, describing cylinder controllers for railway service.

TRADE NOTES

Steinle Turret Machine Co., Madison, Wis., is building an addition for an office and tool-room.

Keller Mechanical Engraving Co., has removed its factory to the Gair Bldg., 70 Washington St., Brooklyn, N. Y.

Foote Bros. Gear & Machine Co., Chicago, Ill, manufacturer of iron, steel and rawhide cut gears has made a large addition to its shop. The new building will double the capacity.

Toledo Bridge & Crane Co., Toledo, Ohio, has made arrangements with A. W. Wyckoff & Co., 2219 Farmers Bank Bldg., Pittsburg Pa., to represent the company in the sale of cranes in the Pittsburg district.

Berger Mfg. Co., Canton, Ohio, recently installed a steel rack storage system for patterns at the Johnston Harvester Co., Batavia, N. Y. The installation consists of 72 units, each 5 feet wide, 11 feet 6 inches high.

A. Eugene Michel advertising engineer, on account of constantly increasing business, has removed his offices to the Park Row Bldg., 21 Park Row, New York, and all business will be managed from the new office in the future.

Cincinnati Lathe & Tool Co., Cincinnati, Ohio, has removed from its former plant at Spring Grove Ave., to its new shop at Oakley, Ohio, a suburb of Cincinnati. The new shop is modern in every way, and the company is now equipped to handle its rapidly increasing lathe manufacturing business.

Dodge Mfg. Co., Mishawaka, Ind., had an exhibit at the exposition in Boston which was held during the latter part of October under the auspices of the Boston Chamber of Commerce. The most prominent items exhibited were solid and split clutches, iron-center wood-rim pulleys, keyless and Collins couplings, etc.

Cincinnati Bickford Tool Co., Oakley, Cincinnati, Ohio, exhibited three Cincinnati upright drilling and tapping machines and one Cincinnati Bickford radial drill at the exposition held this summer at Turin, Italy. Information has just been received to the effect that the jury awarded the company the "grand prix" for its exhibit.

J. H. Williams & Co., 61 Richards St., Brooklyn, N. Y., are reported to have bought sixty-one acres of ground near Buffalo, and will move their business to that city. A $1,000,000 plant will be built, and drop-forging products will be manufactured as soon as the plant is finished. It is expected that about 1000 men will be employed.

Lucas Machine Tool Co., 99th St. and L. S. & M. S. Ry., Cleveland, Ohio, maker of the Lucas horizontal boring machine, is building a 40 by 170-foot addition. The addition is a 40-foot extension of the sawtooth roof sections of the plant, in harmony with the general plan, and enlarges each department by the same amount of floor space.

Roth Bros. & Co., Chicago, Ill., have recently shipped to the Wagner Mfg. Co., Sidney, Ohio, manufacturer of aluminum ware, ten five-horsepower polishing motors of a new, improved, ventilated type which they have recently placed on the market. All ten machines will be used for polishing the aluminum utensils manufactured by the Wagner Mfg. Co.

Adams-Bagnall Electric Co., Stantan Ave. and C. & P. Ry., Cleveland, Ohio, is erecting a six-story steel and concrete construction building, containing 100,000 square feet of floor space, to provide for the needs of its rapidly growing business. The company makes electric lamps for street and factory lighting, electric ventilating fans, etc.

American Ship Windlass Co., builder of the Taylor stoker and marine equipment, which has for over half a century been located at Providence, R. I., has removed all its business to Philadelphia, Pa., where the company already had a large plant. To accommodate the growing business, a large foundry has recently been erected in the latter city.

H. W. Johns-Manville Co., 100 William St., New York, due to the increase of business, has changed the location of its Birmingham, Ala., office from 1220 Empire Bldg. to 606 Chamber of Commerce Bldg. The office will continue under the management of W. H. Fleming. A complete line of the company's products will be handled from the Birmingham office.

Matthews-Davis Tool Co., 219 N. Second St., St. Louis, Mo., manufacturer of Davis expansion boring tools, has just moved into a new plant, the new structure consisting of three stories, having a total floor space of 15,750 square feet. The plant is equipped with the most modern machine tools, and the hardening-room is provided with cyanide, gas and coke furnaces.

Westinghouse Electric & Mfg. Co., East Pittsburg, Pa., recently received a contract for additional electrical equipment for the central power plant of the Mare Island Navy Yard, California. The equipment includes six induction motors, three transformers, two 25-kilowatt turbo-generator exciter sets; one 20-kilowatt motor-driven exciter set, and one 19-panel station switchboard.

International Acheson Graphite Co., Niagara Falls, N. Y., has been awarded a grand prize at the Turin Exposition for the company's exhibit of its products. This company has previously been given the highest awards at other world's expositions where its products have been exhibited, and the last award at the Turin Exposition is thus additional testimony of the quality of its products.

Best Mfg. Co., Pittsburg, Pa., has appointed Mr. Charles E. Hague its representative in Philadelphia, Pa., with headquarters at 1510 Land Title Bldg. The Philadelphia office will have charge of Eastern Pennsylvania, and the Baltimore and Washington territory. The company has also appointed C. L. Stickney & Co. as its representatives in the states of Washington and Oregon, the headquarters being at 108 White Bldg., Seattle, Wash.

H. V. Lewis Co., 30 Church St., New York, has been formed for the purpose of representing a few well-known manufacturers of machine tools in the New York and Philadelphia territory. The officers of the company are: H. V. Lewis, president; George C. Hughes, vice-president; and Arthur H. Valiquette, secretary and treasurer. Mr. Lewis and Mr. Valiquette will be actively engaged in the conduct of the business from this time forth.

New Departure Mfg. Co., Bristol, Conn., has installed at its Western branch, 1016 Ford Bldg., Detroit, Mich., a measuring machine which is available to the trade in general for close measuring. The use of the machine is offered without cost. The machine positively indicates variations of 1/40 of 0.001 inch, and is a duplicate of the machine used by the company in accurately manufacturing gages for inspecting New Departure ball bearings.

American Blower Co., Detroit, Mich., has purchased a four and one-half acre plot in Windsor, Ontario, Canada, for the erection of a plant for the Canadian branch. Application has been made for a charter of incorporation under the name of Canadian Sirocco Co., Ltd. The plant will be completely equipped for building blowers, and heating and ventilating apparatus. The erecting shop, 50 by 200 feet, and office building, will be built immediately, and a foundry, steel plate fan shop, and heating apparatus shop, will be built in the spring.

Davis-Bournonville Co., 97 West St., New York, announces that the company has been appointed exclusive selling agent for the welding and cutting apparatus made by Davis-Bournonville Acetylene Development Co., and the National Pneumatic Co. The business of the Davis-Bournonville Co. will be divided into the Eastern department with offices at 97 West St., New York, and the Western department with offices at 515 Laflin St., Chicago, Ill., where at present the Chicago welding department of the National Pneumatic Co. has its quarters.

Rockford Drop Forge Co., Rockford, Ill., is erecting a reinforced concrete building, 65 by 100 feet, for a drop-forge plant. The building will be 30 feet high in the clear, and will have a monitor roof. It has been designed in accordance with modern ideas as to lighting and ventilation. Windows filling practically the entire side walls are fitted with Fenestra steel sash. The boiler house, engine room, and coal storage building form a wing, 40 by 75 feet. The plot on which the building stands affords room for extensions. Mr. Gustave Falleen is the general manager.

Michigan Electric Welding Co., Third and Congress Sts., Detroit, Mich., has acquired the business of the Detroit Welding Co., and will consolidate the two concerns under the name of Michigan Electric Welding Co. The consolidated concern will have an electric welding equipment capable of handling almost any kind of product, but will specialize on automobile work. The development of electric welding in Detroit is second only to that of Cleveland, the first city in the United States in electric welding. The consolidated concern will also be equipped to do autogenous welding.

Patterson Tool & Supply Co., Dayton, O., of which Mr. W. B. Patterson is president, is endeavoring to interest dealers in machinery in the organization of a "clearing house" for machine tools. Mr. Patterson's idea is that when a dealer gets an inquiry for a machine tool which he has not in stock, he can through the medium of one letter to the clearing house, or a telegram, or a long-distance telephone call, get such information as he may require, instead of having to write to a large number of dealers, or look over advertisements to try to find what he wants. Some dealers have signified

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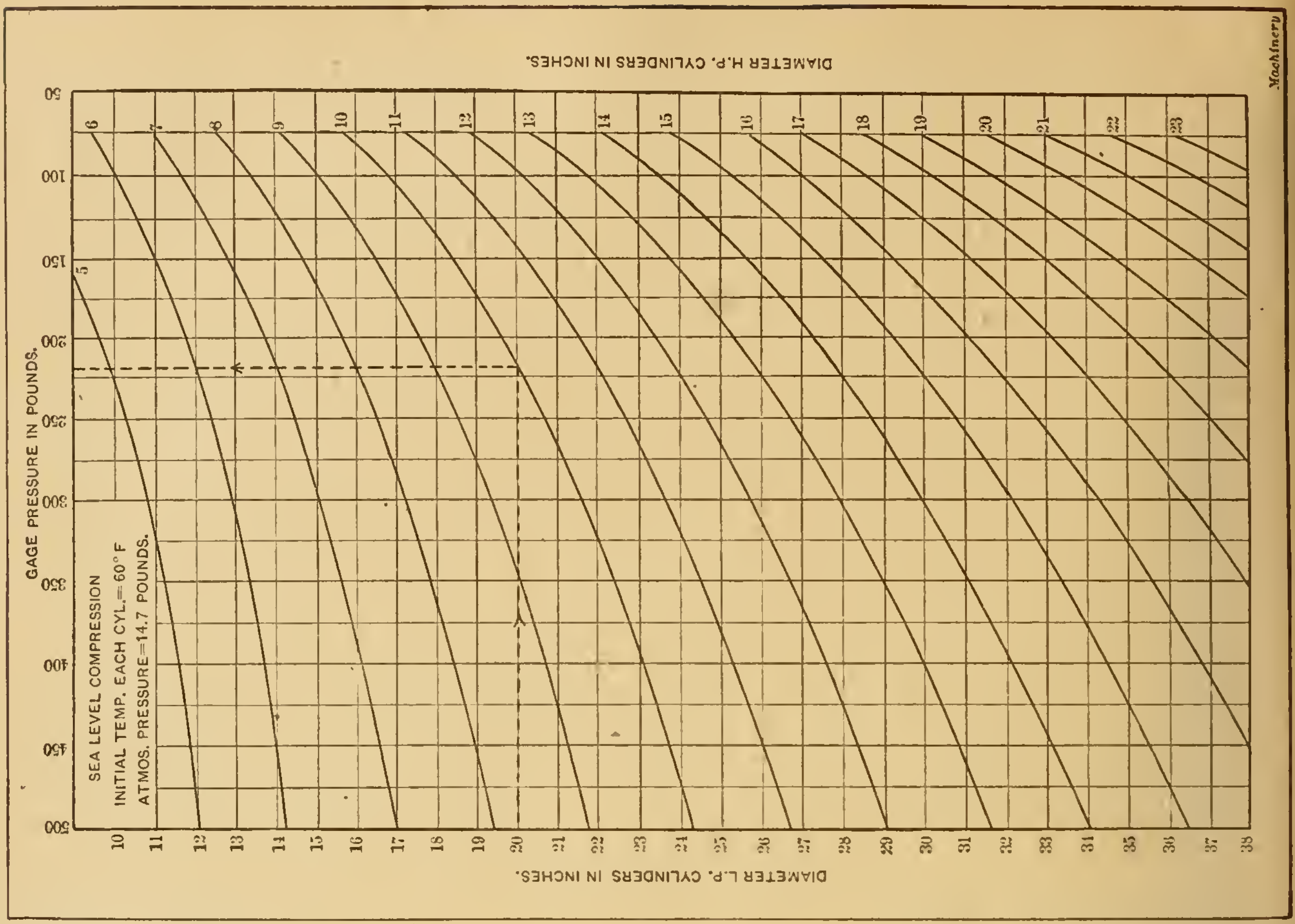
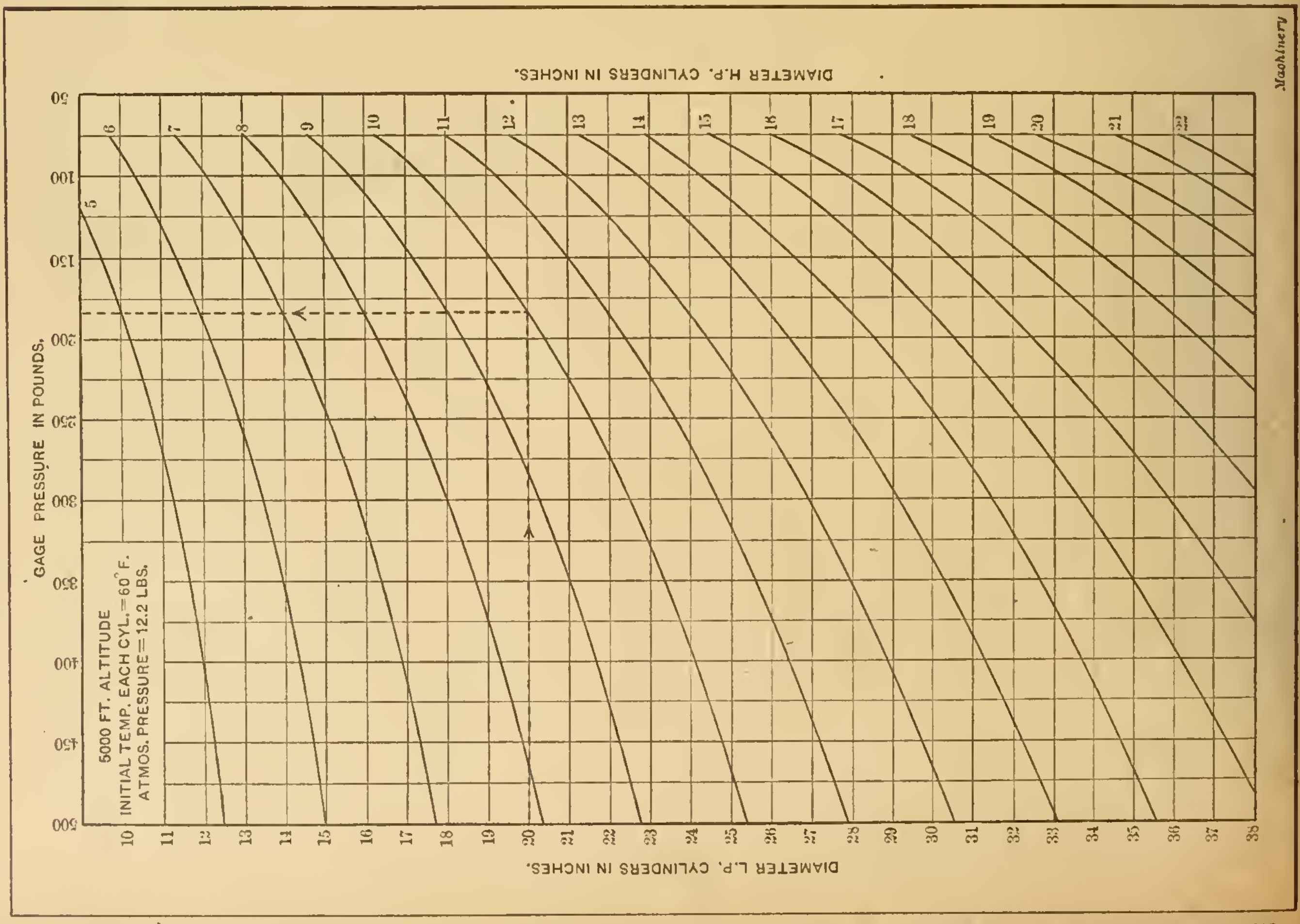
PRESSURES AT WHICH WORK IS EQUAL IN TWO-STAGE AIR COMPRESSORS—I



Contributed by J. William Jones

No. 150, Data Sheet, MACHINERY, January, 1912

PRESSURES AT WHICH WORK IS EQUAL IN TWO-STAGE AIR COMPRESSORS—II



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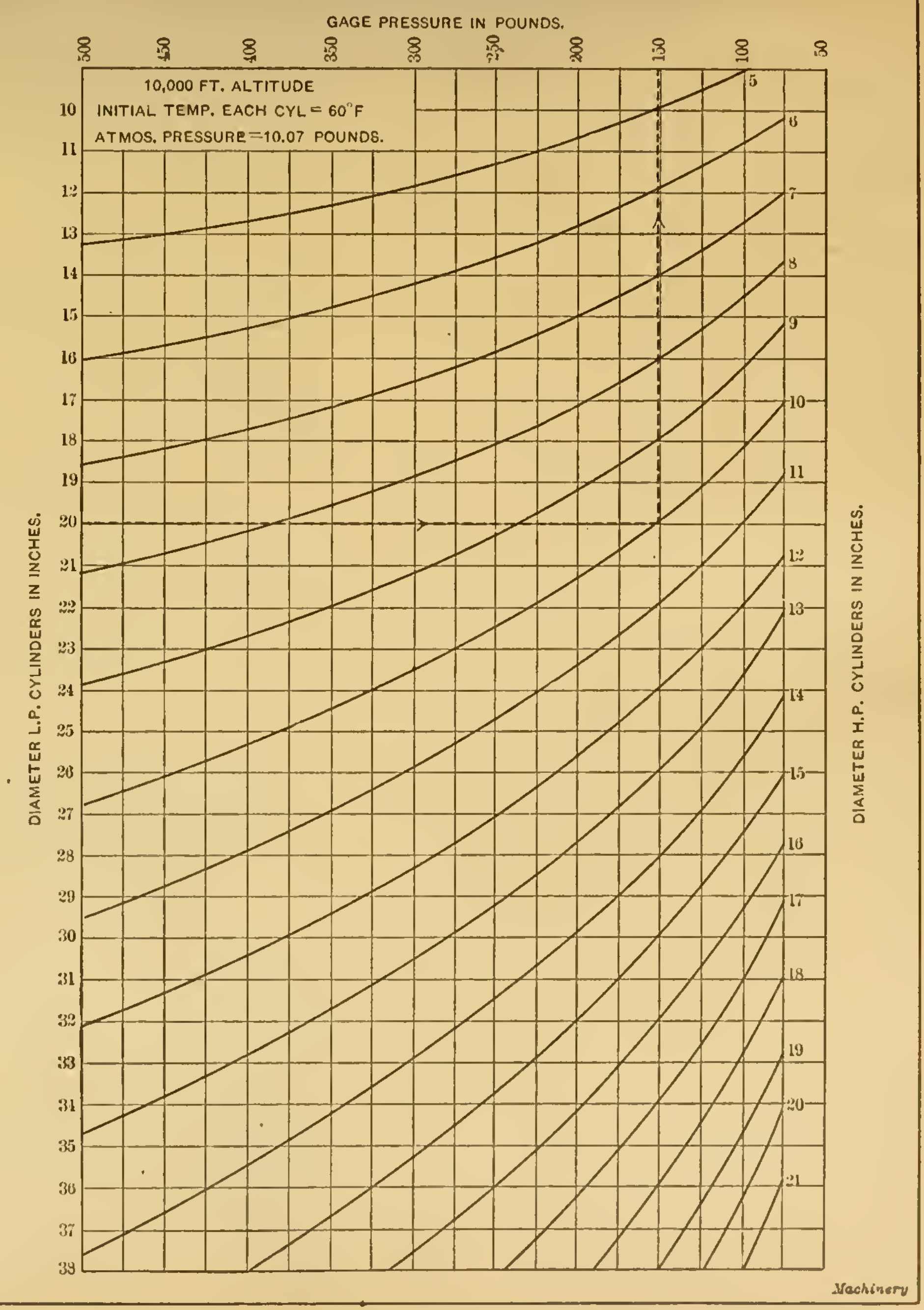
PRESSURES AT WHICH WORK IS EQUAL IN TWO-STAGE AIR COMPRESSORS—III



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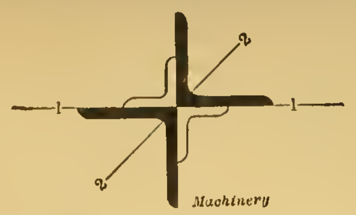
PROPERTIES OF DOUBLE-ANGLE COLUMNS



Size Angles, Inches	Area Section, Inches	Moment of Inertia, Axis 1 1	Section Modulus, Axis 1 1	Radius of Gyration		Weight per Foot, Pounds	Length for 125 Least Radii	
				Axis 1 1	Axis 2 2		Feet	Inches
4 × 4 × 5/16	4.80	13.42	3.36	1.67	1.54	16.4	16	0
4 × 4 × 3/8	5.72	16.14	4.04	1.67	1.54	19.6	16	0
5 × 5 × 3/8	7.22	31.22	6.24	2.08	1.95	24.6	20	3
5 × 5 × 7/16	8.36	36.66	7.33	2.09	1.95	28.6	20	3
5 × 5 × 1/2	9.50	41.92	8.38	2.10	1.94	32.4	20	2
6 × 6 × 3/8	8.72	54.24	9.04	2.49	2.34	29.8	24	4
6 × 6 × 7/16	10.12	63.24	10.54	2.50	2.34	34.4	24	4
6 × 6 × 1/2	11.50	72.28	12.04	2.50	2.33	39.2	24	3
6 × 6 × 9/16	12.86	81.71	13.62	2.51	2.32	43.8	24	2
6 × 6 × 5/8	14.22	90.88	15.15	2.52	2.31	48.4	24	1
8 × 8 × 1/2	15.50	171.60	21.45	3.32	3.15	52.8	32	9
8 × 8 × 9/16	17.36	192.96	24.12	3.33	3.14	59.2	32	8
8 × 8 × 5/8	19.22	214.42	26.80	3.34	3.13	65.4	32	7

Double-column Formulas for Unit Strength

$$17100 - 57\frac{L}{R} \text{ (Carnegie Handbook)}$$

$$16000 - 70\frac{L}{R} \text{ (Maintenance of Way)}$$

Contributed by Edmund B. La Salle

No. 150, Data Sheet, MACHINERY, January, 1912

MACHINERY
January, 1912

STEEL LETTER STAMPING DIES

By CHESTER L. LUCAS

THE making of steel letter stamping dies, for imprinting designs or lettering upon metal products, requires the knowledge of many interesting mechanical methods, and their set-up and operation differs from the general run of punch and die work in many respects. It is the purpose of this article to show the principles involved in marking both flat and round work, to illustrate some of the best methods of making a few types of steel letter stamping dies, and especially to give an outline of the work of cutting the letters. With the cooperation of Noble & Westbrook, of Hartford, Conn., a firm well-known to the machinery trade as a maker of steel letter stamping dies, we are enabled to give the readers of MACHINERY a description of this interesting work.

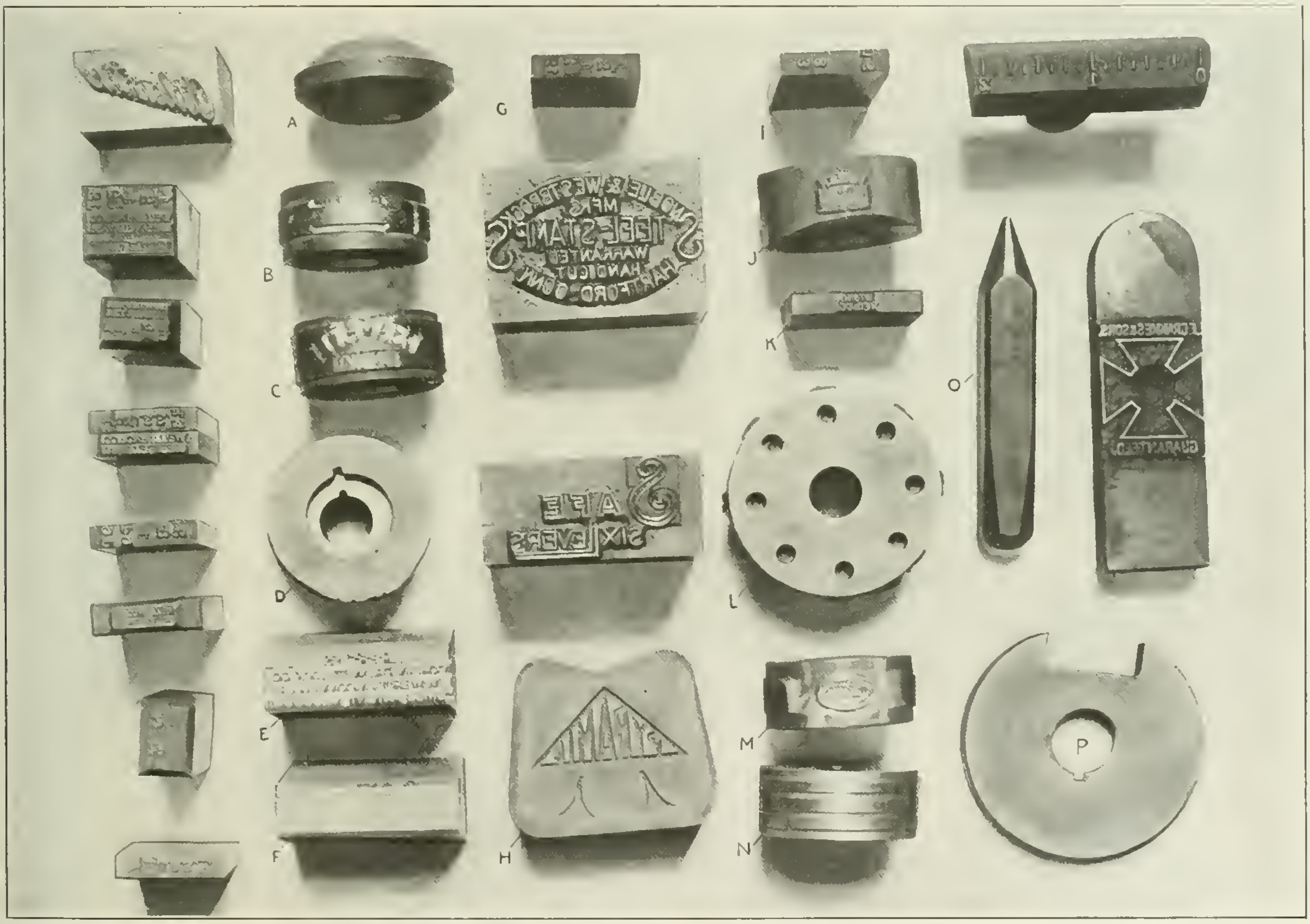


Fig. 1. Steel Letter Stamping Dies and Rolling Dies

The simplest forms of steel letter stamping dies are, of course, the single letters and figures that are in everyday use in the machine shop. From the single letter to the stamping die and from the hand-hammer to the power press, is but a step in the course of evolution.

Plain flat stamping dies for use in the power press are usually made with the raised letters engraved upon the punch, the die being simply a flat block of steel, held in a die shoe and fitted with a gage for the proper location of the work. In making or setting-up a flat stamping die, perhaps the most essential point outside of cutting the letters is to have the punch and die absolutely flat and exactly parallel with each other. The method usually employed in holding the stamping punch is by means of a shank turned to fit the hole bored in the ram of the press. The gage for locating the work may be a flat piece of sheet brass or iron, approximately 1/8 inch thick, held to the die with screws at the corners. The essential parts of a die of this kind are shown in Fig. 2. If the punch is large, it is held upon a punch plate which is, in turn, fastened to the ram of the press by four countersunk screws.

Curved Surface Stamping Dies

While the piece shown in Fig. 5 might be lettered by rolling, it is very much simpler and quicker to do the lettering in a punch press, after the manner of flat stamping. To do this successfully, however, the surfaces of both the die and punch must be formed to fit the work closely. Wherever possible, the practical way of stamping a curved piece is to perform the operation while the blank is flat, afterward curving the metal to shape. With the piece shown in Fig. 5, this, of course, is impossible on account of the recess. Therefore, the radius of curvature of the blank to be stamped is scribed upon the side of the punch blank, and the steel shaped away close to this line, after which the punch is mounted upon the lathe faceplate and bored true to the scribed line. Similarly, the die is shaped and turned to conform to the under side of the blank. It is also necessary to mill a recess at the center, to clear the depressed part of the blank. From this point on, the making of this style of die is the same as with a flat stamping die, except that care must be taken to have the surfaces of the die and punch carefully fitted to the blank.

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* Associate Editor of MACHINERY.

Rolling Dies

Rolling dies may be of several different types: First, the roll may be mounted in a holder and rolled upon the work, which latter is placed on an arbor in the lathe; second, the roll is sometimes used in the reverse order, being itself held on an arbor in the lathe; third, one roll is used blank in connection with the lettering roll on special machines for rolling lettering, so that as the work passes between the two rolls, the letters are imprinted upon the surface of the work. Referring to Fig. 1, *D*, *J*, and *M* are rolling dies.

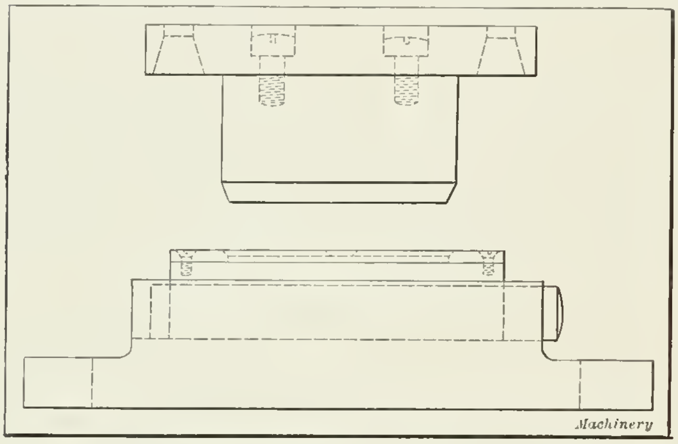


Fig. 2. Details of Die used for Stamping Flat Blanks

Segment Dies

Segment dies are similar to rolling dies. The advantage of using the segment die is two-fold—it saves a large amount of the steel and labor required in making a solid roll, and reduces the liability of loss in hardening. At *P*, Fig. 1, is a roll in which segment dies are used. As some manufacturers use a great many different designs, the saving in steel is considerable if a segment die is used.

Another use for segment dies is in special lettering fixtures like the one shown in Fig. 3. In this instance the segment die *A* which has the lettering on it is held in the casting *B*. The segment die is backed up by a spring *D* that tends to keep an even pressure upon the work that is being marked. In this way any irregularities in the work being marked are compensated for. The work is held upon the arbor *C*, and by moving the lever *B* forward, the lettering die is brought into contact with the work, and by means of the spring pressure the letters will be impressed into the surface of the work.

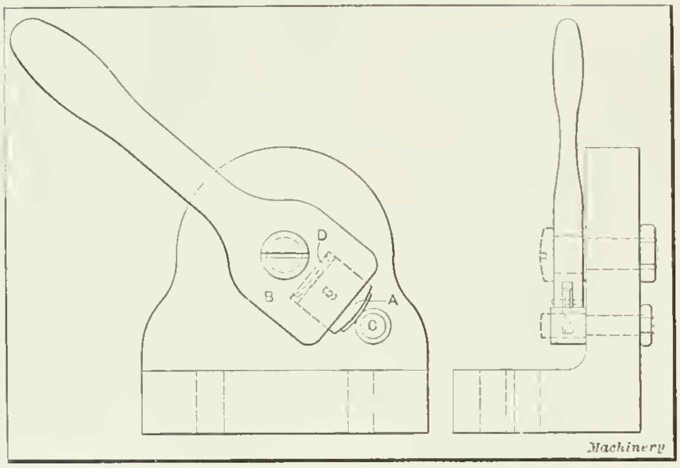


Fig. 3. Fixture used with Segment Dies for Lettering Tubes, etc.

A Type of Marking Machine

The illustration Fig. 6 shows one of the best methods of marking all classes of work, especially work that is other than flat sheet metal. There is no better way of marking sheet metal than in the punch press. The essential parts of a marking machine are the lower table *A* and the upper slide *B* which supports the die-holder *C*. The foot lever *D* is for raising the work high enough to allow the lettering to be imprinted to a sufficient depth. Adjustment for increasing or decreasing the depth of the letter is secured by means of screw *E*. The die is moved across the work by means of a hand-lever *F*. The machine is shown set up for marking chisels. All round work is marked with flat dies, and all flat work requires rolling dies; either the work or the die must roll. In this case, then, a rolling die is used. The roll is mounted on an arbor that is supported in die-holder *C*. Upon the outer end of this arbor, a gage is mounted. A pin on the side of the die-holder engages the semi-circular slot in this gage, and by means of spring *G*, the die is kept normally in the starting position. Hand lever *F* moves slide *B* forward, and consequently the letters on the rolling die are impressed into the chisels. As the roll passes over the work, the cord attached to spring *G* is wound upon the arbor that carries the die, thus furnishing a means of returning the roll to its starting position when the operation is finished. The length of stroke of the table is regulated by screw *L*.

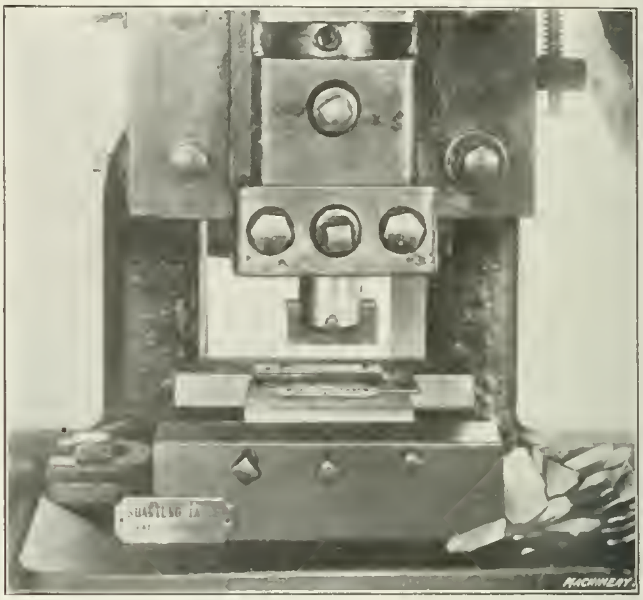


Fig. 4 Stamping Die used for Lettering Name-plate

When it is desired to mark round work, such as taps, drills, or screw-drivers, a flat die-holder is substituted for roll-holder *C*. The piece is laid against a gage on table *A*, and the flat die passed over it, thus causing the work to roll. This marking machine is used in many factories whose product requires marking.

Making the Dies

The work of cutting the letters upon the stamping dies, whether they are flat dies, rolling dies, or segment dies, is practically the same, except that rolling dies and segment dies are more difficult to make correctly. In machining the blank for a flat die, if there is to be more than one line of letters, the lines are separated by shaping, leaving them in the condition shown at *F* in Fig. 1, before going to the letter cutter. In the case of rolling dies, the same idea is carried out by cutting grooves in the die while it is in the lathe, leaving it as shown at *N*, Fig. 1. The steel generally used for steel letter stamping dies is made by Wm. Jessop & Sons.

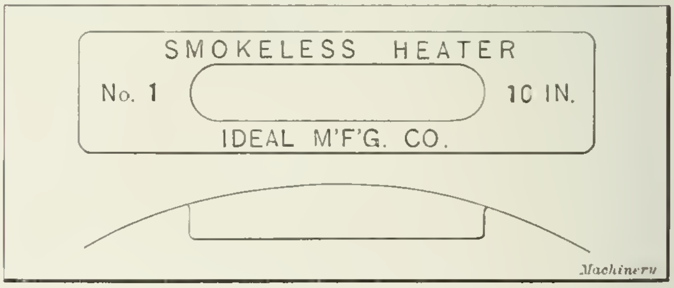


Fig. 5. Curved Name-plate that should be lettered after Forming

The letter cutter commences his work by coppering the panels or by heating the blank until it has turned to a dark blue color. The latter method gives a more durable marking surface. Next, with a pencil, he draws on the design or lettering to be cut, taking care to lay out the letters symmetrically on the blank. The lettering or design must be drawn "reversed," so that the impression that the stamp makes will read right. When the lay-out is finished in pencil, the lines are scratched into the steel with a scriber. This operation is indicated in Fig. 7.

Countering

The next step is to "counter" the letters. Before going further it may be well to explain what a counter is. In Fig. 9 may be seen the successive steps in making a stamp for the single letter O. At *A* is the stamp with a letter scribed upon the surface. At *E*, is shown the counter for this letter, which is really a punch for forming the inside of the letter. The reason for using counters is that they facilitate the work of shaping the inside of the letter, for it would be a difficult matter, or at least a rather lengthy task, to remove this metal with chisels. After the punch has been driven into the blank, the letter O will appear as shown at *B*, after which the steel is filed away from the outside, which practically completes the letter, as shown at *C*. Fig. 8 shows a steel letter cutter countering the stamp shown being laid out in the preceding illustration, Fig. 7. The letter cutter counters each of the letters on the die in which it would be hard to remove the center of the letter by chipping. This, of course, means that he does not have to counter the letter 1 or the figure 7, because these and similar characters are easily made by chipping. At *D* in Fig. 9 are shown a few illustrations of figures and counters for letters, figures, etc.

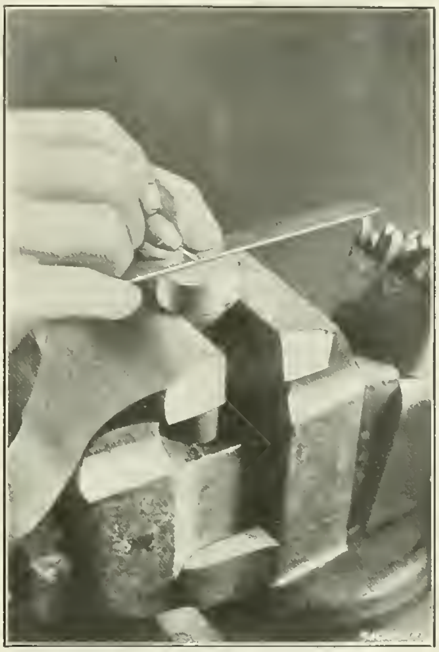


Fig. 7. Laying Out a Stamping Die

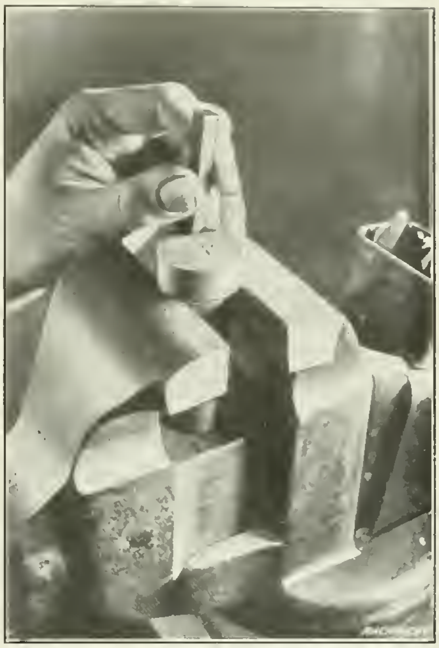


Fig. 8. Countering

At *F*, Fig. 9, the effect that countering has upon the steel is shown; at *G* is shown a hand-cut stamp. Under the pressure of the counter, the steel is "mashed" down in the center and spread apart at the sides, slightly rising around the impression as well. It is obvious that this must be detrimental to the steel, but most firms consider that they must employ this method because it is so much quicker than "cutting" the letters complete. It is only fair to state that in making stamping dies at the Noble & Westbrook shop, no counters are used. The steel is removed entirely by cutting, within and without the outlines of the letters. Nine steel letter cutters out of ten use counters in stamp making; therefore, this part of the work is here described.

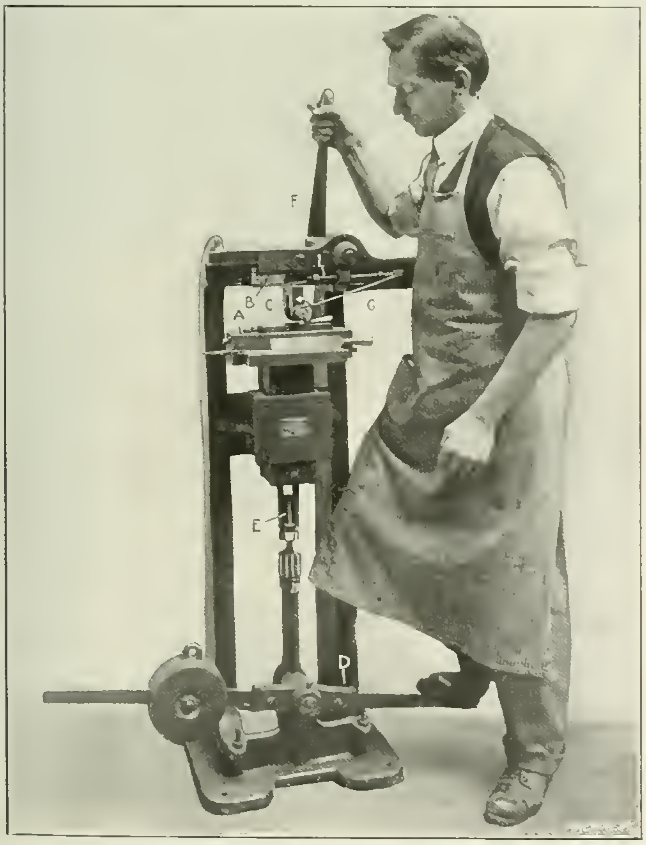


Fig. 6. Marking Machine

After countering, if countering is employed, the next part of the work is to file away all of the stock possible. This operation is shown in Fig. 10. It should be borne in mind that it is much quicker and surer to remove the steel by filing than by chipping. The proper angle for the filed bevels is 60 degrees.

Chipping Out the Letters

After all possible surplus steel has been filed away, the metal must be chipped out from between the letters, and, in fact, from every part of the surface that is not required in making the impression. The steel is removed to an approximate depth of 1/64 inch, except on large dies, in which case the cut is deeper. Some of the chisels used are shown in Fig. 13, and it is easy to understand that great care must be taken not to cut out too much stock, nor to cut it out in the wrong places, and there is also constant danger of the back side of the chisel doing damage to the letter with which it may come in contact. At *C* in Fig. 1 may be seen a rolling die that is about one-half chipped out. This will give some idea of the skill that is required to successfully chip out such a die, especially as this rolling die was not countered. The rolling die shown at *B* has been outlined, and is ready for chipping within the design. At *M* is a rolling die that is finished, except for removing the part of the panel that is not required for the lettering. If care is used in the chipping to leave each letter as "clean" as possible, much time will be saved in the subsequent operation of trimming-up the letters. Especially is this true of stamps that are entirely hand-cut, and, moreover, the bevels should be kept as uniform as possible, both within and without the letters, to insure the strength of the letters.

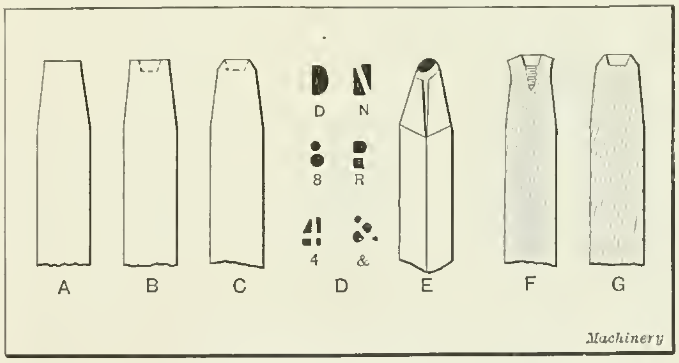


Fig. 9. Making a Stamp with the Aid of Counters

The final operation in the letter cutting, and the most important as well, is the trimming-up of the letters. By this is meant the evening and shaping of the letters from the rough chiseled state. Fig. 11 shows the way in which this part of the work is done. The roll or die is held in a ball vise and the letter cutter steadies the work with his left hand, while he uses the sharp graver with his right hand. At the completion of the work impressions are taken with ink to make sure that the letters are properly shaped, that there are no places under-cut, and that the lines are correct in every detail. In Fig. 13 are shown some of the hand tools used for this operation, and in Fig. 14 the shapes of the cutting points are illustrated. While all of these styles are used, most of the trimming is done either with the "square" or the "sharp" tools, according to the preference of the workman.

Fig. 12 shows another steel letter cutter at work on one of the most difficult pieces of work that it is ever required to produce. It is a rolling die, the face of which is concaved for rolling lettering on a fountain pen, the die being used as shown in Fig. 15 of the article "Fountain Pen Manufacture" in the December, 1911, number of MACHINERY. A concaved rolling die presents unusual difficulties to the steel letter cutter, for he must be very careful not to "lose" the printing surface of the die.

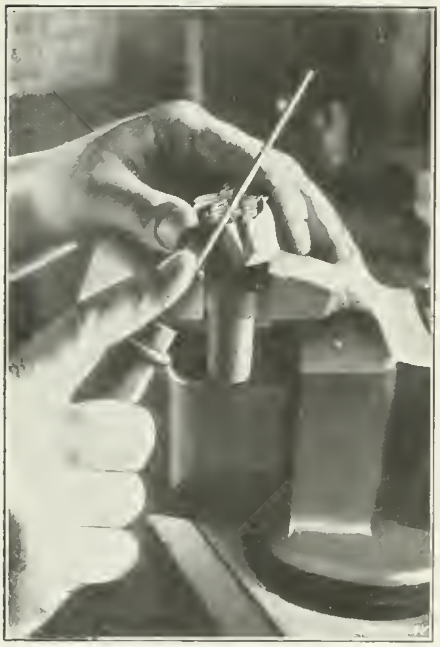


Fig. 10 Filing away the Surplus Steel around the Design

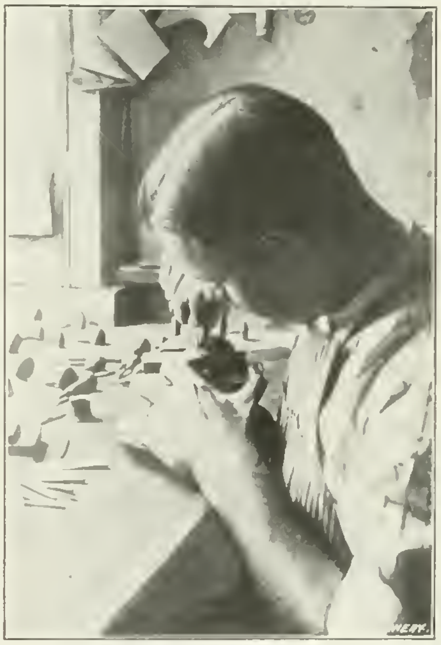


Fig. 11. Trimming up the Letters on a Rolling Die

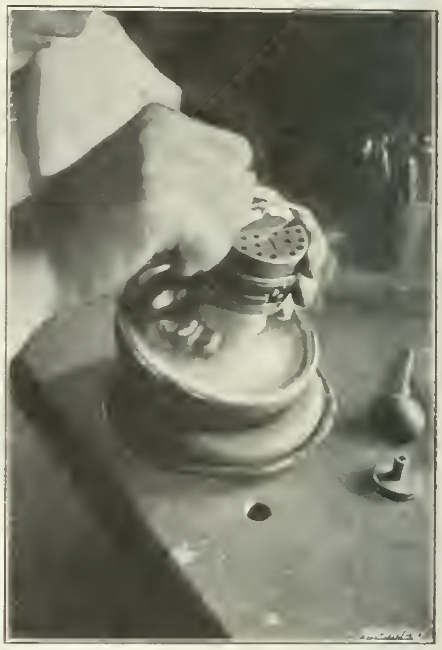


Fig. 12. Showing the Use of an Engraver's Vise in Trimming up Difficult Work

An exceedingly difficult job of steel letter cutting which shows the possibilities of fine work, is illustrated in the stamp shown at *O*, Fig. 1. The face of this stamp is shown enlarged in Fig. 15, the words "Noble & Westbrook, HFD. CT." being cut upon the face, which on this stamp measures but 1/16 inch in diameter. The minuteness of these letters will be appreciated when it is stated that each letter is about 0.010 inch high. The entire surface of the stamp is exactly the same size as an ordinary pin-head. This work was done under the direction of Noble & Westbrook, Hartford, by one of their employes. Such a feat is possible only for a skillful workman, having extraordinarily good eyesight, and then only with the aid of a powerful magnifying eye-glass.

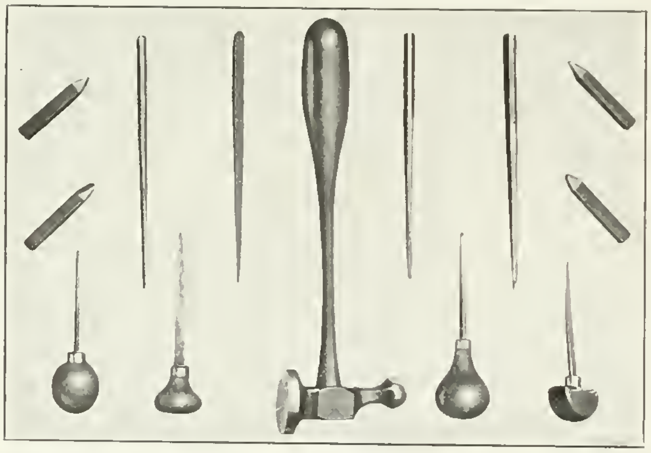
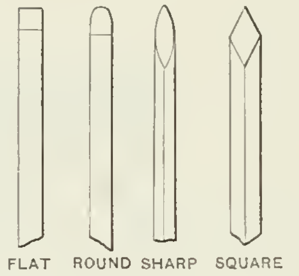


Fig. 13. Chisels, Counters and Hand-tools



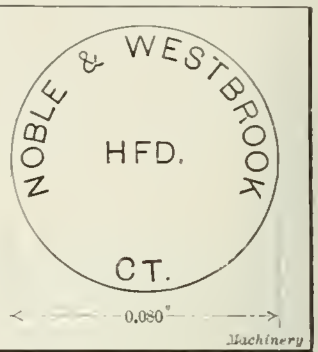


Fig. 14. Various Styles of Gravers used in Letter Cutting. Fig. 15. Enlarged View of Design cut in Raised Letters upon a Stamp Face the Exact Size of a Pin-head

Hardening and Tempering

In hardening a rolling die or a stamping die, it is only necessary to harden the part that includes the lettering. In the case of a rolling die on which the lettering extends around the entire circumference, it is, of course, necessary to harden the die all over. Generally speaking, however, as much as possible of the die should be left soft, in order to lessen the danger of cracking. Steel letter stamping dies are always hardened in brine—never in oil—and the temper is drawn from a faint straw to a very dark straw, according to the metal the die is to work upon.

* * *

As is well known an automobile engine in good condition can often be started "with the spark" when it has not stood idle long. An explosive mixture is retained under compression in a cylinder in the starting position and the spark fires the charge and sets the engine in motion. One of the ingenious automobile accessories brought out in 1911 by the Prest-O-Lite Co. is an engine starter that injects a charge of acetylene gas into the cylinders. The gas forms an explosive mixture with the contained air and when fired with a spark starts the engine. A multiple cylinder pump injects gas into each cylinder using gas from the lighting storage tank. The convenience and simplicity of the device will be generally appreciated. An effective starter eliminates a fruitful source of broken bones caused by engines firing too soon and throwing the crank backward with great force.

A COMPASS FOR DRAWING CIRCULAR ARCS OF LARGE RADII

By GEORGE W. BURLEY

By means of the instrument described in the following, the arcs of circles of radii exceeding the capacity of ordinary and beam compasses can be drawn with a fair degree of accuracy. The principle which underlies the working of the instrument is that of the rolling cone or frustum of a cone. The different radii are obtained by varying the distance between the two ends of the frustum and the ratio between their diameters.

The instrument is shown in Fig. 1. It consists essentially of a round metal beam *A*, on which are carried two thin beveled wheels *B* and *C*, the former being firmly fixed on the beam at one end, while the latter is movable, although it can be fixed in any position on the beam by means of the set-screw shown. A suitable length for the beam is 24 inches; this length can, of course, be either increased or reduced to suit special conditions. On the front face of the large wheel an arm is mounted in such a way that the wheel can rotate without carrying the arm around with it. This arm carries the pencil or pen, the point of which can always be arranged to be on the straight line joining the points of contact between the two wheels and the paper. The distance between the point of the pencil or pen and the point of contact of the large wheel should be as small as possible—in any case not more than one-quarter inch. A handle *E* is provided whereby the instrument is directed in its movements. A weight on the outer end of the pencil arm keeps the pencil or pen-point on the paper.

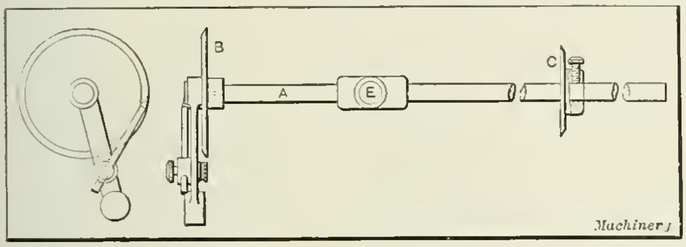


Fig. 1. Device for Drawing Circular Arcs of Large Radii

It will be readily seen that when the instrument is moved at right angles to the axis of the beam, the two wheels, and every part of the beam and the pencil point, will move in circular paths of different radii, but having a common center. These radii depend upon the distance between the two wheels and their diameters. Usually, though not necessarily, the diameter of the large wheel is fixed and never altered, while the diameter of the small wheel is a variable quantity, the range of diameters depending upon the required range of the instrument. By means of this instrument either an arc of a known radius can be drawn, or the radius of a given arc can be determined; of the two the former is the more common case. In this case, before the instrument can be properly set, it is necessary to find the distance between the two wheels. The conditions of the problem are indicated in Fig. 2. The diameter of the large wheel is *D*, and that of the other *d*. The radius required is *R*, and the distance between the wheel edge and the pencil point is *a*, while *A* is the distance required, measured, as will be readily seen, from edge to edge of the wheels and not parallel to the beam; *P* represents the pencil point.

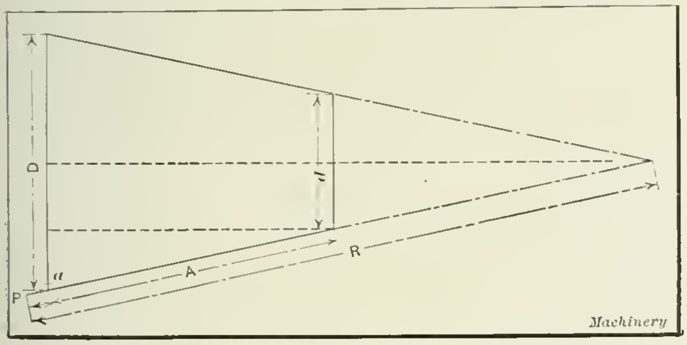


Fig. 2. Diagram indicating Principle on which the Device in Fig. 1 is based

According to the principle of similar triangles:

$$\frac{A}{(D-d)\div 2}=\frac{(R-a)}{D\div 2}$$

Hence,

$$A=\frac{(R-a)\ (D-d)}{D}$$

Let $R = 48$ inches; $D = 5$ inches; $d = 4$ inches; and $a = 1/4$ inch. Then,

$$A=\frac{(48-\frac{1}{4})\ (5-4)}{5}=9.55 \text{ inches.}$$

For radii above 48 inches the value of *a* may be neglected when it does not exceed ¼ inch.

For each set of values of *D* and *d* there is a definite range of radii which can be obtained, the length of the instrument and the maximum value of *A* being assumed to be constant. To increase this range the value of *d* is altered, *i. e.*, other wheels are used. This is clearly shown in the following table, which gives the values of the diameters of the smaller wheels necessary for a range of radii from 0 to 640 feet, the diameter of the large wheel being 5 inches and the limiting values of *A* being 3 and 24 inches. In each case the value of *a* is neglected.

Range of Radii, Feet	Diameter of Large Wheel, Inches	Diameter of Small Wheel, Inches	Value of *A* in Terms of Radius
0 — 5	5	3	$\frac{2}{5} \times R$
5 — 10	5	4	$\frac{1}{5} \times R$
10 — 80	5	$4\frac{7}{8}$	$\frac{1}{40} \times R$
80 — 640	5	$4\frac{63}{64}$	$\frac{1}{320} \times R$

To determine the radius of a given circular arc, it is necessary first of all to set the instrument so that the pencil point will trace the arc. The value of *A* can then be obtained by measurement, and substituted in the following formula for the determination of *R*:

$$R=\frac{A\ D}{(D-d)}+a$$

To illustrate, let $A = 22$ inches; $D = 5$ inches; $d = 4$ inches; and $a = 1/8$ inch. Then,

$$R=\frac{22\times 5}{(5-4)}+\frac{1}{8}=9 \text{ feet, } 2\frac{1}{8} \text{ inches}$$

What has been said will suffice to show the usefulness of the instrument; its cost is not very great.

* * *

ORIGIN OF STEAM SUPERHEATERS

While superheating in locomotives has only recently been applied in a successful manner, the idea is a very old one. The earliest recorded attempt to use superheated steam in a steam engine is that of Richard Trevethick, an Englishman, who in 1832 used superheated steam in a condensing pumping engine making eight revolutions per minute and having a boiler pressure of 45 pounds per square inch. At this slow speed and under the conditions of operating steam engines in use in those days, the condensation was very great. Trevethick conceived the idea of re-heating the steam in the cylinder to evaporate the condensation; he surrounded the cylinder and piping with firebrick and heated them from a fire on a grate beneath. A remarkable saving was noted, and while 9000 pounds of coal had previously been consumed per day, only 6000 pounds were now required, including the coal used for the superheating grate. This led to further experiments resulting in the Trevethick tubular boiler and superheater, patented in 1832, in which some features that have been retained in modern apparatus were apparent.

* * *

About the worst kind of useless brooding that can be indulged in by a workman is that of imagining that the boss has it in for him. The boss has other things to think about and the man should strive to find other thoughts, too.

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THE ROSS RIFLE AND ITS MANUFACTURE—4

GAGES AND GAGING METHODS*

By DOUGLAS T. HAMILTON†

Interchangeable manufacture on a paying basis is not possible without the use of gages and gaging systems. When few parts are to be made the question of gaging does not enter materially into the problem, but when thousands or perhaps millions of pieces are to be produced and made interchangeable without having to be fitted, it is necessary to provide a complete and accurate system of gaging. The present development of gaging systems is to be credited largely to the manufacturers of firearms, who have fully realized the necessity of absolute interchangeability in their product. While the system which is briefly outlined in the following article pertains more particularly to the production of firearms, it can, with slight modifications, be adapted to other classes of manufacture as well.

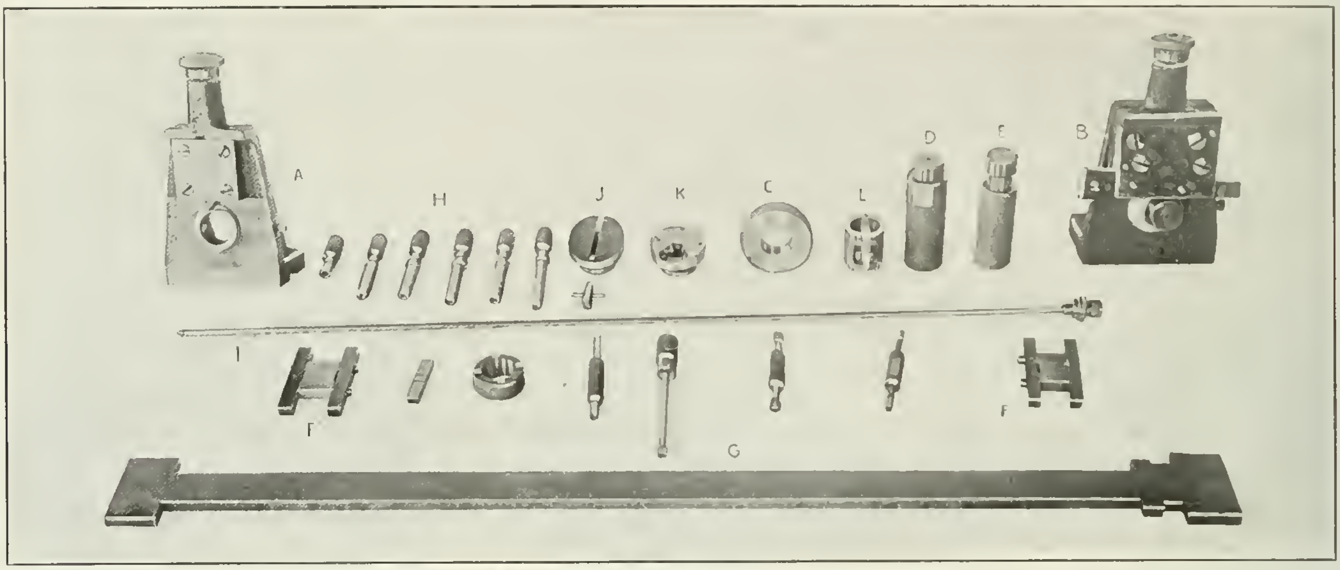

Fig. 48. A Representative Group of Gages used on the Barrel and Receiver

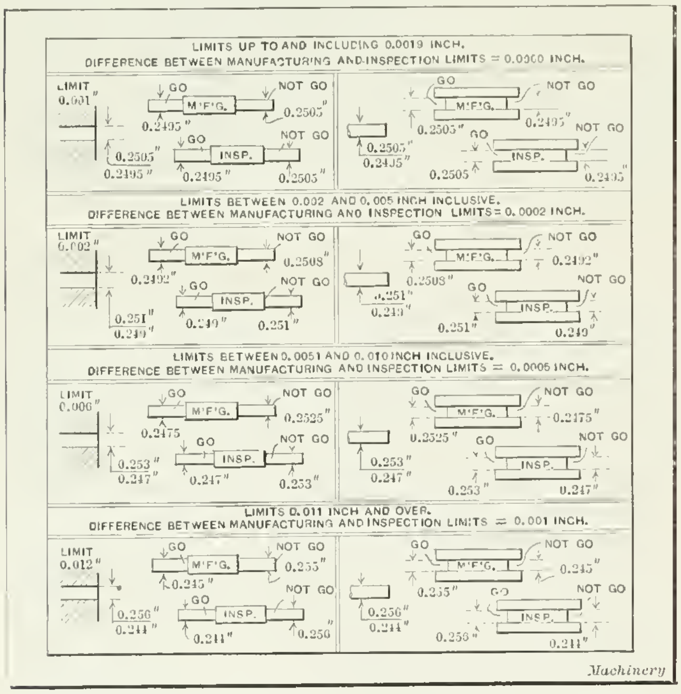
LIMITS UP TO AND INCLUDING 0.0019 INCH.
DIFFERENCE BETWEEN MANUFACTURING AND INSPECTION LIMITS = 0.0000 INCH.
LIMIT 0.001"
GO
NOT GO
M'F'G.
INSP.
0.2505"
0.2495"
LIMITS BETWEEN 0.002 AND 0.005 INCH INCLUSIVE.
DIFFERENCE BETWEEN MANUFACTURING AND INSPECTION LIMITS = 0.0002 INCH.
LIMIT 0.002"
0.2508"
0.2492"
0.251"
0.249"
LIMITS BETWEEN 0.0051 AND 0.010 INCH INCLUSIVE.
DIFFERENCE BETWEEN MANUFACTURING AND INSPECTION LIMITS = 0.0005 INCH.
LIMIT 0.006"
0.2525"
0.2475
0.253"
0.247"
LIMITS 0.011 INCH AND OVER.
DIFFERENCE BETWEEN MANUFACTURING AND INSPECTION LIMITS = 0.001 INCH.
LIMIT 0.012"
0.255"
0.245"
0.256"
0.244"
Machinery

Fig. 49. Diagram showing Method of Figuring Limits on Plug and Snap Gages for Manufacturing, Manufacturing Inspection and Government Inspection Purposes

Setting Limits on Gages

The limits to be allowed in manufacturing depend entirely on the accuracy required in the product. The greater the accuracy, the closer are the limits that must be employed. Working to close limits brings about a consequent increase in the cost of manufacture owing to the frequent sharpening and resetting of the cutting tools which is necessary. It can therefore be seen that the question of setting limits is very important and should not be decided upon in a haphazard manner.

The limits usually allowed in manufacturing—especially in the production of firearms—vary from 0.0005 up to 0.005 inch for steel parts and from 0.005 up to 0.012 inch for the wooden stock, etc., the limits depending entirely on the requirements of the work. Where two inspection departments are employed—in this case manufacturing and government inspection—it has been found advisable to have the manufacturing and manufacturing inspection gages made within closer limits than the gages furnished to the government inspectors. There are several reasons for this: The manufacturing gages are used more often than the government inspection gages, and are subjected to greater abuse, so that the manufacturing gages wear much more quickly than the other gages. Another reason is that if the parts are made to a gage which is held within closer limits than the gages used by the government inspectors, it is evident that the number of parts returned on account of not coming within the limits will be considerably reduced, which is no small item where a large number of interchangeable parts are to be manufactured. Still another reason which might be given is that the inspection gages act as a detector of wear in the manufacturing gages, and always keep the work within the required limits. The term "inspection gages" used in the following description refers to the gages used by the government inspectors, and not to the manufacturing inspection gages, the latter having the same limits as the manufacturing or working gages.

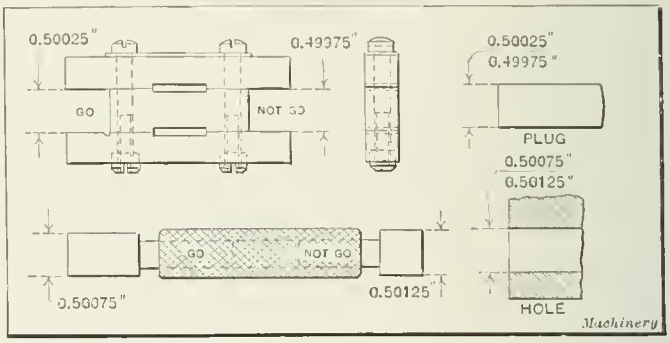

Fig. 50. Typical Plug and Snap Gage used

The strict requirements to be met in the manufacture of rifles for the Canadian government calls for a high degree of efficiency in manufacturing. All of the various parts of the rifle are inspected by government inspectors before they are assembled; and to avoid the possibility of the parts being rejected by these inspectors, the Ross Rifle Co. has found it advisable to allow a larger limit on the gages furnished to the government inspectors than those used in manufacturing and manufacturing inspection.

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* For further information on gages and gage making previously published in MACHINERY, see "A System of Gages for Small Parts," November, 1910, and other articles there referred to; see also MACHINERY'S Reference Book, No. 64, "Gage Making and Lapping."

† Associate Editor of MACHINERY.

To make this difference between the limits used on the manufacturing and inspection gages clear to the gage-maker (gage-making is now a special business), the chart, shown in Fig. 49 was laid out for plug and snap gages. On gages having a limit of not over 0.002 inch, it is not practical to make any measuring difference between the manufacturing and inspection gages. When making the gages, if there is any difference in "feel" between two gages supposed to be the same size, the gage having the smaller limit is sent to the manufacturing department. On gages having limits over 0.002 inch and under 0.006 inch, the manufacturing gages are made 0.0002 inch inside the limits used on the inspection gages. The figures given in the chart, Fig. 49, for plug and snap gages do not refer to gages for parts intended to fit one another. This chart simply shows the difference between the manufacturing and inspection gages after the original sizes and limits have been established.

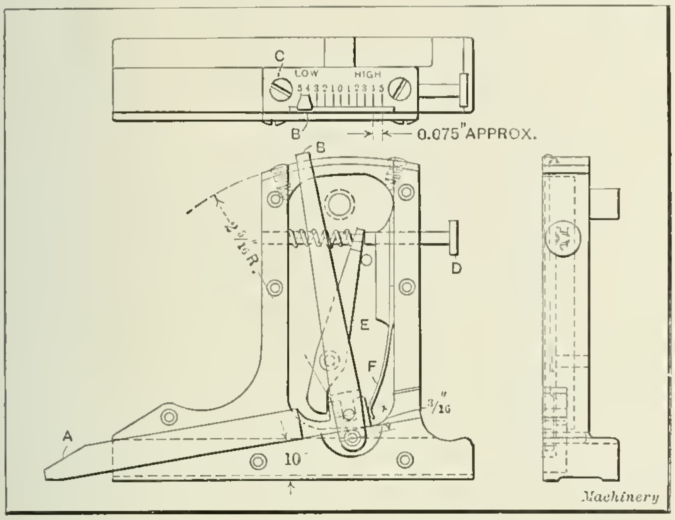


Fig. 51. An Indicating Tool-setting Gage

Working to Limit Gages

The limit gages with which the workman is usually provided are of the snap and plug gage variety, as shown in Fig. 50. The snap gages are made with "Go" and "Not go" slots, and the plug gages are made with "Go" and "Not go" plugs. The difference between the diameters of the "Go" and "Not go" slots and plugs is the allowable manufacturing limit on the part.

In making a set of limit gages, the limits are usually given above and below (plus and minus) the mean dimension. To illustrate, say that it is necessary to make a plug or shaft which must fill a hole as shown in Fig. 50, with a fixed maximum and minimum shake or looseness. Suppose that the mean diameter of the hole is 0.500 inch, and that we decide on allowing 0.0005 inch as a limiting difference between the maximum and minimum sizes of the plug and snap gages, giving a maximum freedom of 0.0015 inch between the plug and the hole, or, in other words, a good interchangeable running fit.

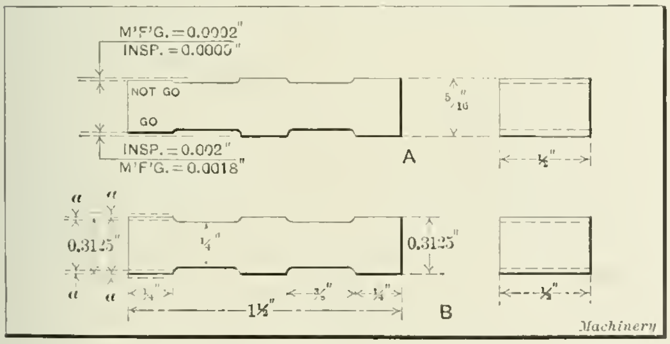


Fig. 52. A Tool-setting Rocker Gage compared with the Ordinary Gage used for Manufacturing and Inspection Purposes

Referring to Fig. 50, the "Go" end of the snap gage for the shaft or plug is made 0.50025 inch and the "Not go" end, 0.49975 inch. The "Go" end of the plug gage for the hole is made 0.50075 inch, and the "Not go" end 0.50125 inch. The greatest shake, therefore, would be the difference between the largest hole and the smallest shaft or plug, which equals 0.50125 — 0.49975 = 0.0015 inch; and the least shake is the difference between the largest shaft or plug and the smallest hole, which is 0.50075 — 0.50025 = 0.0005 inch.

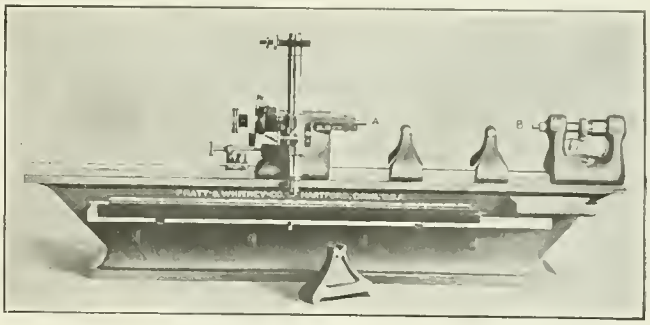
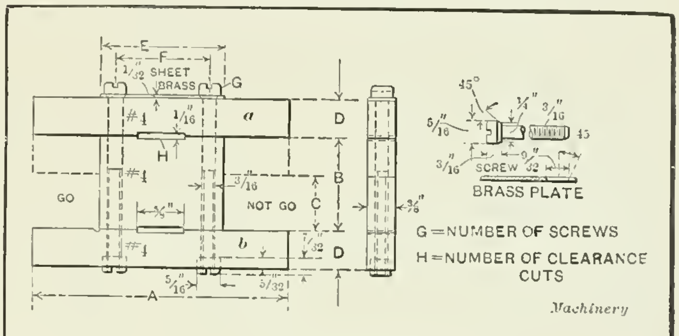


Fig. 53. Pratt & Whitney Measuring Machine, which is used as a Standard Reference for Gages

Work gaged by gages which are made in this manner will always go together; but the natural tendency of the operator, to avoid spoiled work, is to work as close as possible to the "Go" end of the gage. This means that a large majority of the parts will go together with the minimum allowable freedom, or 0.0005 inch, when the ideal freedom is the mean or 0.001 inch.

This tendency of the operators to always work to the "Go" end of the gage, has brought about the adoption of a tool-setting gage. This tool-setting gage is made to the mean dimension, and shows the operator what is desired for the part he is making. As soon as the operator becomes familiar with the tool-setting rocker, or gage, he finds it a great help, as it avoids frequently adjusting the machine. If the cutter wears or the machine springs, so that the part is not cut to the mean dimension after the machine has been set, there is still a sufficient marginal limit between the extremes (maximum and minimum) so that the working gages will not reject the work.

DIMENSIONS OF STANDARD PARTS FOR SNAP GAGES



No. of Gage	Dimensions in Inches							
	A	B	C	D	E	F	G	H
1	2 1/16	1/4	0.00	1/4	1 5/8	1 1/4	2	1
2	2 3/8	1/2	1/4	5/16	1 5/8	1 1/4	2	1
3	2 5/8	3/4	1/2	3/8	1 5/8	1 1/4	2	1
4	3 3/8	1 1/4	3/4	1/2	1 5/8	1 1/4	2	1
5	5	2	1 1/4	3/4	2 1/2	1 1/16	3	2

By the old method (working to the limit gages exclusively), the least variation in the work from the "Go" end of the gage, caused the operator to recut the work—a waste of time—or if the "Go" end went over the work easily, he was afraid that the next piece would go in the "Not go" end and be spoiled; hence he attempted to adjust his machine. This waste of time increased the cost of the parts considerably, and also tended to confuse the operator and make him inefficient.

Tool-setting Gages

To hold the work as close as possible to the mean dimensions—the ideal aimed at in interchangeable manufacture—the Ross Rifle Co. has adopted what is called a tool-setting gage. The first gage designed to perform this function is shown in Fig. 51. This gage, as can be inferred, is expensive to make, and as a large number of tool-setting gages are necessary, it was discarded in favor of a simpler and cheaper gage. As it might be possible, however, to use a gage of this type for other work, a short description of it is included.

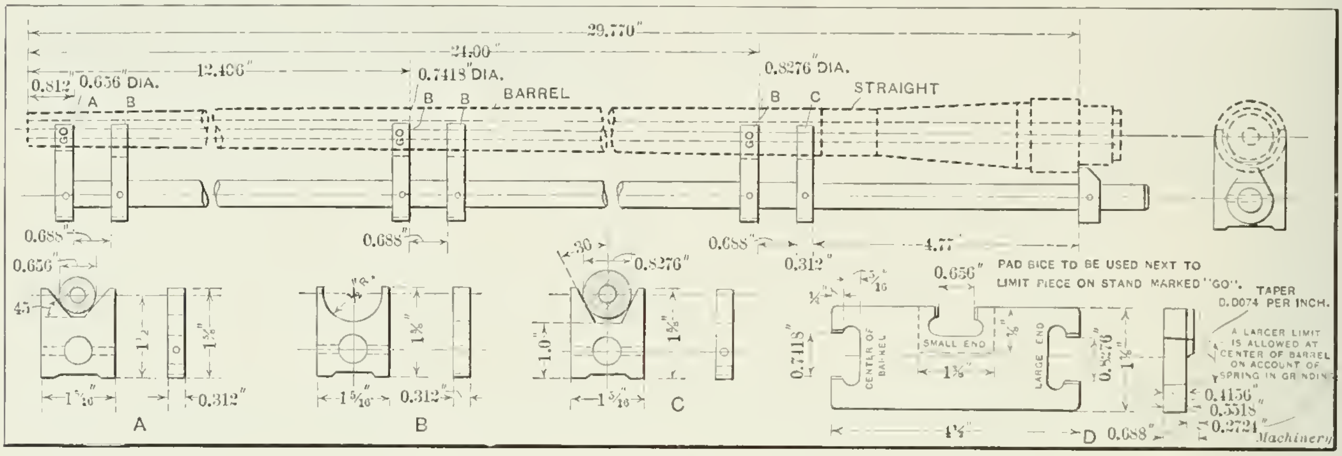


Fig. 54. Gages used in Gaging the Taper on the Barrel

The gage shown in Fig. 51 is designed on the multiplying lever principle, combined with an angularly operating finger, and multiplies an error about seventy-five times; that is, a difference of 0.001 inch in the distance from the lower face of the measuring finger *A* to the base of the gage equals a movement of approximately 0.075 inch of the pointer *B* on the scale *C*. The movement of the pointer *B* corresponding to a difference of 0.001 inch on the finger *A* equals 2 5/16 × 3/16 × sin 10 deg. = 2.3125 × 0.1875 × 0.17365 = 0.0753 inch. As the spaces between the graduations on the scale are not uniform in gages of this type, they are usually marked off after the gage is assembled; this is accomplished by using "feelers" or thickness standards for each thousandth of an inch movement of the indicating finger. This gage is operated by pushing in the spring plunger *D*, which, through the lever *E* pivoted to the frame, draws back the finger *A* against the tension of the flat spring *F*. The finger *A* is slotted and fits a pin driven into the pointer *B*, pivoted in the base of the gage, this action moving the pointer along the scale *C*.

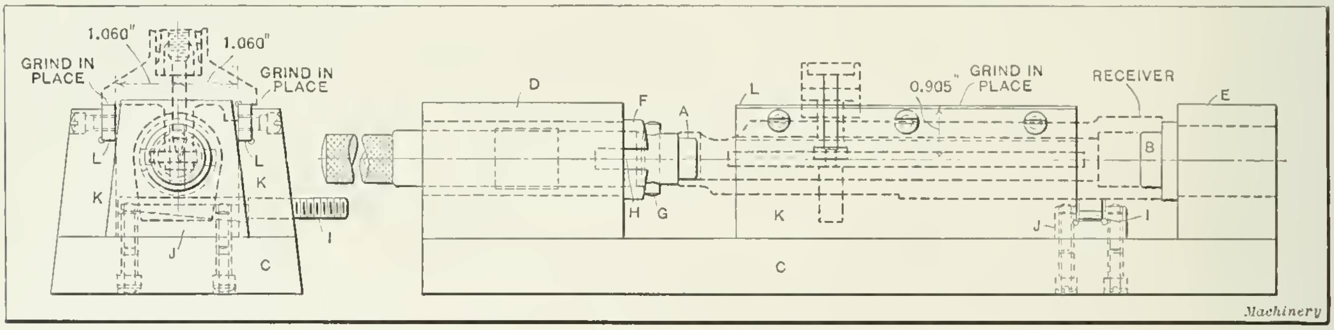


Fig. 55. Stand used in Connection with the Gages shown in Figs. 57 and 58 for Gaging the Guide Slots in the Receiver

A gage which is used extensively in the manufacturing of the parts for the Ross rifle, and especially on those parts which are milled and profiled, is the "block" and "rocker" gage. This consists of a stand for holding the work, with a hardened and ground block fastened to its top face, and a small block called a "rocker" as shown in Figs. 52 and 59. The rocker *A*, Fig. 52, is provided with three bosses on each side, the bosses on one end being ground lower than the other two an amount equal to the limit allowed. Three of these rocker gages are made, two for manufacturing and the other for government inspection purposes.

The same trouble is encountered in the use of the rocker gage as with the limit plug and snap gages, that is, the operator always works as close as possible to the "Go" boss. To obviate this, a tool-setting rocker gage, as shown at *B* in Fig. 52, was made. This block is ground so that the operator sets the cutter to the mean size instead of above or below the mean, as would be the case if the ordinary rocker gage shown at *A* were used. Limits are not allowed on this tool-setting gage, the object of which is to show the mean size of the gages. A slight allowance, however, is sometimes made to provide for wear on the cutter, thus obviating the too frequent sharpening and resetting of the cutter. The position of the limits *a* above or below the mean surface of the rocker depends on the character of the operation and the cutter used.

In making gages, it is absolutely necessary to have some standard of measurement. The Ross Rifle Co. uses a Pratt & Whitney micrometer measuring machine, as shown in Fig. 53, as the standard of measurement, and all gages are tested for accuracy in this machine. The machine is first set with a master gage which is held between the jaws *A* and *B*. Then it is adjusted so that the small plug *C*, when touched, will swing back and forth between the two auxiliary jaws without dropping out. By taking the reading on the micrometer dial and then putting the gage to be measured between the jaws *A* and *B* in place of the master, it can readily be seen whether the conditions of pressure upon the gage to be measured are the same, by noting the action of feeler gage *C*. Any variations between the standard gage and the gage being measured may then be read off by means of the subdivisions on the divided index circle. By means of this instrument it is possible to duplicate sizes of working gages from a standard to within 0.000025 inch.

Standardizing Snap Gages

The ordinary solid snap gage has been found unsatisfactory for accurate work, mainly on account of its short life. As soon as this gage wears to any appreciable extent, it has to be discarded. This unsatisfactory feature has brought about a design of gages, the wearing points of which can be duplicated at small cost. A standard snap gage of this kind is shown in connection with the accompanying table. This gage is made in five sizes, numbered 1 to 5. The spacing blocks are made from machine steel, varying in thickness by 1/32 inch, that is, the space between the maximum and minimum sizes *B* and *C* for each number of gage is divided into thirty-seconds of an inch. For example, eight spacing blocks would be made for gage No. 2. These spacing blocks are case-hardened and ground and have the size stamped in the clearance cut. The top block *a* is ground perfectly parallel, while the bottom block *b* is made with the limit allowed, and is stamped accordingly. Both of these blocks are made from tool steel and hardened.

When a snap gage of a certain size is desired, the two blocks *a* and *b* and a spacer of the required thickness are obtained from the store-room and fastened together by screws, which are also standardized. A brass name-plate which carries the piece and operation numbers is put on, thus obviating the stamping of the gage proper, and when worn the gage can be taken apart, ground, put together and used indefinitely. The advantages of this type of snap gage for interchangeable manufacture are obvious.

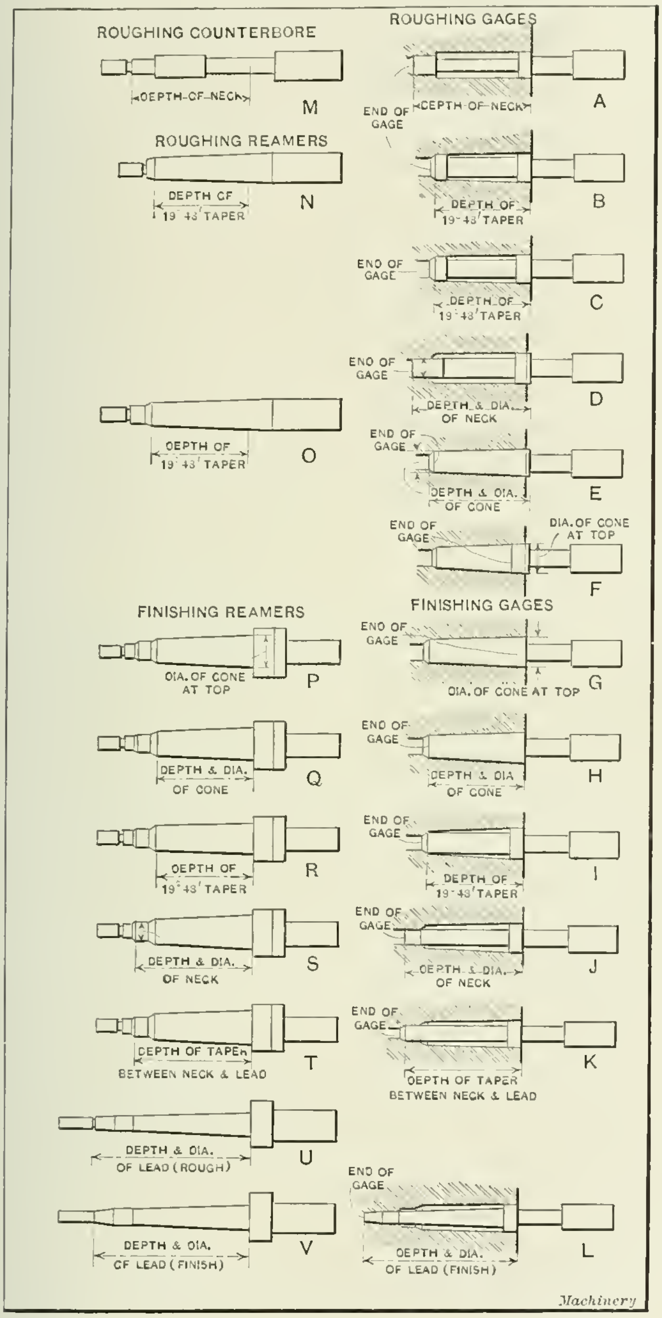


Fig. 56. Diagram illustrating the use of the Tools for Machining and the Gages for Gaging the Chamber in the Barrel

Gaging the Taper on the Barrel

After the barrel has been finish-ground externally in the Brown & Sharpe plain grinder, the taper, which is 0.0074 inch per inch, is inspected in the gage shown in Fig. 54. The barrel is held in the supports *A*, *B* and *C*, which act as a stand, and also as limit "points", snap gage *D* working in between them. The limit blocks are all placed the same distance apart—0.688 inch—and as a greater limit is necessary at the center of the barrel on account of spring in grinding, that part of the gage for the muzzle end is padded on one side to reduce the limit. The limit allowed at the muzzle end is 0.001 inch, the padded side of the gage being held against the "Go" block *A*. The limit allowed in the center and large end of the barrel is 0.002 inch; the gage *D* for these parts not being padded, has a greater movement between the limit blocks. The barrel is gaged at the muzzle and near the breech end at the points where the front and rear sight bases are located, so that the sight bases will be in the same relative positions on each barrel. The gage shown at *G*, Fig. 48, is used for gaging the over-all length of the barrel, while the gages used for the extractor and entrance cuts in the breech end of the barrel are shown at *J*, *K* and *L*.

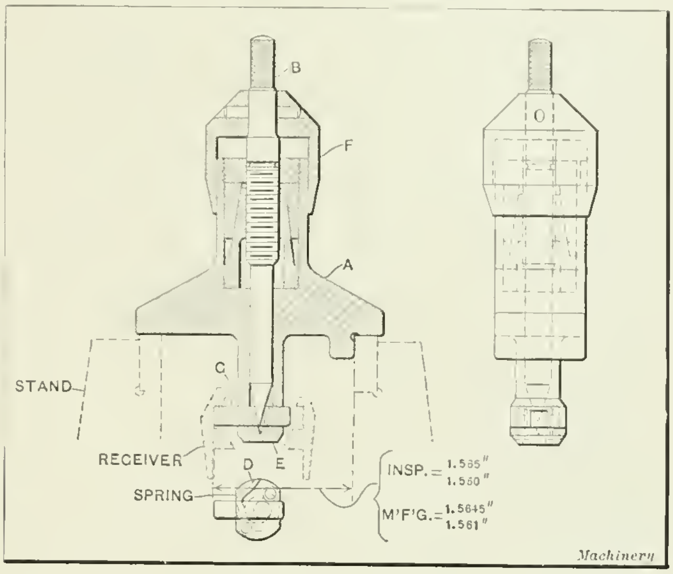


Fig. 57. Gage used in Gaging the Distance from the Center Line to Sides of the Guide Slots in the Receiver

Gaging the Chamber in the Barrel

One of the greatest difficulties which confronted the pioneer rifle manufacturer was the finishing of the chamber for the cartridge so that the bullet would always be held concentrically and started properly. Since the adoption of the solid-drawn cartridge case in 1885, great strides have been made in designing and making the cartridge chamber. The increasing demand for accuracy in the modern rifle necessitates the production of a chamber concentric with the bore, so that the bullet will leave the rifling grooves with the least possible distortion and without any change in its concentricity and gyroscopic stability.

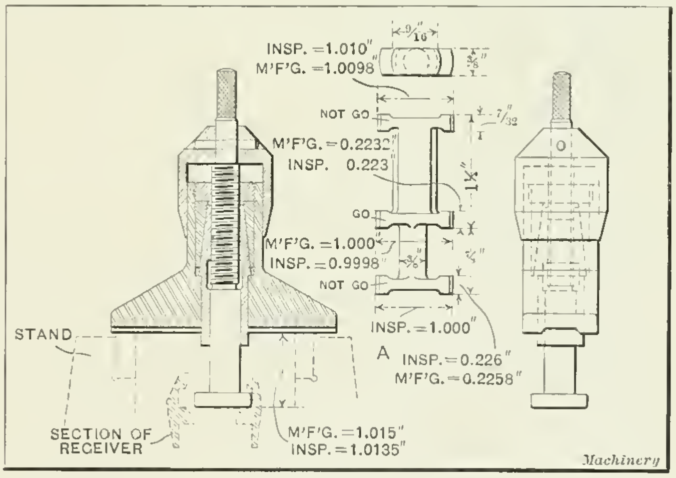


Fig. 58. Gage used in Gaging the Distance from the Center Line to the Bottom of the Guide Slots in the Receiver

It is not an easy problem to produce a perfectly chambered rifle, and it requires both a high degree of workmanship and a complete and practical gaging system for its accomplishment. The chart shown in Fig. 56 illustrates the counterbores, roughing and finishing reamers, and also the roughing and finishing gages used for machining and gaging the chamber in the 0.303 Ross military rifle. Those not familiar with this problem will, no doubt, think that a number of gages and reamers shown on this chart are superfluous. This is not the case, however, as will readily be seen by a close inspection of the chart.

The chamber is first roughed out with the counterbore *M*, and then gaged at the mouth and in the bore with the gage *A* to see that the counterbored hole is of the exact diameter and is concentric with the bore in the barrel. Then the chamber is reamed with a roughing reamer *N* and gaged with the gage *B*. The reamer shown at *O* is then used for finish-reaming the taper and neck and also for roughing the cone diameter. Now it would be impossible to make one gage so that it would act as a detector for all the various diameters finished by this reamer, this inspection requiring the use of the gages *C*, *D*, *E* and *F*, the lines on which should come flush with the end of the barrel when the reamer is of the correct size and is put in to the proper depth.

This finishes the rough-reaming and gaging operations, after which every part of the chamber is again finished with finishing reamers and gaged. The operations accomplished by the reamers *P* to *T*, inclusive, are inspected with the gages *G* to *K*, the latter also appearing at *H*, in Fig. 48. These gages are made so that a very slight change in diameter could easily be noticed by shaking the gages.

The reamers *U* and *V* and the gage *L* are used for machining and gaging the lead. The lead may be briefly defined as "the conical funnel which leads from the chamber to the bore". If the chamber were to end abruptly at the beginning of the bore in the barrel, the sharp ends of the lands would cut strips out of the nickel-jacketed case of the bullet and the latter would fly to pieces when it left the muzzle of the rifle. The lead must be perfectly concentric with the chamber and bore or else the bullet is likely to wobble or tumble after it leaves the muzzle.

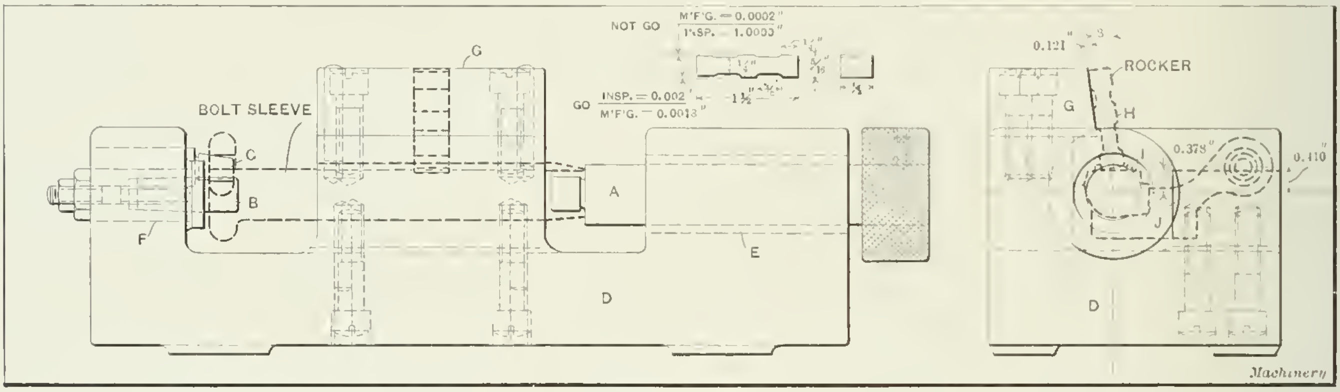


Fig. 59. Rocker Gage and Stand used in Gaging the Position of the Milled Groove in the Under Side of the Bolt Sleeve

The bullet is usually made equal to the nominal diameter of the bore plus the depth of one rifling groove, but it is sometimes made equal in diameter to the nominal bore plus one and one-half times the depth of one groove. The result of this is that the lands form corresponding grooves in the case of the bullet, the latter expanding and filling the rifling grooves when the cartridge is discharged. The function of the lead, therefore, is to allow the bullet to gradually take the lands of the rifling. The gage used in testing the diameter of the rifling grooves is shown at *I* in Fig. 48.

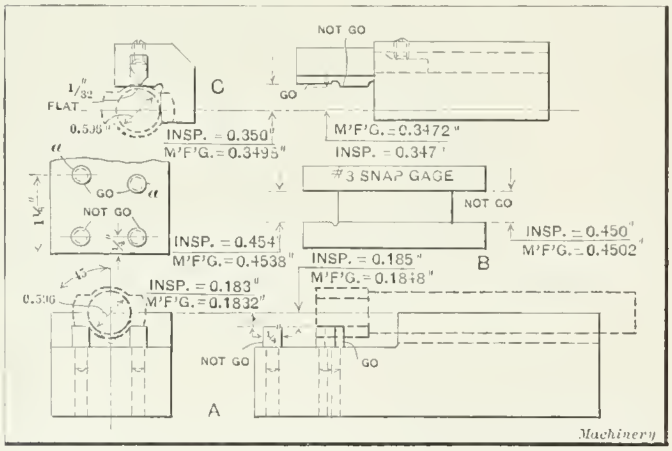


Fig. 60. Snap and Stand Gages used in Gaging the Head of the Bolt after Form Milling

No doubt the exceptional accuracy of the Ross rifle is largely due to the care taken in finishing the chamber, making it perfectly concentric with the bore in the barrel. The method of gaging shown by the chart Fig. 56, being peculiar to rifle manufacture, illustrates, probably better than anything else would, the extreme accuracy which is necessary in this class of work.

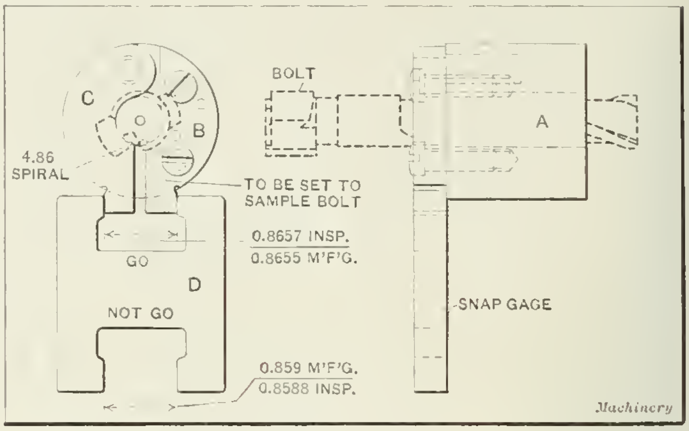


Fig. 61. Snap and Swinging Gage used in Gaging the Width of the Spiral Ribs on the Bolt

Gaging the Receiver

To gage the guide slots for the bolt sleeve in the receiver, the latter is placed on plugs closely fitting the reamed holes in each end, as shown in Fig. 55. These plugs *A* and *B* are held in a cast-iron stand *C*, provided with bosses *D* and *E* on each end. The plug *B* is driven into a reamed hole in the boss *E*, while the plug *A* is held in a hardened and ground sleeve *F*, forced into the boss *D*. The front end of the sleeve *F* is provided with a cam face against which the pin *G*, driven into the plug *A*, works. When the receiver is placed on the plugs, the plug *A* is turned by gripping the knurled end, and when this plug is turned, the pin *G*, working against the cam face on the bushing, forces the plug out, thus holding the receiver rigidly between the shoulders on the two plugs. A slot *H*, cut in the bushing *F*, which is a loose fit for the pin *G*, allows the plug *A* to be withdrawn to remove the receiver.

The receiver is prevented from rotating on the plugs, and the guide slots in it are held parallel with the hardened and ground measuring blocks *L* by means of a tapered wedge *I*. This wedge fits in a beveled slot in the block *J* which is fastened to the base by fillister-head screws. The slot is cut at an angle of 5 degrees with the measuring blocks *L*, so that the top face of the wedge is parallel with them. Shallow grooves are filed in the handle of the wedge *I* to facilitate its removal. The central portion of the stand is provided with two bosses *K* to which are attached hardened and ground blocks *L*. These blocks *L* act as a measuring surface for the micrometer gage shown in Fig. 57, which is used for gaging the distance from the center line of the receiver to the sides of the bolt sleeve guide slots. The gage is shown (dotted) in position for gaging one side of the guide slot in Fig. 55. The other side of the guide slot is measured by simply reversing the position of the gage.

Referring to Fig. 57, it will be seen that the gage consists of a base *A*, provided with a lug which fits against the hardened and ground measuring blocks on the stand, Fig. 55. A cone-pointed and threaded spindle *B* extending downward through the center of the body of the gage actuates by its cone-pointed end a measuring finger *C*. This finger *C* is retained by means of a flat spring *D* (shown in the lower view) which fits in a slot in the finger and also in the base of the gage. A cap *E* is fastened to the stem of the gage by two screws, as shown, to prevent the finger *C* from dropping out. The spindle *B* is provided with forty threads per inch and is pinned to a thimble *F*. The graduations on this thimble are laid out after the gage has been assembled and set by means of a master. Two gages of this type are made, one for inspection and the other for manufacturing purposes. As can be seen, these gages are provided with the ordinary split nut for adjusting purposes.

In Fig. 58 is shown the gage which is used for gaging the distance from the center of the receiver to the bottom of the bolt sleeve guide slots. A stand of the type shown in Fig. 55 is used for holding the receiver, and the measurement is taken from the hardened and ground blocks. The gage is practically of the same construction as that shown in Fig. 57, except that the spindle is provided with a head which acts as a measuring point. Two of these gages also are used, one of which is marked with the manufacturing limits and the other with the inspection limits. After the position of the guide slots in the receiver, relative to the center line, have been determined with the gages shown in Figs. 57 and 58, the limit gage, shown at *A* in Fig. 58, is used to determine the width of and the distance between the guide slots. The use of this gage is clearly indicated in the illustration.

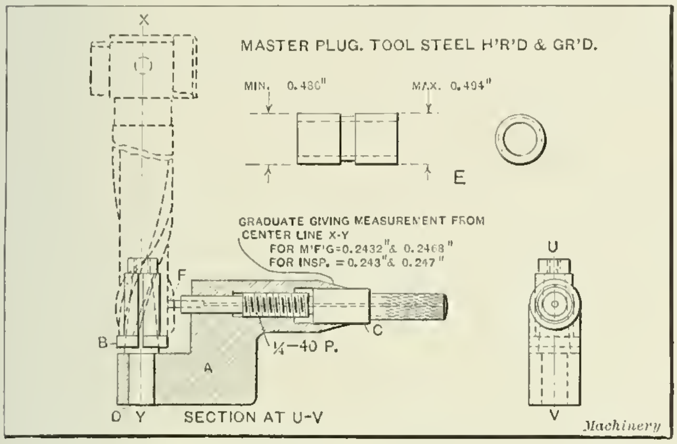

X
MASTER PLUG. TOOL STEEL H'R'D & GR'D.
MIN. 0.480"
MAX. 0.494"
E
GRADUATE GIVING MEASUREMENT FROM CENTER LINE X-Y
FOR M'F'G=0.2432" & 0.2468"
FOR INSP. = 0.243" & 0.247"
U
F
B
C
¼—40 P.
A
D Y
SECTION AT U-V
V
Machinery

Fig. 62. Micrometer Gage for Gaging the Diameter of the Bolt at the "Root" of the Spiral Ribs

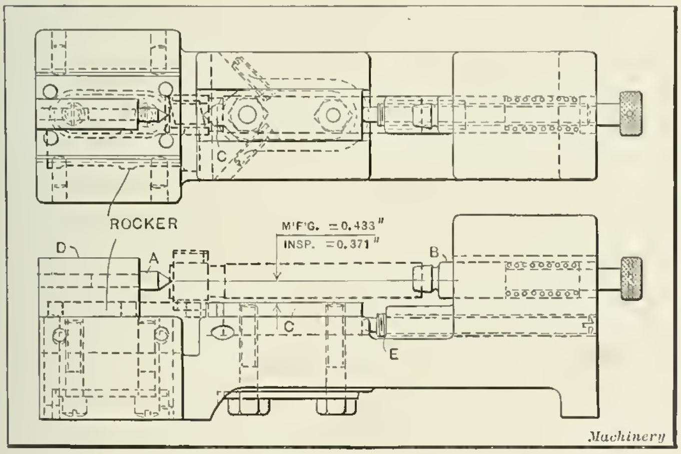


Fig. 63. Stand and Rocker used in Gaging the Locking Cam at the Rear of the Bolt Head

The receiver has a score mark placed on it which lines up with a corresponding mark stamped on the breech end of the barrel. These marks are produced by the marking gages shown at *A* and *B* in Fig. 48. Gage *A* produces the score mark on the barrel, while gage *B* puts the mark on the receiver. These gages consist essentially of a spring-actuated plunger which is sharpened on its lower end and is depressed by hitting the knurled knob with the hand. The receiver is screwed onto a threaded plug, while the barrel is held in a threaded bushing. The gage for testing the thread on the barrel is shown at *C* and those for testing the position of the score mark and the thread in the receiver are shown at *D* and *E*. Two standard built-up snap gages are shown at *F*.

Gaging the Bolt Sleeve

A good example of the application of the rocker gage is shown in Fig. 59. Here the position of the milled groove in the under side of the bolt sleeve is located. The bolt sleeve is placed on the hardened and ground plugs *A*, *B* and *C* which are held in the cast-iron base *D*. The plug *A* is provided with a knurled head and is made a good fit in the hardened and ground sleeve *E*. Plug *B* is made with a tapered shank, and is held in a corresponding hardened and ground tapered sleeve by a stud and nut as shown. The sleeve *F* is provided with a shoulder which butts against the cast-iron boss on the base *D*. The plug *C* is tapered and fits the hole in the handle of the bolt sleeve and is driven into a reamed hole in the boss on the casting.

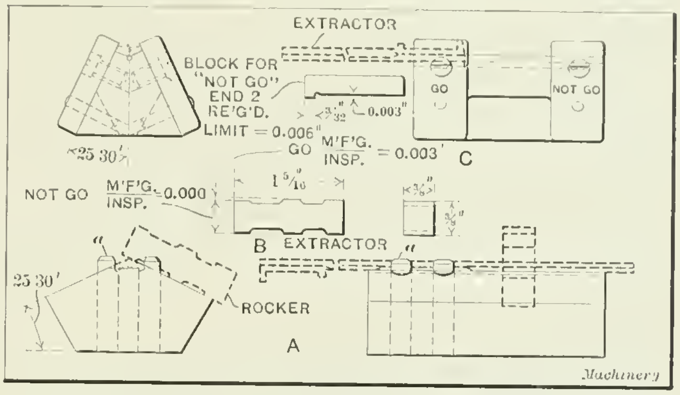


Fig. 64. Gages used in Gaging the Thickness and Width of the Extractor

A hardened and ground block *G*, fastened by screws and dowels to the casting *D*, acts as a measuring surface for the rocker gage *H*, which is applied in the manner shown in the illustration. This rocker is hardened and ground and the bosses on one end are lower than the other two bosses on each side an amount equal to the limit allowed. This stand *D* is also used for gaging the height of the shoulder *I* on the bolt sleeve, the rocker *H* being placed on the hardened and ground block *J* in a similar manner.

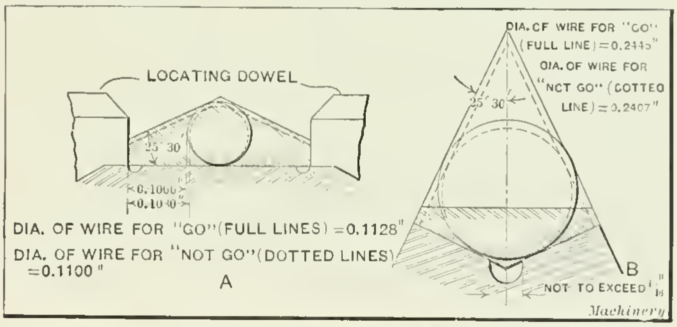

LOCATING DOWEL
25° 30'
0.1000"
0.1030"
DIA. OF WIRE FOR "GO" (FULL LINES) = 0.1128"
DIA. OF WIRE FOR "NOT GO" (DOTTED LINES) = 0.1100"
A
DIA. OF WIRE FOR "GO" (FULL LINE) = 0.2445"
DIA. OF WIRE FOR "NOT GO" (DOTTED LINE) = 0.2407"
25° 30'
B
NOT TO EXCEED 1/16"
Machinery

Fig. 65. Diagram illustrating the "Wire Method" used in Measuring the Gages shown in Fig. 64

Gaging the Bolt

After the head of the bolt is form-milled, it is gaged in the gages shown in Fig. 60. The gage shown at *A* locates the position of the faces of the lugs by means of pins driven into the V-block in which the bolt is placed. A point worthy of attention in this gage is the staggered position of the ¼-inch pins *a*, shown in the plan view. Locating the pins in this manner facilitates the inspection of the work. The thickness of the lugs is tested by means of the standard snap gage shown at *B*, and the height of the shoulder on the bolt head is gaged in the gage shown at *C*. This latter gage consists of a plain block in which the limit gage, provided with "Go" and "Not go" bosses is held by a screw.

An interesting gage for taking a difficult measurement is shown in Fig. 61. This gage is used for inspecting the width of the spiral ribs on the bolt. It consists of a block *A*, to which is held a rigid jaw *B* and a swinging jaw *C*. The limit snap gage *D*, which is used to take the measurement, fits over the ground ends of the jaws *B* and *C*. That part of the jaws which comes in contact with the spiral ribs on the bolt is cut to fit the spiral rib, which makes one turn in 4.86 inches.

The diameter of the bolt at the root of the spiral ribs is measured by means of the gage shown in Fig. 62. This consists of a frame *A*, holding a split sleeve *B*, and a micrometer spindle *C*. The sleeve *B* is held on a conical plug *D* by a nut, and is split so that it can be made to fit snugly in the hole in the bolt. To lay off the limit lines on the gage, the master plug *E* is placed on the sleeve *B* and the measuring point *F* is brought in contact with it.

Another interesting use of the rocker gage is shown in Fig. 63. This gage is used to gage the position of the locking cam on the rear of the bolt head. The bolt is placed on the center *A* and the spring-actuated plug *B*, and is rotated until the cam comes in contact with the 90-degree pointed block *C*. The rocker is then used from the sides of the block *D*, holding the center *A*. The pointed block *C* is adjusted by means of the screw *E* and is set to a master bolt. The block holding the center *A* is also made adjustable and is set in the desired position.

Gaging the Extractor

The extractor, which is used for removing the exploded cartridge from the chamber in the barrel, is beveled on the back and fits in a groove cut in the bolt sleeve. The thickness of this extractor and the angles of inclination of its back are gaged in the block and rocker gage shown at *A* in Fig. 64. The extractor is located between four pins *a*, and the rocker shown at *B* is applied as illustrated. The tapered sides and width of the extractor are gaged in the block gage shown at *C*. This gage, instead of having a rocker, consists of a plain block beveled to the required shape and to which four blocks are fastened, two on each end. The blocks on one end are ground so that a perfect extractor will not enter, while the blocks on the other end are ground so that a perfect extractor will enter. To facilitate the making of these gages, the drafting department laid out two diagrams as indicated in Fig. 65, in which the angular faces of the gages were determined by means of the "wire method," with which most toolmakers are familiar.

Conclusion

No better proof of the accurate work necessary in producing a high-grade military rifle could be given than a description of the methods used in gaging the parts. While all the important gages used in the production of the Ross rifle are not described in the foregoing, the principal ones are included. The gaging of the chamber in the barrel is an excellent example of the care taken in making the chamber in each barrel an exact duplicate—a commendable feature in any rifle. The writer wishes to express his gratitude, at this point, for the assistance given him by the various men connected with this company who are in charge of the production and engineering departments.

* * *

An interesting commercial application of cerium alloys has recently been made. These alloys possess the property of emitting sparks when struck, and this property has been made use of in the shape of a match box. The alloy used is of cerium and iron, and the spark is produced by a rubbing contact with a steel file wheel, the spark igniting a wick saturated with gasoline which is contained in the interior of the case. The application is unique as it employs a metal which heretofore has had no commercial use. The same idea has also been used in a device for lighting gas, consisting of a holder with a cerium iron alloy which rubs on a steel file and emits a sufficient spark to ignite gas.

* * *

EDISON'S LATHES

According to the *English Mail* of August 17, "Edison's sleeping couch is a wooden bench which is placed just where a workman at a certain hour must come for a lathe or a lever."

There is nothing like system—unless perhaps a pocket turret lathe. R. G.

WHY THE SHOP DOES NOT RETAIN THE SKILLED MECHANIC

OBSERVATIONS BY "ONE WHO HAS BEEN THROUGH THE MILL"

By EX-TOOLMAKER

Every once in awhile we read articles relating to the expert mechanic of the future—where he is to come from, and how he is to be trained along mechanical lines to the best advantage. Anyone who is at all familiar with modern shop practice will admit that the expert all-around machinist and toolmaker, who could construct any complicated piece of machinery from drawings alone, are not to be found as readily as they were fifteen years ago, when ten hours constituted a day's labor, and three dollars for ten hours' work was considered good wages. In the last fifteen years wages have increased about twenty-five per cent; this increase has been necessary to keep pace with the present cost of living. The hours of labor in many sections of the country have been reduced from ten to nine, and the machinist and toolmaker often work under better conditions in modern, well-ventilated and sanitary shops. Why it is, then, that good mechanics are so hard to find?

There are several reasons for this. In the first place very few shops have anything like an effective system for training apprentices. To hire a boy for small wages and put him on routine work under the supervision of a straw boss may be an excellent method for cutting down the cost of production, but it is certainly a poor way to try to make an expert mechanic. No matter how much mechanical intuition a young man inherits, he never can become a good mechanic without practice and a varied experience. To become an expert machinist or toolmaker under present-day conditions is no small undertaking. To begin with, a young man should—to a marked degree—possess mechanical intuition, or the ability to see through mechanical problems readily. After working for say three years in one shop he should travel and work in different shops to become better familiar with different methods of modern shop practice. It is a generally acknowledged fact that the mechanic who has had only a limited experience in one or two shops is seriously handicapped by his lack of knowledge concerning different methods of handling and getting out work. To be sure, he can go ahead and do as the foreman tells him, but no foreman places much confidence in the man who cannot go ahead and do a little independent thinking for himself.

However, after a young man has traveled for a few years, working on everything from sewing machines to battleships, he has gained a considerable knowledge of different methods of handling work, and he cannot be blamed if a possible twenty-five cents per day more than the average stay-at-home mechanic receives does not seem attractive enough for a steady diet. His traveling has taught him self-confidence and self-reliance. Therefore, he generally finds something more attractive than a possible forty cents per hour, with his time rung up on a time clock. And this is no idle dream, either. Let anyone who doubts it take a trip through the Middle West, where salesmen are plentiful, and note the number of expert machinists who are selling everything from high-speed steel to complete machine shop outfits.

An ever-increasing army of expert machinists is employed in this manner, and they certainly cannot be blamed for giving up the shop for a traveling position with a good house. If a man has the courage and persistency to put up with the hardships that are a necessary part of the roving machinist's life, he generally has brains enough to plan out some way for getting paid for what he knows by representing, in one way or another, some reliable concern dealing in machinery or shop accessories.

The chief trouble in the shop is that everything is against the individual man; he plays a losing game from start to finish. If, while on his way to work, he is delayed by a car being stalled, or a drawbridge being open, or by some other cause beyond his control, he is the loser of a few minutes which mean just so much money to him. If the whole shop's crew form the opinion that they deserve an increase in wages and go to the manager in a body, they generally are told that they can only be dealt with as individuals. If, on the other hand, one man asks for an increase in wages, he is told that he is receiving the maximum rate paid to mechanics of his kind, and that the shop does not pay above a certain limit. If he happens to be working on piece-work and originates methods for cutting down the cost of production, does he get more pay for getting out more work? Well, not so that you would notice it; his rate is cut instead. This certainly does not look like the proper way of encouraging ambition; however, it is part of the present system.

Expert machinists and toolmakers are a highly intelligent class of men, and to tie them to a time clock along with men who often cannot read or write is wrong from the start. It is not to be wondered at that they take the first opportunity to go to work at something that has at least the semblance of a Mr. before it. The greatest trouble is that the average manufacturer does not seem to make any distinction between the skilled and the unskilled labor in his employ. It takes a number of years for a man to become a skilled mechanic, and the average manufacturer is making a serious mistake in ignoring this fact and treating skilled and unskilled labor alike.

Expert machinists and toolmakers of recognized ability should be hired by the year and not by the hour. This would do more toward solving the problem of retaining expert help than any other means, as it would, in the first place, give the mechanic confidence in his employer, where distrust now exists. This would result in a large increase of the amount of work turned out; as it stands now, confidence does not exist, which often means curtailment of production.

The average manufacturer has put his office help on the honor system because he had to. Does the pretty little typewriter stand for being docked if she is a few minutes late? Certainly not, nor does the cub draftsman, for that matter. It certainly takes more skill to become an expert machinist or toolmaker than it does to become a stenographer or draftsman. Why then not put the expert machinist and toolmaker on the honor system also? They certainly are employes that cannot be dispensed with. These conditions probably will not come about in the near future, but they may in time. In the meanwhile the smoking section of a Pullman and a good hotel seems to satisfy a small army of expert mechanics who never would have left the shop if conditions had been somewhere near what they should be.

* * *

ITALIAN STEAM TURBINE LOCOMOTIVE

In the August, 1910, number of MACHINERY, railway edition, a turbine locomotive built by the North British Locomotive Co., Ltd., of Glasgow, was described. According to the *American Engineer and Railroad Journal*, a small locomotive fitted with specially designed turbines has recently been successfully tried at Milan. The peculiar feature of the turbine is the use of movable blades, which are operated in series. Four sets of blades are used. At high speed, the steam strikes the first set of blades only, while at intermediate speeds, two or three sets come into play. The reversing mechanism is a rather unique feature. The rotors have two sets of blades of opposite curvature. When running in one direction, the steam passes over the blades from left to right; when running in the opposite direction, the steam passes over the other set of blades from right to left. It is reported that the engine starts well under load, both on curves and grades, and that the steam consumption has not exceeded 38 pounds per horsepower-hour, when running in either direction.

* * *

Unofficial reports of the large Hamburg-American liner, originally called the *Europa*, but now named the *Imperator*, state that the vessel will be approximately 900 feet in length with a width of 96 feet and a gross tonnage of 50,000. It is claimed that 4250 passengers can be accommodated in addition to a crew of 1000. The engines will develop 70,000 horsepower.

A UNIVERSAL INDICATOR

By H. V. PURMAN

One of the most necessary tools in the jig-maker's kit is the indicator. With the micrometer he can determine sizes and with the height gage, set buttons, but without the indicator he would be at a loss to know when his button is running true and when the bored hole will be in the correct position. There are also many other uses for the indicator, such as setting a surface "level," aligning a piece of work parallel to the travel of any moving part of the machine, or finding the offset between two surfaces. These matters can be determined by other means, but the quickest way is to use the indicator. When it comes to setting work on a lathe faceplate so that a button previously set will run absolutely true, the indicator is indispensable. It is with the idea of assisting mechanics who may need such a tool that the following description is given.

The indicator shown in use in Fig. 1 and assembled in Fig. 2 was designed by Mr. F. A. Turner, who for many years was foreman of experimental and jig work in the United Shoe Machinery Co., of Boston and Beverly, Mass. It is through his kindness that the author was enabled to make a duplicate of the original for his own personal use. This is not the best indicator made, that honor belonging to the Boulet indicator made by Mr. J. H. Boulet of Beverly, Mass., but after a wide experience and familiarity with many indicators of the dial, arc-and-lever classes, the writer would say that this indicator is second best.

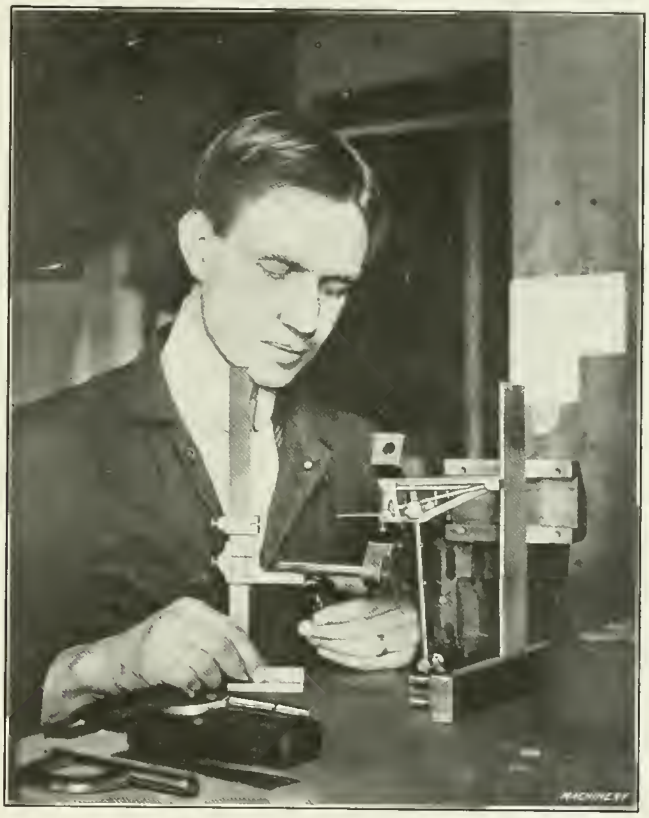


Fig. 1. The Indicator in Use as a Height Gage

Referring to Fig. 2, *A* is the frame, made from 1/16 inch bright-finished sheet steel, cut out light, and of a slightly ornamental design. It is drilled and tapped for six headless pointed screws, which hold the three pivots *B*, *C* and *D*, in which the levers are located. The motion of the work is transmitted by the finger *E* through links *F* and *G*, and rod *H* to the pointer *I*. *E*, *B* and *F* form a bellcrank operating a second bellcrank *G*, *C* and *H*, simply by means of the contact between links *F* and *G*, the contact points being hardened to reduce wear. Lever *H* supports and operates needle *I* by means of a cross-pin *M*, driven into the needle, the latter being held in the pivot *D*. The free end of needle *I* is reduced to an arrow head and swings over the graduated arc *J*. Lever *H* and needle *I* are made of aluminum, thus requiring little power to move them, and consequently making the indicator very sensitive. The other working parts are all made of steel. A small music wire spring *K* is secured to the frame and rests upon the cross-pin *M* in needle *I*, thus confining the motion of the latter to that actually given to it by lever *H*. This spring allows the indicator to be used in any position—upside down, sidewise or vertical. The indicator may also be rotated in the spindle of a machine to bring a hole or boss central with the spindle, but when it is used in the position shown in Fig. 2, the spring *K* is removed from the pin *M* and placed on the pin *L*, which also restrains the upward motion of lever *H*. This allows the indicator to return by gravity, and makes it more sensitive and delicate in its action. An adjusting screw *N* fitting in a nut brazed onto the frame serves to restrain the downward motion of finger *E*, and thus checks the fall of the needle *I* at any desired point on its arc.

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* Address: Winchester, Mass.

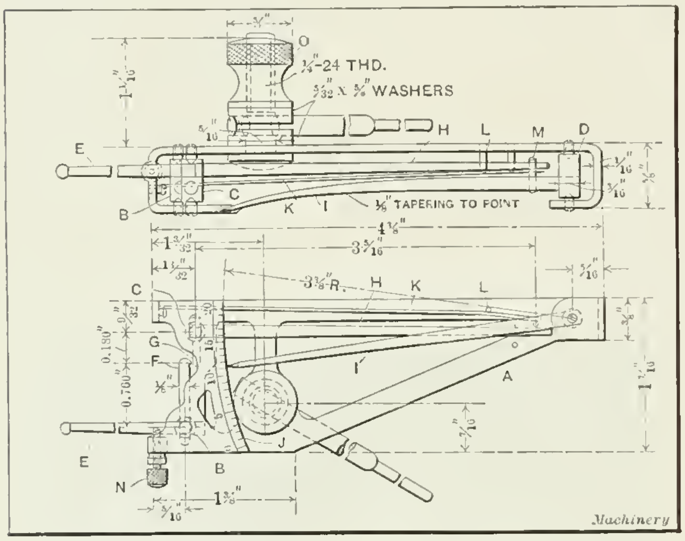

Fig. 2. Assembled Views of the Indicator shown in Fig. 1

In use, the indicator is held by the clamp *O* on a 3/16-inch rod, of which a number are provided with the different holders. One of the additional clamps used, which fits onto the tool held in a lathe or planer, is shown at *A* in Fig. 3. Another holder for the indicator is the stem shown at *B*, which obviously fits in a sleeve in the lathe, drilling or milling machine spindle.

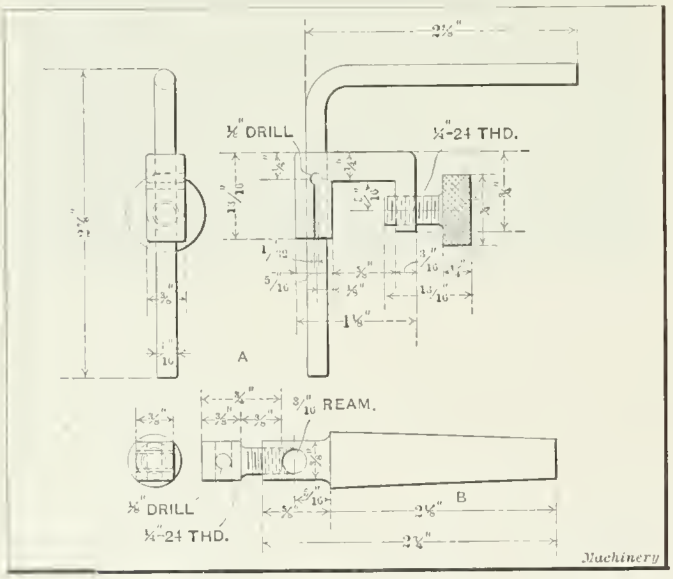

Fig. 3. Special Indicator Holders

Some additional fingers for the indicator are shown in Fig. 4. The large end of the shouldered rod *A* fits in the indicator clamp, and the small end is reduced to fit in the universal surface gage, thus permitting the use of this tool on the surface plate as a sensitive surface gage. The clamp *O*, Fig. 2, fits directly on the spindle of the small universal toolmaker's surface gage. Rod *A*, Fig. 4, however, is also useful in reaching over projecting obstructions, and allowing the use of the indicator in every conceivable place where its size permits or the fingers will reach. The "reach" of the indicator is greatly augmented by the additional fingers shown at *B* and *C*, which are interchangeable with the finger *E*, Fig. 2, and will reach over a projection.

The indicator is especially useful on the surface plate on points inaccessible to the height gage. The height may be taken on the indicator and transferred to the height gage as shown in Fig. 1. The additional finger *D*, Fig. 4, fits into the clamp *O*, Fig. 2, and extends out above and in line with the ball end of the finger *E*, Fig. 2. It is adjustable by swinging the clamp *O* to any desired position, thus making the tool a sensitive indicating inside caliper, which will reach where an inside micrometer could not enter. The reading can be noted, then the indicator withdrawn, and the needle *I* (Fig. 2) brought to the same reading by closing the micrometer caliper over the contact points, when the size of the hole or opening can be readily obtained.

This indicator, by actual test, has proved readily sensitive to the 0.00025 inch; that is, a motion of 0.00025 inch is magnified into a movement plainly discernible at the needle tip, the multiplication being 70 to 1. The arc on the indicator is slightly in excess of 1 7/16 inch in length and a space 1.4 inch long is marked off on it, the levers being so adjusted that the needle *I* moves that distance while the tip of finger *E* (Fig. 2) is moved 0.020 inch. The ratio then is $\frac{1.4}{0.020}$ or 70; therefore, as the arc is divided into twenty equal spaces, each space represents a movement of 0.001 inch.

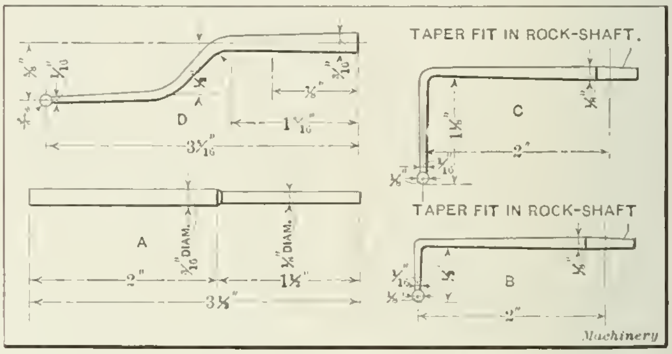

Fig. 4. Additional Rods and Fingers

* * *

ENGLISH CRANKPIN TURNING MACHINE

By FRANK C. PERKINS

In Manchester, England, a novel machine has been designed for the rapid and accurate machining of crankpins, as shown in the accompanying illustrations, Figs. 1 and 2. The principle involved in the method adopted in this new machine is that of actually "forming" the crankpin by means of a tool which is the full width of the crankpin. To render this method of turning possible, a positive drive, as close to the crankpin as possible, is absolutely necessary, and this is one of the features of the design.

This machine consists of a headstock with a large hollow spindle, carefully and accurately fitted. The spindle is actually a drum, large enough in internal diameter to accommodate one end of the crankshaft, when supported eccentrically according to the required throw of the crank. On the face of this drum is mounted a special chuck which determines positively the exact throw of the crank. The crankshaft is supported in the chuck close to the web. Inside the spindle it also rests in a special "steady-disk" which can be moved to any point to suit the length of the crank. In addition to this, the crank is further held by the web by means of clamping screws on the face of the chuck, thus eliminating all torsional stresses in the crankshaft.

The headstock drum or spindle carries on its outer end a large helical gear, which is driven by a pinion on the end of the main spindle of the gear box. The main drive to the machine consists of one pulley only, 16 inches in diameter, for a 4-inch belt, running at 350 revolutions per minute. All speed variations are obtained from a system of gears carried in the gear box mounted on the headstock. This gear box gives eight speed changes arranged in geometrical progression, the speed changes being obtained by means of interlocking levers. These levers prevent the possibility of two speeds being simultaneously engaged and thus damaging the gears. The headstock is carried on a ribbed bed of box section, the interior of which is used as an oil well for the cutting lubricant, and provision is made for the returning of the oil to the well after leaving the cutting tools.

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The machine is provided with a long cross-slide; on the front end of this is mounted a tool-holder which carries the roughing tool. A second tool-holder, carrying the finishing tool, is mounted behind the crankpin, so that the turning operation can be entirely completed without removing either the crank or the tools. In addition to the "necking" tool-holder, a "crowning" rest is also provided, at the back of the cross-slide, for the purpose of crowning the ends of the crank webs. Both the cross-slide and the crowning rest have the necessary automatic feeds. For "crowning" the webs, the crank is held in the same chuck as for the necking, but to obtain the correct position for this operation, a second hole is provided in the chuck to receive the crankshaft.

It is claimed that the pins are finished true within a maximum limit of error of 0.0005 inch. There is perfect control of the finishing tool, the diameter of the crankpin being readily and accurately controlled by means of a large graduated disk on the feed-screw. When the disk is once set, the correct diameter can be reproduced any number of times without actual gaging.

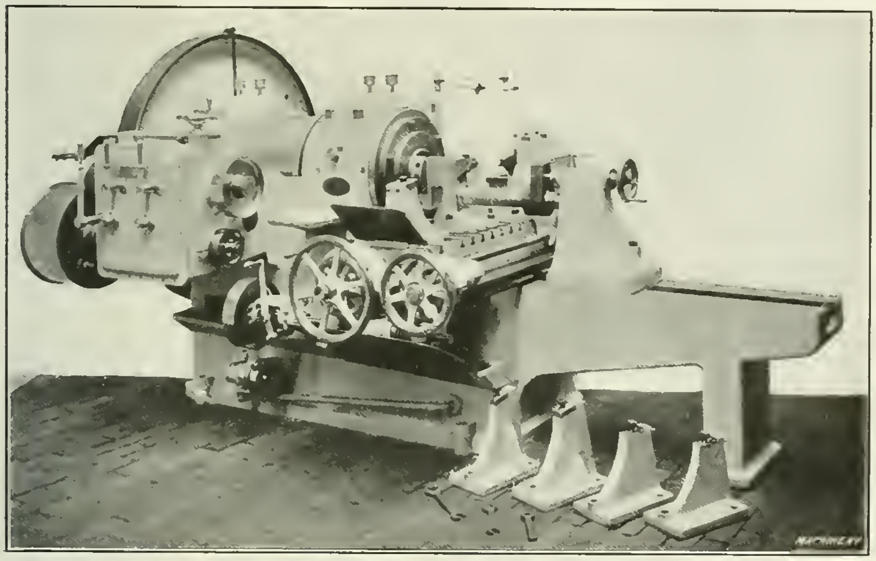


Fig. 1. An English Crankpin Turning Machine

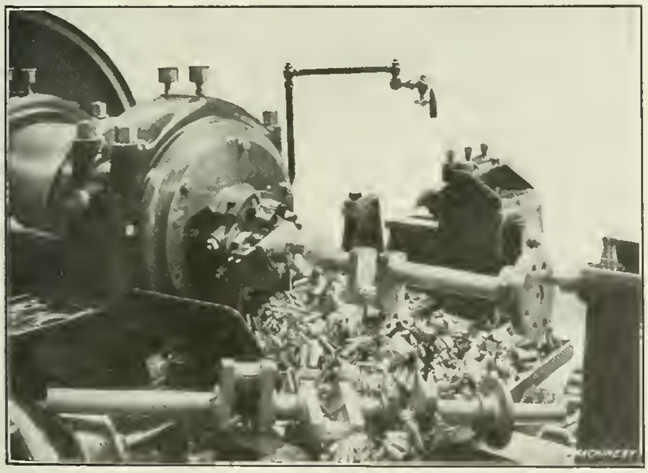


Fig. 2. Example of Chips taken when Turning Crankpins

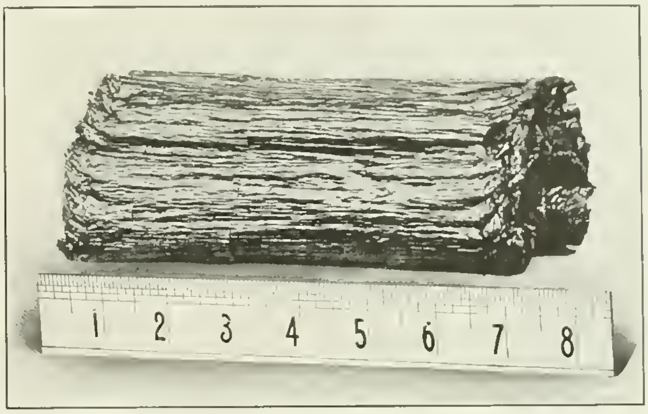
* * *

The business of a modern engineering concern has been tersely expressed as that of translating the brains of the engineers into mechanical devices and methods, and selling them to the world.

CRANKSHAFT TURNING[*]

By "NOMAD"

The writer has followed with interest the articles in the January and March, 1911, numbers of MACHINERY, referring to the rough turning *vs.* rough grinding of crankshaft pins. I am personally interested in grinding and grinding machines. Mr. Norton's comments appealed to me very much, and upon a visit to the shops of one of the largest oil- and gas-engine manufacturers in England, a firm which also has an international reputation, I called attention to this matter. It was apparent that my remarks aroused a certain interest, for upon finishing, the shop superintendent said, "We have a machine here that both roughs and finishes our crankpins at the same setting; this machine was especially made for this purpose." I was then shown the machine, and it certainly was a revelation. The crankshaft passed through the center of the driving-head, and the pin being machined was as close to the head as practicable, and was supported in a plate in the end of the tailstock. The crankpin was roughed down and brought to a cylindrical shape by a coarse hand feed, at a cutting speed of about 90 feet per minute. After that, the machine was run at a very slow speed, not more, it seemed, than four revolutions per minute, and a finishing cut was taken with a plain broad forming tool, the crankpin being finished in this manner to the exact diameter and shape.



Chip taken when Finishing Crankpin on Crankshaft Turning Machine

I was shown a pile of a dozen or more four-throw crankshafts, which upon inspection appeared to be all that could be desired. While I still hold my opinion as regards grinding crankshafts and similar parts, it is evident that one cannot lay down hard and fast standard rules for machining, as there is and always will be a difference of opinion as to the best practice, even for work of so general a nature as crankshafts. The accompanying illustration shows a chip taken during the finishing cut. It is approximately seven inches wide.

* * *

The manufacture of gasoline from natural gas is a profitable and comparatively new industry that is being developed in the oil regions of New York, Pennsylvania, West Virginia and other states that produce large quantities of gas. The gasoline is extracted from the gas by compression and cooling, the pressure varying somewhat with the quality of gas, 150 pounds being a common pressure. The gas is pumped from the line, treated and returned to the line freed of the hydrocarbons that burn with smoke and deposit soot. While the treated gas is thus somewhat more desirable for household use than untreated gas, it does not burn with quite as hot a flame in gas stoves. According to an article on the subject by Mr. F. W. Brady in *Mines and Minerals*, the product from 150,000 cubic feet of gas is 500 to 800 gallons of gasoline, 92 degrees Baumé.

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[*] See MACHINERY, March, 1911, "Rough Turning *vs.* Rough Grinding of Crankshaft Pins," and January, 1911, "The Field for Grinding."

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JANUARY, 1912

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THE FARM TRACTOR

The success of the internal combustion engine as applied to automobiles and trucks for hauling merchandise, has naturally caused many minds to study the possibility of developing tractors for hauling plows, harrows, seeders and other implements on the farms. Traction engines have been used with marked success for years on the big ranches of the West, but they are too costly and cumbersome to be bought and used by the farmers working one hundred to two hundred acres of land.

The tractors that will have an enormous sale will be those selling for four to five hundred dollars, and capable of developing ten to fifteen horsepower. They must be adaptable not only to haulage but to stationary uses as well, such as cutting hay or straw, grinding feed, sawing wood, pumping water, etc. Tractors of this type will enable farmers keeping, say, five horses, to do their seeding and harvesting, to dispense with three and save the cost of keeping them through the winter and other idle periods of the year.

The importance of the farm tractor manufacturing business is shown by the large amounts of capital already invested in it, and the probability is that the present capitalization will be largely increased within the next five years.

* * *

FORM GRINDING

A branch of machine work that is acquiring considerable importance, especially in the automobile industry, is form grinding other than flat or cylindrical shapes. The features of form grinding machines are wheels of the contour required on the work piece and means for constantly maintaining the correct wheel shape. It seems assured that machines of this type will become important factors in mechanical production, unless methods of heat treating steel are devised which will insure that no distortion takes place after the ordinary machining methods are completed. Even if such a discovery should be made there is still the probability that the grinding process will develop commercially because of inherent advantages. These have been amply demonstrated by the grinding of automobile crankshafts from the rough at a rate that puts the best lathes to the test to equal. Form grinding simplifies the production of parts that have integral splines, such as sliding gear transmission shafts, and enables them to be produced within limits of accuracy that are hardly obtainable commercially in any other manner. Not to mention hardened gears which of course are the most important examples of form grinding, there are innumerable other hardened parts used in manufacturing that can be advantageously finished thus when made in large quantities.

* * *

SCIENTIFIC MANAGEMENT IN THE SEVENTIES

James W. See in his famous "Chordal's Letters," published over thirty years ago, tells a story of Pratt & Cady who were "up against it" after the panic of 1873. They were building a steam engine on the cut-throat competition basis. The men were working for small wages and the firm was selling few engines, despite the fact that the selling price was pared to the bone. One day a Yankee from down East appeared on the scene, and after some dickering made a contract to build the engines in the firm's own shop at a price far below what they were then costing, and guaranteed his offer with a cash forfeit.

The story of how Doolittle, the contractor, organized the work, provided jigs and cut the costs, and at the same time raised the pay of the men is interesting reading to-day. It sounds so much like what we hear in the talks on scientific management, that we are forced to conclude that Doolittle, in the guise of a contractor, was really an efficient superintendent, hired at a salary far beyond what Pratt & Cady would have paid, to reorganize the building of steam engines to meet the conditions of the times and make money for the firm, himself and the men. His success did not hinge on card systems, forms, work tickets, time study or functional foremen; but he undoubtedly used some of the principles, if not all of them, which have made for success in modern management. The point is that the substance of successful management must be separated from the clothes or forms in which it appears in various industries in order that the average man can grasp and understand it.

* * *

BALL AND ROLLER BEARINGS IN MACHINE TOOLS

Ball bearings have been used in machine tools for several years in a conservative way, and the results have been generally satisfactory. The time has come when we may confidently expect to see them used to a much greater extent with a resultant saving of power and preservation of accuracy through the general elimination of wear.

It is not perhaps to be expected that ball or roller bearings will be generally applied to such parts as lathe spindles. While they have given excellent results in severe service, the jar and vibrations of heavy intermittent cuts would prejudice most mechanical engineers against their use. But even if the main bearings of working spindles are hardly feasible places to apply them, there are many other plain bearings in lathes, milling machines, drilling machines, and other machine tools, that could be displaced by anti-friction bearings with large resultant saving of power. The fact is that the power lost in friction in machines is not absorbed as much in the spindle bearings as in the transmission parts running at high speed.

One well-known maker of annular ball bearings supplies data sheets showing methods of applying ball bearings to almost every conceivable situation; and designers of machinery generally and of machine tools in particular should not neglect these important suggestions for eliminating waste effort. Probably the greatest waste in the mechanical world is caused by friction. Friction wears out machinery and wastes coal without accomplishing useful work. Wide-awake designers should provide the means whenever possible and feasible to conserve power and thus prolong the life of the machines they design.

THE GAS ENGINE INDUSTRY

One of the busiest metal-working industries of the present is the manufacture of small stationary internal combustion motors for farmers and other users of small power. The Middle West is absorbing great numbers, and the capacities of engine plants is being increased to meet the demand. One concern in Illinois has doubled its capacity twice within a year, and is now equipped to turn out two thousand engines a month.

The gas engine is displacing the windmill because of its greater reliability, compactness, movability and lower initial cost. It is true that the gas engine is a source of expense for fuel and lubricant when in operation, but it is subject to fewer deteriorating influences. The windmill is at the mercy of the elements. Every high wind leaves in its path broken and dismantled wheels and wrecked towers. Towers without wheels are a common sight in the prairie regions of the West, mute evidences of destructive storms.

The growth of gas engine building has been rapid and has acquired great commercial importance, but it will assume far greater importance in the near future. The perfection of kerosene engines suited to agricultural and similar uses is practically assured, and that will give a tremendous impetus to the use of internal combustion engines generally. Kerosene is now a by-product with the oil refiners, the consumption of gasoline having so increased within a few years that the two products, both relatively and actually, have exchanged places in commercial importance. Kerosene is the more ideal fuel for engines, being obtainable everywhere and much safer to handle. Eventually crude oil may displace both as fuel for internal combustion engines, large and small. The importance of the gas engine business when that era is reached can only be guessed at now.

* * *

AUTOMATIC VS. HAND MACHINES

The development of automatic machinery in America has been the wonder of the world. Since Spencer invented the automatic screw machine in the seventies, the trend of machine tool design has been toward automatic machine tools of every kind. The inventive genius of the country has been largely concentrated on the problem of eliminating hand labor by making the machine perform all the operations necessary to complete a part without the guidance of an operator. Every improvement that makes the control of a machine easier and quicker is a manifestation of this tendency. Power traverse of slides, spindles, and cross-rails, and quick-change speed and feed boxes, are examples. Full automatic machines that turn out tiny watch screws from wire or massive machine parts from six-inch bars are commonplaces, as are the machines that completely machine a casting after it has been placed in the chuck by the operator.

The high cost of labor and the difficulty of getting trained men when the demands for product are imperative are potent reasons for the existence of automatic machinery, but besides that is the incentive to equip factories with special machines that are supposed to be the last word in mechanical development. In short, there is something of faddism in it.

The question of providing automatic machines for many kinds of work is one that should be carefully weighed. Is the quantity of work to be produced large enough to keep the machines employed? Will the cost of supervision and equipment outweigh the saving in labor? Are the machines adaptable to other work than that for which they are purchased?

The problem is one similar to that which perplexes many builders of machine tools themselves:—"To jig or not to jig: that is the question." No one questions that jigs and fixtures should be provided when the quantity of machines to be built runs into thousands, but where a design is subject to change after fifty or a hundred machines are built, the cost of changing the tool equipment may be greater than the saving effected by it. In other words, manufacturing on a large scale and automatic machines go together; but building machinery is generally best carried on with adaptable tools operated individually. Provide the machines with labor-saving features generally, but let their functions be readily changed to suit the work in hand.

SELLING MACHINE TOOLS BY DEPARTMENT STORE METHODS

The echoes of Prof. Cardullo's* ball-pein hammer have been heard in various machinery centers during the past month, and his article in December MACHINERY has apparently had the desired effect. But the professor hammered a hole right through his own proposition when in the same paragraph he advocated direct contact between manufacturer and consumer as well as department store methods for selling machine tools; because the most prominent and successful intermediary between manufacturer and consumer is the modern department store—represented in the machinery industry by the dealer. And Prof. Cardullo's argument was not helped by the comparison which naturally suggested itself between the character of the selling forces employed by machinery dealers and by department stores where the selling ability is frequently limited to furnishing the price of an article that is marked in plain figures. The largest and one of the best department stores in New York City is noted in the writer's family for certain peculiarities in handling correspondence which throw Prof. Cardullo's examples into the shade. This department store seldom spells our name right, even on receipts for money, although we have had an account there for twenty-four years; it usually requires a week to ten days to answer an inquiry; it seldom has just the right shade of material and never offers to get it. Its correspondence is usually conducted on postcards in grammar school hand-writing and phraseology. Yet those in authority are always courteous and obliging, when they are reached. The trouble is with the kind of help they employ.

There are all kinds of machinery salesmen, from those like Prof. Cardullo's jig friend up to the cracker-jacks, whom we all know but won't name, because present business conditions do not warrant salary increases. First-class machinery salesmen are hard to get. They all have jobs, and their bosses are not letting them go. Many of them came up through the shop, where they thoroughly learned the mechanical end of their business; then they developed selling ability on the road and formed an acquaintance among machinery users which is one of their most valuable assets. Somewhere between these men and Prof. Cardullo's horrible example will be found the average machinery salesmen.

A few of the things Prof. Cardullo says sound queer to the writer, who is neither a manufacturer, a dealer, nor a consumer, and therefore unprejudiced. For instance, his proposition that machine tool builders should advertise the price of their machines like shoes or corsets, and that the man who wants to buy one should work one manufacturer against another, getting "concessions" until the price is low enough to suit, would make even a publisher laugh. That is certainly not a department store method.

Then Prof. Cardullo says: "If the price is higher than that of his competitor, the reader naturally looks to see if the article is not a better one, and if it is not better than the one he contemplated purchasing, he will give his order to the manufacturer who advertises his price." How can Prof. Cardullo "look to see" which is the better tool when the manufacturer may be a thousand miles away, and when he has eliminated the local machinery dealer where one of the machines could have been seen? The department store method would be to have a stock of tools all marked in plain figures—a \$500 lathe would be \$499.98, and a \$1500 milling machine \$1498.64. You could then take them or leave them; the department store makes no "concessions" on its prices.

Possibly Prof. Cardullo means to rely on *reputation*, which is acquired through quality and publicity—one is just as essential as the other, and both cost money. But besides reputation the successful manufacturer must have a marketing organization of some kind through which he can follow up inquiries and quickly reach possible buyers of his machine some of whom don't know they need it. The writer's observation shows that, generally speaking, the most successful manufacturers of standard machine tools are those who are represented by the best dealers. Take two standard tools of equal merit, equally well known, and priced about the same; and the one represented by the best line of dealers will outsell the other. Every manufacturer knows this, and those who are not satisfactorily represented in the industrial centers, or not represented at all, are constantly looking for good dealers to handle their line; but the supply is below the demand. There are fifty makers of engine lathes in the United States, and in New York City not over six, strictly, machine tool dealers.

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* Prof. Forrest E. Cardullo, Department of Mechanical Engineering, New Hampshire College of Agriculture and the Mechanic Arts, Durham, New Hampshire.

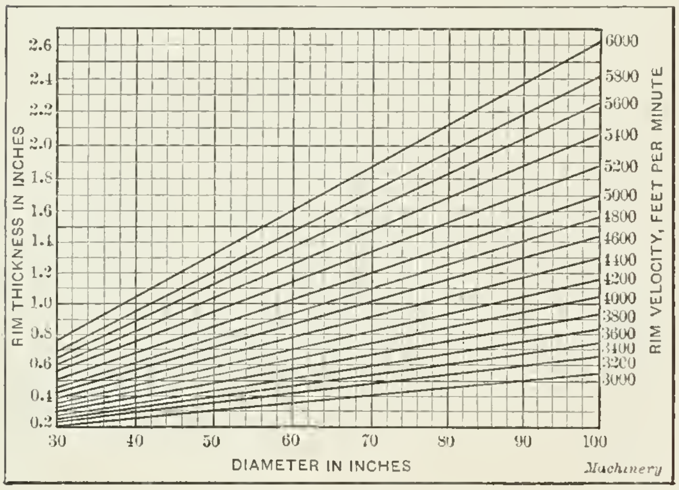

Fig. 1. Diagram for Finding Thickness of Solid Flywheel Rims, Six Arms

It is almost elementary to say that no engine lathe manufacturer can market his product economically except through dealers or agents who handle a sufficiently varied line of machine tools to warrant the expense of covering their territory through systematic traveling. This method of selling tools may be all wrong. It certainly can be improved; but it is the fault of the buyer more than of the manufacturer. There is hardly a machine tool builder who would not prefer to sell his product direct, but it is not practicable except in the case of special machines, automatics and the like, which are sold at a sufficiently higher price to carry the extra selling cost.

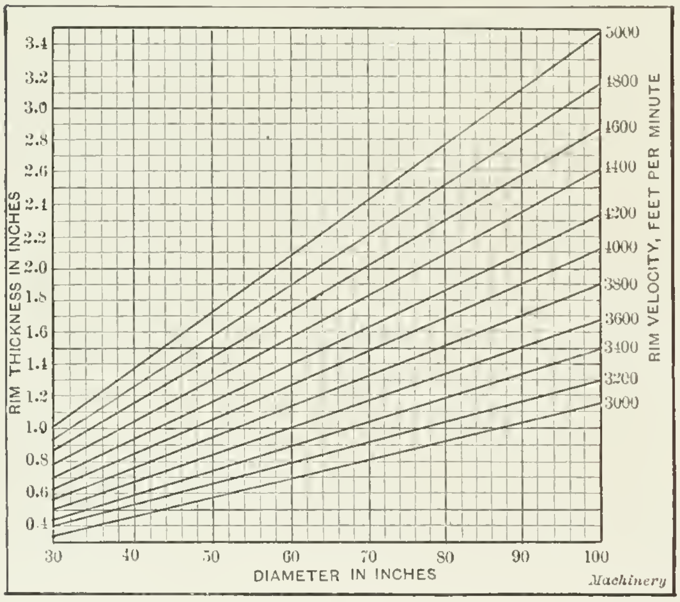

Fig. 2. Diagram for Finding Thickness of Jointed Flywheel Rims, Six Arms

Competition makes it necessary to cover the country thoroughly through travelers, and this condition has brought into existence the expensive organizations which the various dealers maintain. One firm of dealers covering a comparatively limited territory employs twenty-two trained men at an average outlay for each, including salary and traveling expenses, of $4000 a year. Dealers covering the entire country have much larger organizations. There are advantages to the manufacturer besides that of economy, in selling through dealers. The latter carry a stock which is usually paid for in advance of sale, releasing a large amount of capital which the manufacturer would otherwise have tied up. The dealer can often make a sale by taking old tools in part payment for new ones, and disposing of the former, which, of course, cannot be done by a manufacturer.

There is truth in some of Prof. Cardullo's criticisms of methods; but most of them apply to small manufacturers who are their own foremen and office force. A man may possess the mechanical ability to design and construct a machine of unusual merit, and yet be unable to describe it satisfactorily in an advertisement or letter. The larger manufacturers do not handle their inquiries in the way he described.

If Prof. Cardullo will come to MACHINERY's Outing or Inning he will meet a large detachment of the "army" including a number of the generals; and when they are not engaged in lapping up cream or other things, they will doubtless be glad to impart to him some ideas that may change his point of view.

L.

* * *

THICKNESS OF FLYWHEEL RIMS*

By E. D. GAGNIER†

The tendency of a flywheel rim when revolving is to bow out between the arms. With thick rims this condition does not need to be considered, but in the case of a thin rim running at a high rate of speed, the stress in the metal might become sufficiently great to cause the wheel to fail. The proper thickness of a cast-iron rim to resist this tendency is given by the following formula:

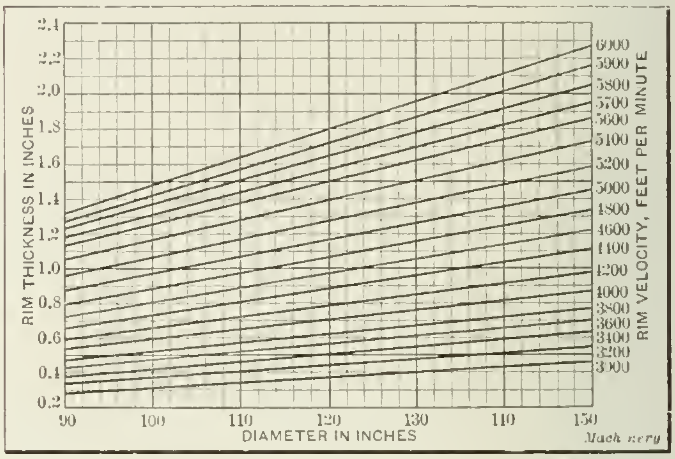

Fig. 3. Diagram for Finding Thickness of Solid Flywheel Rims, Eight Arms

$$t = \frac{0.475\,d}{n^2\left(\frac{6000}{v^2} - \frac{1}{10}\right)} \qquad (1)$$

for a solid rim; and

$$t = \frac{0.95\,d}{n^2\left(\frac{6000}{v^2} - \frac{1}{10}\right)} \qquad (2)$$

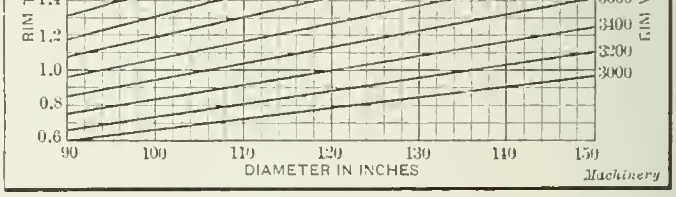

Fig. 4. Diagram for Finding Thickness of Jointed Flywheel Rims, Eight Arms

for jointed rims. In both formulas

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* For additional information on this and kindred subjects, see MACHINERY, November, 1910, engineering edition, "Flywheels for Internal Combustion Engines," and other articles there referred to. See also MACHINERY's Reference Book No. 40, "Flywheels."

† Address: 356 East High St., Salem, Ohio.

$t =$ thickness of rim in inches,
$d =$ diameter of wheel in inches,
$n =$ number of arms,
$v =$ peripheral speed in feet per second, and
$6000 =$ permissible stress in pounds per square inch.

The first formula was given by J. B. Stanwood in a paper read before the American Society of Mechanical Engineers in 1893. It will be noticed that the values of t in Formula (2) are just double those in Formula (1). Prof. Gaetano Lanza, in a discussion which followed the previously mentioned paper, gives the value of the constant in the second formula as 1.424; and in the same paper Mr. Stanwood used 0.712. However, it is the practice of an old engine-building concern to use the value 0.95.

The values obtained from these formulas are shown plotted in the four accompanying engravings, which cover both solid and jointed-rim flywheels having either six or eight arms. A rim speed of 6000 feet per minute, gives a stress in the metal due to the two halves of the rim tending to pull apart, of nearly 1000 pounds per square inch, beyond which it is unsafe to proceed. As a jointed rim is not as efficient as one that is solid, the value of 5000 feet per minute for jointed rims has been used in plotting the curves for flywheels with this kind of rims. With very thin rims, where the joint is heavy in proportion to the rim, a speed of 4500 feet per minute should not be exceeded.

* * *

The Cadillac Motor Car Co., Detroit, Mich., has a plant organized on the departmental system by product. Each department has, in general, the equipment needful for furnishing the work that it does on a unit. A feature of the work, interesting from the viewpoint of cleanliness, is the practice of dipping castings and other parts into a boiling soda solution after each major operation to clean off the chips and oil. Thus each part goes to the next operation thoroughly clean and agreeable to handle. The practice promotes turning out work with the accuracy for which the concern is noted.

THE J. E. REINECKER WORKS AT CHEMNITZ-GABLENZ

MODERN GERMAN METHODS AND DESIGN IN THE PRODUCTION OF HIGH-GRADE SHOP TOOLS

By C. A. TUPPER[*]

With Düsseldorf and Berlin, the industrial district of Chemnitz, in Saxony, forms one of the most interesting parts of the German Empire for an American, Canadian or English machinery manufacturer to visit. Here he has an opportunity of going through numerous modern metal-working plants, including the Wanderer Fahrradwerke, the Werkzeugmaschinenfabrik Union, the shops of Biernatzki & Cie and of Schubert & Salzer, the Sächsische Maschinenfabrik and others, and will be given a particularly cordial welcome at the recently extended works in Chemnitz-Gablenz of the firm of J. E. Reinecker, now composed of the sons of the founder, *viz.*: Johannes G., Julius Richard and Paul Alfred Reinecker. This business, which was started in a small tool shop in 1859, and will be remembered by many Americans as having been represented by one of the principal exhibits of Germany at the World's fair in Chicago, 1893, now commands over 400,000 square feet of working floor space, with shops that are among the best appointed of any in the world.

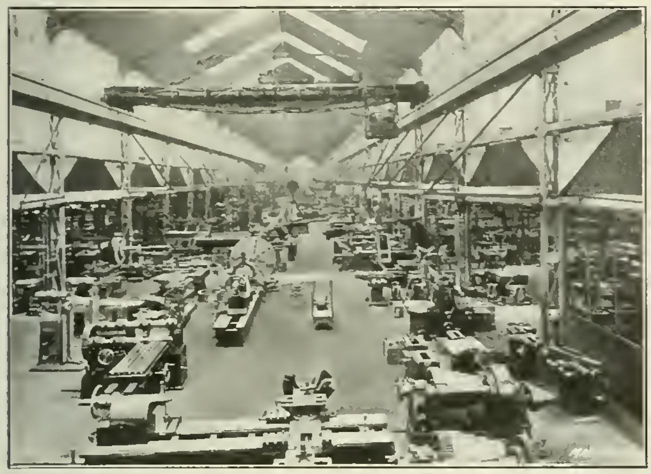
Fig. 1. Erecting Department, J. E. Reinecker Works, Chemnitz, Germany

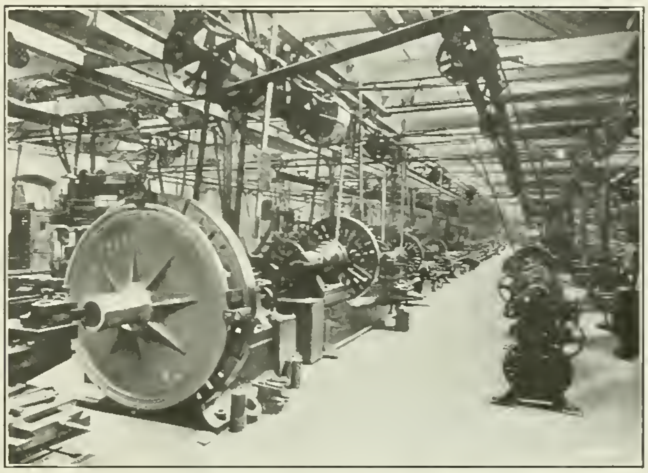
Fig. 2. Lathe Department

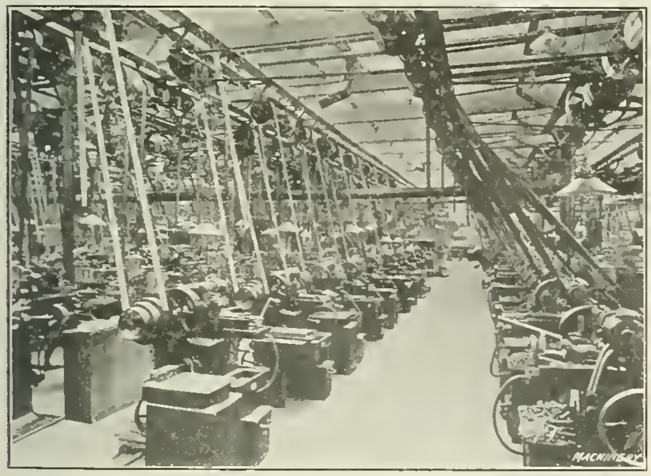
Fig. 3. Milling Department

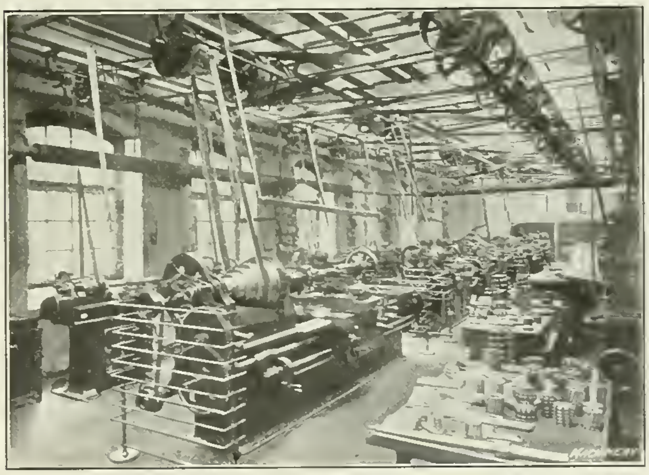
Fig. 4. Relieving Lathe Department

Fig. 1 shows the interior of the erecting shop for the larger tools, nearly 670 feet in length, which forms, as it were, the backbone of the works. This is known locally as the "large machinery hall." Opening into it at right angles, from each side, are the various manufacturing departments. In addition, there is, at the left, an older group of shops. This group is connected with the new section by the former erecting department, now used for the smaller machines, which runs parallel with the large erecting shop. Thus, the whole system is "interlocking," and the work progresses along clearly defined paths, without any retrogression, confusion, or loss of time. The main erecting shop is three stories high, with a

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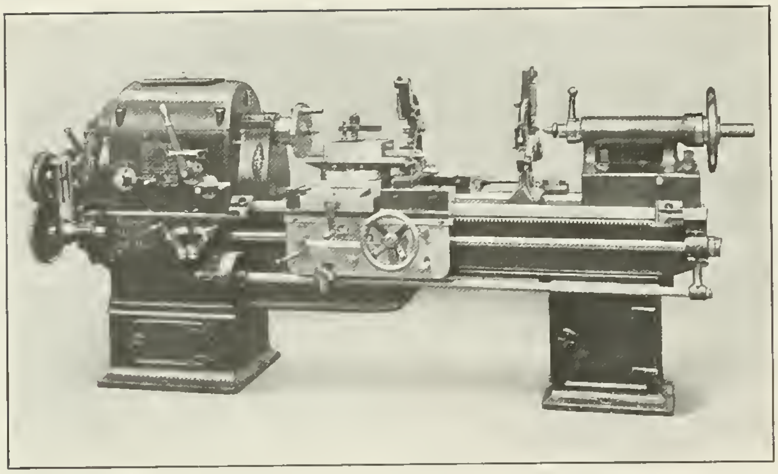

Fig. 5. Recent Design of High-speed Engine Lathe

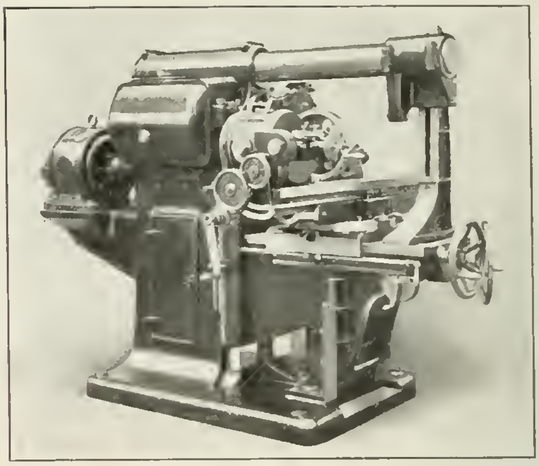

Fig. 6. Universal Milling Machine with Electric Drive

lofty roof, while the machine shops are two stories high, with a central peaked skylight extending the length of each. The smaller erecting shop is similarly constructed but with more head-room. Leaving, until later, a closer inspection of the details revealed by Fig. 1, let us take up the other departments.

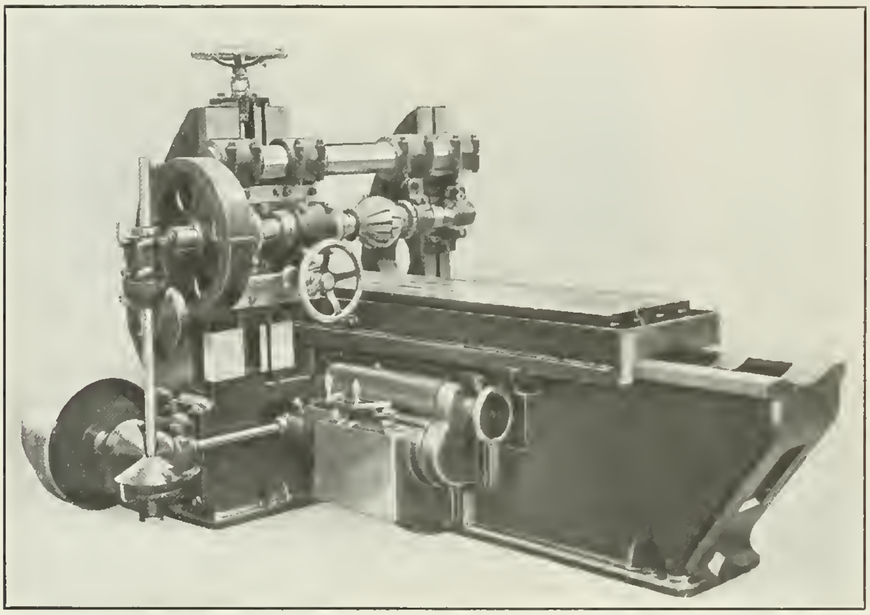

Fig. 7. Plain Horizontal Slab Miller

Fig. 2 shows the rows of heavy lathes driven from shafting, each line of which is actuated by a motor at the end, which is not here shown. At the extreme right, just visible in the halftone, are row upon row of speed lathes similarly arranged. For the larger machines, tight and loose pulleys will be observed on the driving shafts, while for the smaller lathes friction clutches are used. The standard engine-type lathes made by the Reinecker firm, itself, include three styles and twenty-one sizes, for all classes of work. Some of the designs are distinctively German, while in others various features of English and American practice have been followed. The greatest importance is attached to the use, even for the simplest styles,

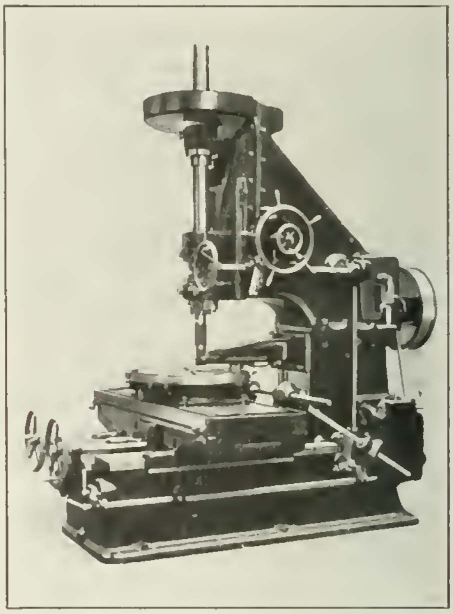

Fig. 8. Latest Design of Vertical Milling Machine

of the best material obtainable for each detail. As an example, the main spindles are made of hammered steel, having a tensile strength of 137,000 to 145,000 pounds per square inch. A similar policy has been pursued with reference to the other tools mentioned in this article. Special engine lathes are built according to specifications.

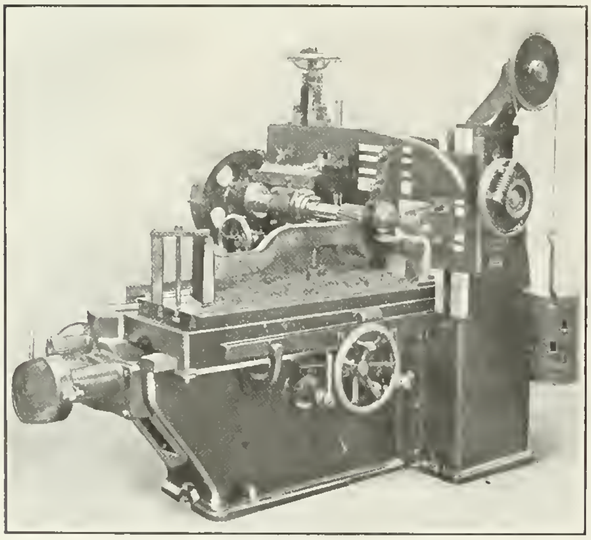

Fig. 9. Profiling Slab Milling Machine for Milling Locomotive Connecting rods

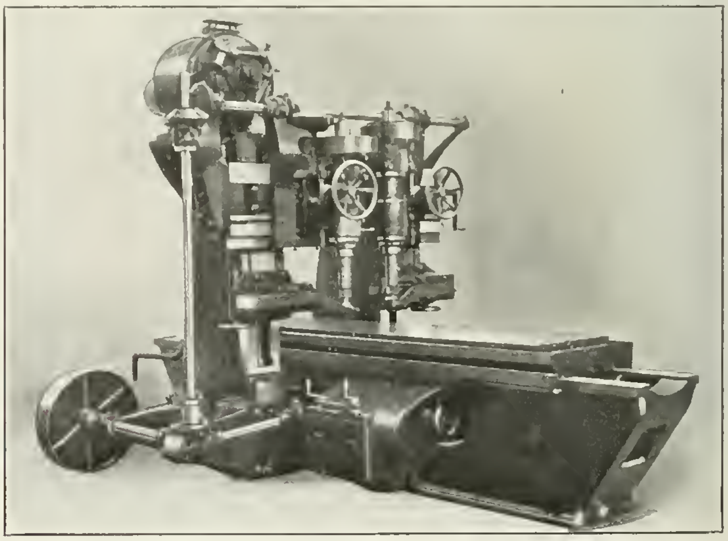

Fig. 10. Vertical Slab Milling Machine for Milling Locomotive Axle Boxes, etc.

High-speed sliding, surfacing and screw-cutting lathes are made in two styles and twenty-four sizes, adapted to every class of service. The lighter machines have both lead-screws and feed-shafts, while the heavier are provided with a splined lead-screw, which for screw cutting is driven by change gears, but for ordinary sliding and surfacing, by a belt and step cones. A feature of these machines of value in the export trade is the fact that both English and metric screw pitches, according to the Whitworth or International systems, can be cut on all Reinecker speed lathes by the use of suitable change gears. Plain "capstan" and turret lathes, combination turret lathes, and special machines of this type, for stud and stay making, are also manufactured.

American lathes, including purchases made some time ago from the New Haven Mfg. Co., Prentice Bros. Co., Gisholt Machine Co. and F. E. Reed Co., have been quite largely used in these shops and their operating details carefully studied, together with English tools for the same classes of service from Alfred Herbert, Ltd., and others. The advantage of this practical observation is apparent in the Reinecker designs, dating originally from 1898, one of the latest of which appears in Fig. 5.

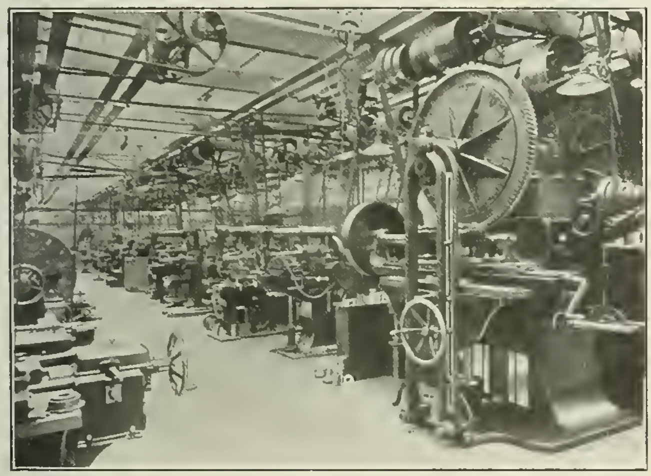

Fig. 11. View of a Portion of Gear-cutting Department

In Fig. 3, a part of the milling department is illustrated. Here the method of driving and of obtaining the initial speed variation needed may be plainly seen. At the left of the machines shown are others considerably heavier. The manufacture of milling machines at the Reinecker works was entered into in 1893 and now embraces all types. They are designed, as most advertisers say, with a view to combining simplicity with convenience, durability and capacity for heavy duty. "For this reason," the Reinecker management naïvely remarks, "many perhaps interesting but complicated ideas, which are found to a great extent in American machines, have been avoided." Plain, horizontal milling machines are made in six sizes, universal in eight, vertical in seven and slab or plano in five, with special types including parallel and duplex millers, nut and bolt-head millers, stud millers, slot millers, profiling millers, combination cam-shaft millers and grinders, twist drill millers, relieving millers, etc., in considerable variety. The line is certainly exceptionally complete, and the writer doubts whether it can be even approximately matched anywhere else in the world. Figs. 6, 7, 8, 9 and 10 show some of the newer machines that have been brought out. In Fig. 3 will be noted the arrangement for flooding the cutters with oil or soda-water, which is customarily furnished with Reinecker millers.

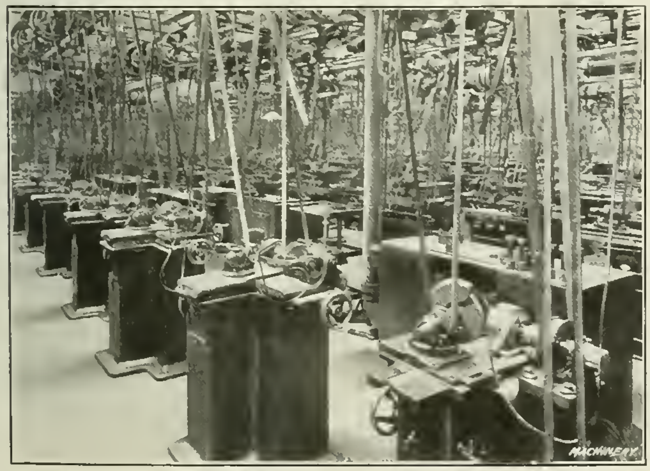

Fig. 12. Surface Grinding Machines at Work in Reinecker Shop

Fig. 4 illustrates a corner of the department devoted to backing-off or relieving lathes, the work done upon which will be seen on the tables at the right. These lathes are worthy of a separate article, being perhaps the most distinctive and among the best of the Reinecker products. They are designed for relieving straight or spirally gashed milling cutters and also for side or axial relieving.

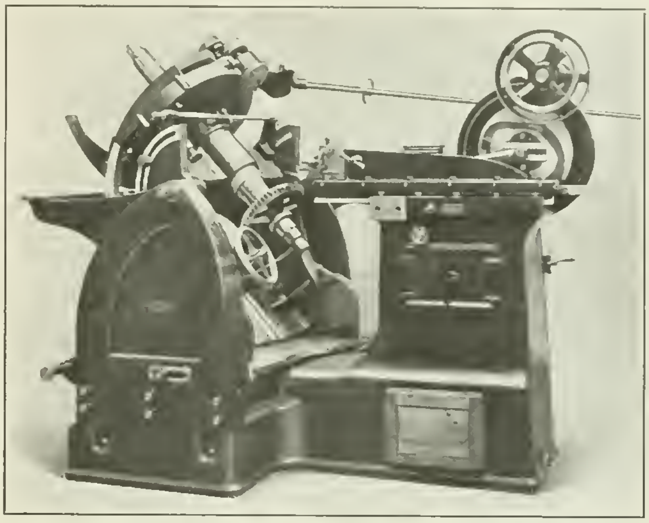

Fig. 13. Automatic Bevel Gear Planer

Fig. 11 shows a section of the gear and pinion cutting department, which is very extensive. Among the earliest machines used here were gear planers of the type brought out in Philadelphia, years ago, by the Bilgram Machine Works, the German rights to which, as the writer understands, the Reinecker firm secured; but the tools illustrated were manufactured in these shops, which now produce a line that, for completeness and apparently uniform excellence, rivals that of any toolbuilder anywhere. Certainly, it is the best in Germany. In Figs. 13, 14, 15, 16, 17 and 18, are shown examples of recent types. The line includes spur-gear cutting machines using either formed milling cutters or worm hobs; worm-wheel hobbing machines; universal machines for hobbing spur, spiral or skew gears and worm-wheels; worm milling machines also adapted for milling spur and skew gears; automatic and semi-automatic rack cutting machines; automatic and semi-automatic bevel gear planers; automatic bevel gear stocking machines; automatic spur gear planers; and tooth-chamfering machines for spur gears.

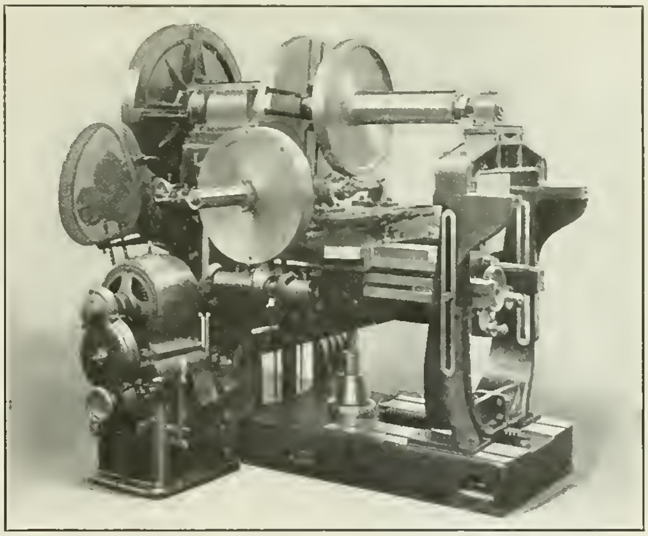

Fig. 14. Universal Gear-cutting Machine for Worm, Spur and Spiral Gears

In Fig. 12 will be observed a row of surface grinding machines, also of Reinecker design, at work in their shops. The firm has had experience with the best American types, including those of the Norton Grinding Co., Wm. Sellers & Co. and others, and has taken due advantage of this in the construction of the tools now offered to the trade. They comprise plain and universal grinders and automatic cylindrical grinding machines, also such specialties as automatic tool grinders, caliper gage grinders, cam grinders, fillet and spherical surface grinders, internal grinders and attachments for similar work with other machines, ball race grinders, center grinders and various combinations for special purposes. There seems to be no limit to the ingenuity which these display. Figs. 19, 20, 21, 22 and 23 show examples of some of the types of grinding machines manufactured.

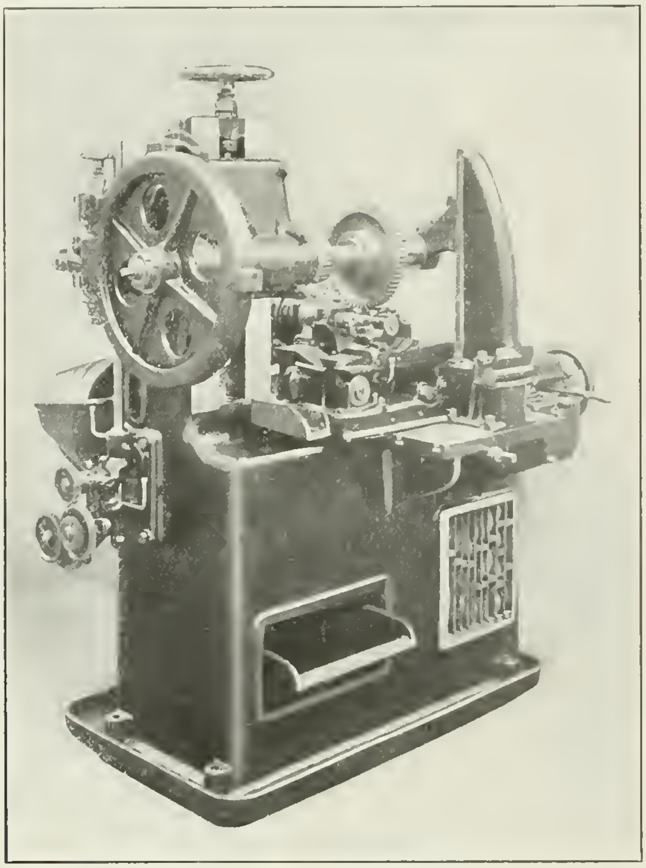
Fig. 15. Automatic Spur Gear Cutter

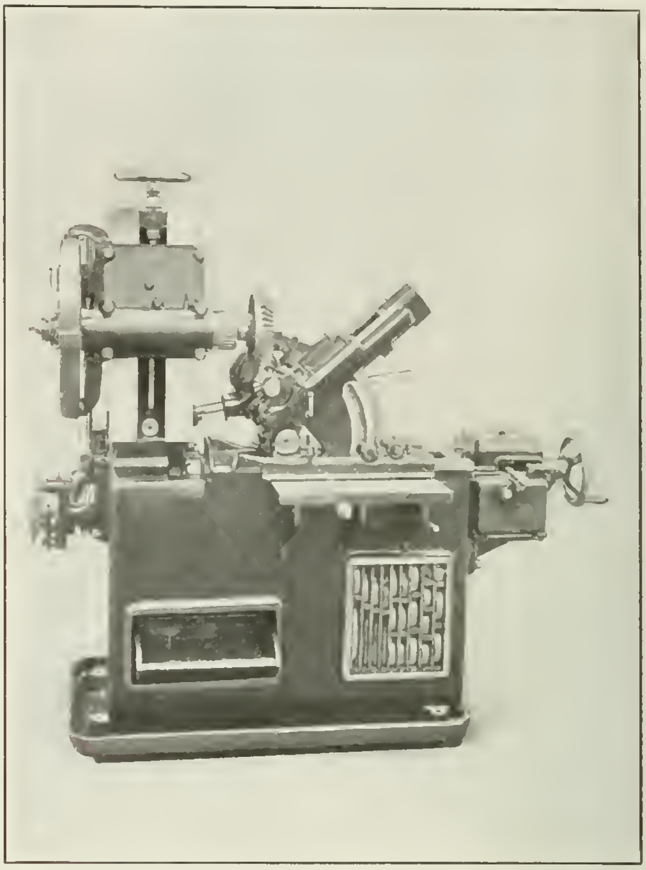
Fig. 16. Gear Cutter shown in Fig. 15, set for Stocking Bevel Gears

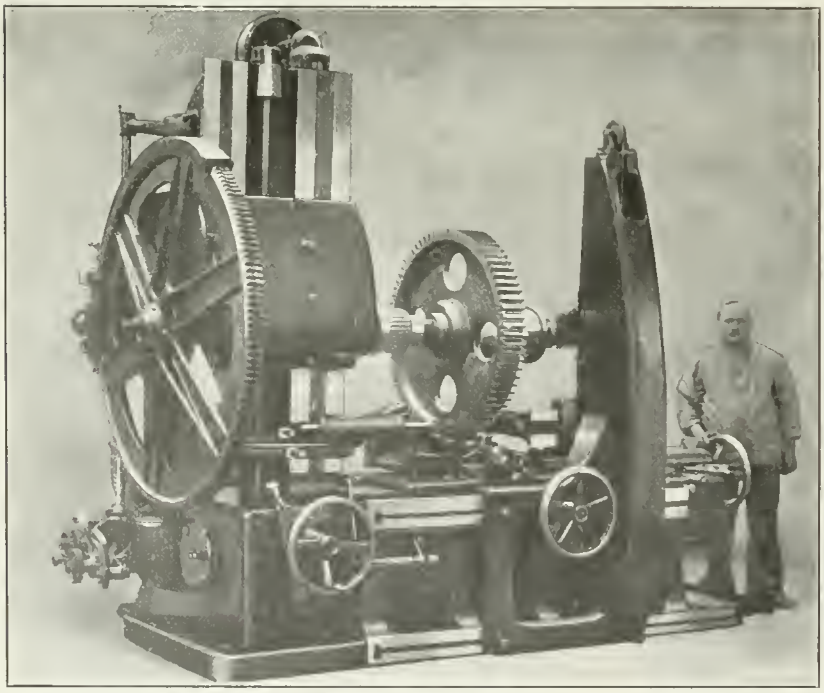
Fig. 17. Automatic Spur Gear Cutter with Vertical Adjustment of Slide for Large Work

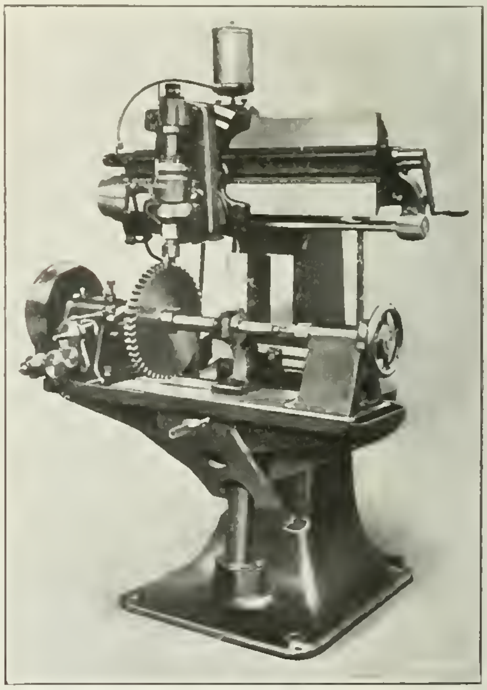
Fig. 18. Tooth Chamfering Machine for Sliding Gears

The Reinecker firm does not build planers for ordinary service but, naturally, there are in its shops many heavy machines of this type, and others of lighter construction, one of which, built by Ferdinand Kunao, Leipsic, impressed the writer favorably. Other departments of interest, illustrations of which cannot be given here, will be mentioned later. Two styles and two sizes of Reinecker vertical boring and turning mills, one of which may be seen partially erected in the right foreground of Fig. 1, are manufactured in these works. Other products include a special precision screw-cutting lathe, high-speed testing lathe, tool-room precision tap-making lathe, stud and shaft-turning lathes, and the dividing heads, special spindles, adjustable centers, indexing devices, chucks, etc., which go with high-grade tools.

Among American machines of types not manufactured by the

Reinecker firm, which have been in use in these shops, are drills from the Baush Machine Tool Co., Fosdick Machine Tool Co., H. G. Fish Machine Tool Co. and Gould & Eberhardt; cold saws from the Newton Machine Tool Works; nut and bolt forging machines from the Acme Machinery Co.; thread cutters from Pratt & Whitney; manufacturing automatics from Potter & Johnston; boring machines from the Binsse Machine Co., and various tool specialties of Brown & Sharpe manufacture.

As mentioned, the method of driving is through shafting, from only one motor for each long row of machines—an arrangement which is carried out for each section. That this system has some advantages cannot be doubted. The motors are sturdy four-pole machines for direct current, and of surprisingly small size for the service. Owing, however, to the skill with which the work is planned and distributed, the various operations during the day are so evenly apportioned that the load is very steady, being about as near to a continuous manufacturing process as can be attained in machine shop practice. The motors, also, are so situated that they can be carefully watched and any signs of trouble at once given attention. Under less favorable conditions individual motor drive for a part of the system would probably give more satisfactory results, but in the Reinecker shops the method used could hardly be bettered.

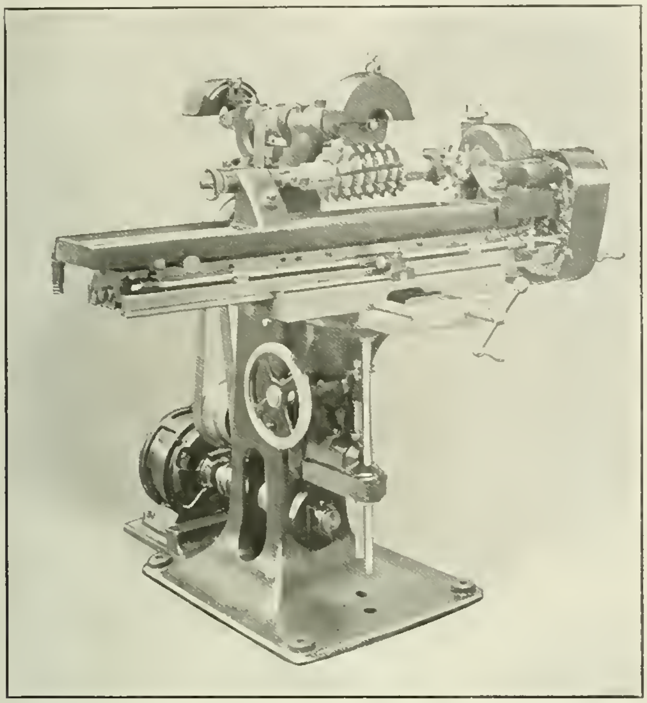
Fig. 19. Tool Grinder with Spiral Dividing Head, electrically driven

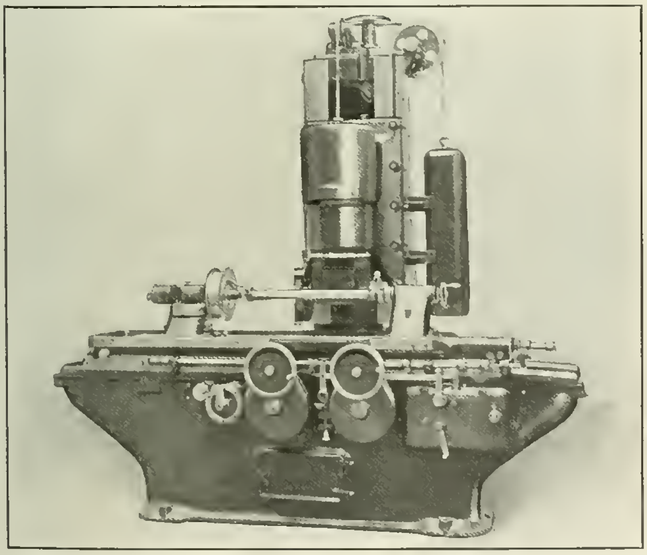
Fig. 21. Tool Grinder shown in Fig. 20, set for Cylindrical Grinding

Returning to the view of the large assembling and erecting shop, Fig. 1, the reader will note the excellent arrangements for handling material afforded there: the ample head-room, the large traveling electric cranes, and the swinging-arm cranes with chain hoists at each side. There is one of these for every pillar. It is plainly marked with its capacity and bears a number that serves to designate the exact place at which a machine tool part is to be delivered for erection. The shop floors are of cement, all on one level, and light material is quickly moved about on hand trucks, as in the case of the motor shown in the middle foreground of Fig. 1.

The tools used on the shop machines are kept in classified cabinets, and at each machinist's station there are suitable places for keeping the tools and other property of the firm which he has on hand at the time. Frequently they are to be found in the pedestals of the machines, themselves, good examples of which are to be seen in Fig. 3. These tool cupboards serve a double purpose, for the pedestals, being nearly hollow, carry the beds of machines in such a manner as to permit expansion and contraction, due to temperature changes, to take place without straining or buckling. For handling heavy parts, etc., the machine tools are served by chain hoists running on I-beams parallel with each row. There is good natural lighting from skylights and windows; also electric illumination, when needed, by arc lights and incandescent lamps suspended over the tools in the manner now common to good shop practice the world over. The shops are heated

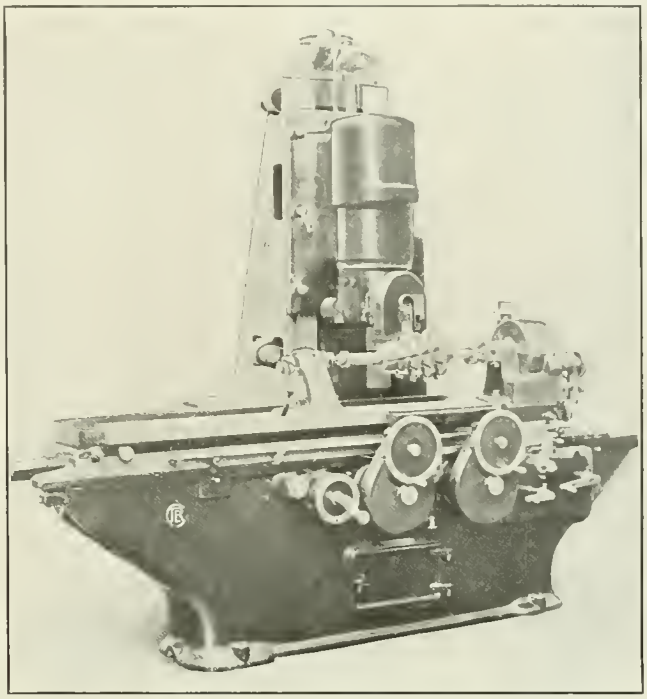
Fig. 20. Automatic Tool Grinder set for Sharpening Worm Hobs

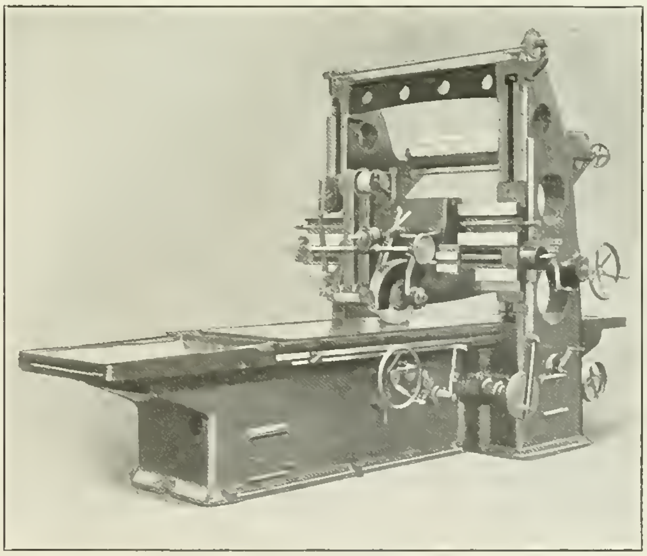
Fig. 22. Surface Grinding Machine

by steam sent through fluted pipe radiators, as illustrated in Figs. 3 and 4.

For machine cleanliness and the protection of the operatives, all moving parts extraneous to the work are enclosed by removable panels, and exposed gears are protected, where dangerous, by light rod or wire-screen guards as in Figs. 4 and 11. This protection, however, is not carried to quite the extent that the writer has observed in other shops, both at home and abroad.

There is a large department devoted to patternmaking, with good machine equipment and also a great deal of careful hand-work. If the plant has an iron foundry connected with it, the writer does not recall seeing it and is under the impression that iron and steel castings are purchased, which is usually the economical thing to do. A small brass foundry, however, provides what the plant needs in this line. The smith-shop, containing a fair complement of hammers, hand forges, etc., has been enlarged and a steam-hydraulic forging press added. The furnaces and other equipment are about what one would expect to see. A modern electric power and compressor plant, with engine-driven generators for direct current, water-tube boilers, automatic stokers, etc., helps to make the works "self-contained;" and there are the usual steam lines to the hammers, heating system, etc.

The facilities for tool hardening and tempering are about what one would find in a first-class English, American or Canadian establishment; but rather more space and better space is devoted to the tool making and sharpening department than is usual elsewhere. This is a large area extending along one side of the rows of heavy lathes and having windows all the way. Julius Eduard Reinecker, the founder of the business, began life as a toolmaker, and especial attention has always been given to this branch of the work. The first machine tools built, beginning in 1885, were milling cutter- and tool grinders, and four years later the manufacture of machines for making milling cutters, taps, twist drills, etc., was commenced. From this, the business naturally developed; and *its success is largely to be ascribed to the fact that the study of machine design was preceded by and coordinate with a thorough knowledge of the tools used with the machines.*

Strict discipline is maintained among the workmen, who number upward of 2000. They check in and out on time clocks, which are grouped near the stations occupied. Every possible provision is made for the comfort and convenience of the employes. Individual numbered lockers, lavatories and closets are at their disposal, and each has a numbered chest, with lock and key, as shown in Fig. 12, for his personal belongings. At the windows there are curtains to keep out the sunshine when too warm or bright. During the noon and the morning and afternoon rest periods, coffee is served from a stand in the center of each shop. There are also various features of welfare work along lines somewhat similar to those described by the writer in the article on the "Metal Working Industries of Düsseldorf" in the November issue of MACHINERY.

The apprenticeship system is given particularly careful consideration, being very much on the order of the one at the Ludwig Loewe works in Berlin, mentioned by the writer in MACHINERY, engineering edition, for September. The same loyalty to the employers who gave them their training—whether in service at the Reinecker works or as journeymen elsewhere—also appears to characterize the machinists educated here, as the writer learned from conversations in various parts of Europe. There is, in the Reinecker works, a special department devoted to various features of apprenticeship instruction, completely equipped, and arranged at the side of one of the shops, next to the windows, where there is good light. Provision is also made for the usual continuation school course.

In each of the well-appointed business offices, as one enters, is to be seen a large globe of the world, showing the marks of constant usage. This is a good illustration of the cosmopolitan character of the firm's trade.

In conclusion, the writer would say that he found Reinecker tools in the best equipped shops, not only of Germany but also of Austro-Hungary, Italy, Switzerland, Holland, Belgium and France. In England and other European countries they also have a large sale. For automobile, locomotive and turbine building, and for all work involving the production of milled parts and gears, they are particularly prized. In comparison with American tools, the Reinecker machines offer as strong competition as any manufactured on the continent of Europe. The present senior member of the firm is well acquainted with the work of the best shops in the United States, having spent a full year here on one occasion; and the firm has taken every possible opportunity of studying the best of contemporary machine design, in all manufacturing countries. The reasons for its success, therefore, are not difficult to find.

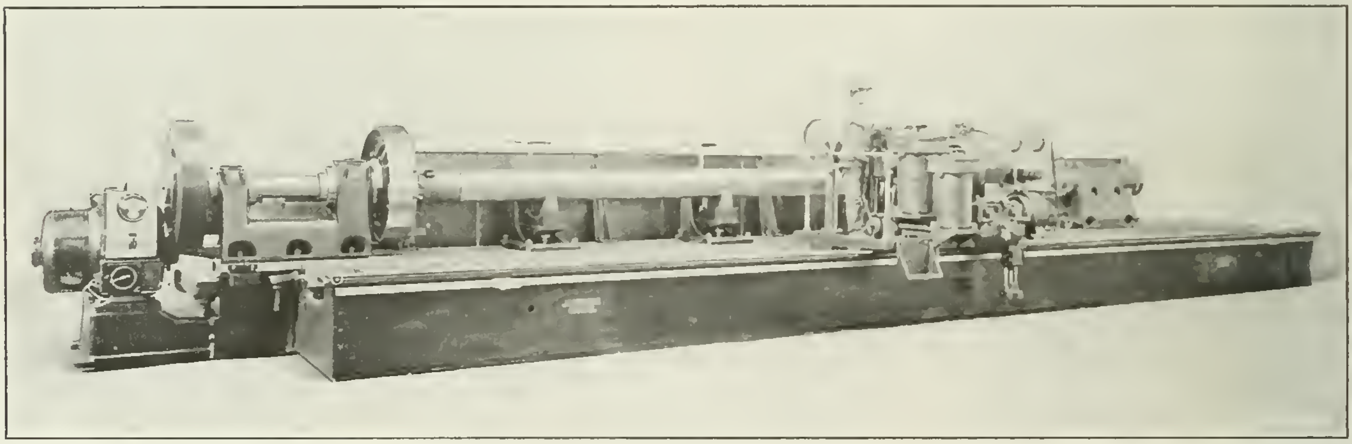

Fig. 23. Large Automatic Cylindrical Grinding Machine

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COMPLAINTS WITHOUT INVESTIGATION

Many complaints are made to makers of small tools when the failures are in no way the fault of the makers. In investigating some of the cases a great deal of diplomacy is necessary on the part of the maker to avoid "getting in bad" with a superintendent or foreman who has made the report without careful personal examination of the conditions. If a workman breaks an expensive high-speed twist drill by carelessness, his impulse, if not too honest, is to report it as being due to a fault in the steel. Those in charge should, for the sake of prestige with those who know small tools and their capabilities, carefully examine all complaints and determine to their own satisfaction the causes of the failures. They will often discover grave abuses and save their concerns heavy losses, to say nothing of imposing additional losses on small tool makers through traveling expenses and replacements.

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Experiments undertaken for measuring the temperature on the inner surface of the cylinder of a small gas engine have shown that the temperature is about 465 degrees F., and that the variation from cycle to cycle is usually less than 18 degrees F. The steady conditions of low temperature at the wall surface were caused by the jacket water, while very great changes of heat take place at a very short distance from the walls.

HERRINGBONE GEARS*

WITH SPECIAL REFERENCE TO THE WUEST SYSTEM

That the helical principle in toothed gearing is ideal from a theoretical point of view is well known. From a practical standpoint herringbone gears have been less satisfactory than straight-cut spur gears because, until recently, no method was devised for producing them with the requisite speed and accuracy. Within the last six years, however, a method has been developed, in England, to a high degree of perfection. Herringbone gears made by this method are called Wuest gears, after the inventor.

The distinction between these gears and those of the ordinary herringbone type is that the teeth of the former, instead of joining at a common apex at the center of the face, are stepped half the pitch apart and do not meet at all. This arrangement of the teeth does not affect the action of the gears, but it facilitates their commercial production. The utilization of power constantly calls for means to transmit rotary motion from one axis to another. While there are many ways in which such transmissions may be produced, the merits of all of them must be judged from the following standards: (*a*) reliability and freedom from wear and tear; (*b*) economy of outlay; (*c*) mechanical efficiency; (*d*) compactness; (*e*) evenness of transmission, absence of shock, jar or vibration; (*f*) absence of noise.

Action of Spur Gearing

The aim of all designers of gearing is to transmit rotary motion from one axis to another in a perfectly even manner without variation of angular velocity. Let us consider the action of a straight spur pinion driving a gear. There are three distinct phases of engagement:

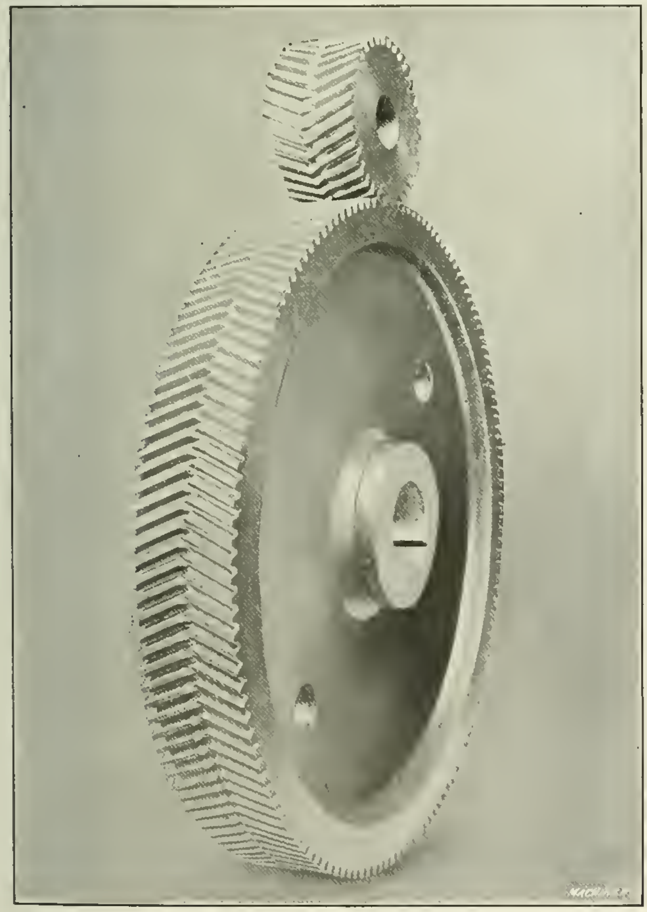

Fig. 1. Typical Wuest Herringbone Gear and Pinion

First phase: The root of the pinion tooth engages the point of the gear tooth.

Second phase: The teeth are engaged near the pitch line.

Third phase: The point of the pinion tooth engages the root of the gear tooth.

Let us assume that the teeth are accurately cut to involute form, so that if the pinion moves with even angular velocity it will produce corresponding evenness of motion in the gear; and also that the pinion has sufficient teeth to allow the engagement of successive teeth to overlap. At the beginning of the first phase, while the load is carried near the point of the gear tooth, that tooth is subjected to a maximum bending stress along its whole length. The portion of the pinion tooth near the root is sliding over the outer portion of the gear tooth; that is to say, two metallic surfaces of small area are sliding under heavy compression.

The action during the second phase more nearly approaches ideal conditions. The teeth are engaged near their respective pitch lines and very little sliding takes place. During the third and final phase, the pinion tooth is subjected to a maximum bending stress, while the tooth surfaces again slide over each other, this time with the outer portion of the pinion tooth engaging the gear tooth near its root. The point to be noted is that while those portions of the mating teeth which are near the pitch lines transmit the load with rolling contact, those which are more remote have to transmit the same load with sliding contact. The inevitable result is that the points and roots of all the teeth tend to wear away more rapidly than the portions near the pitch lines.

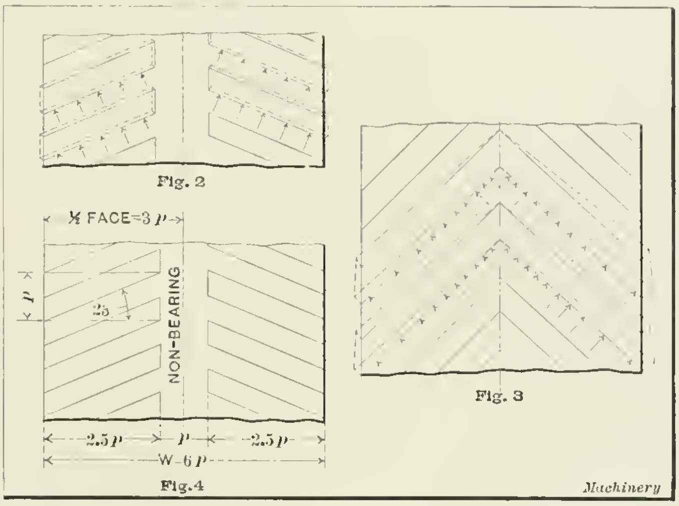

Fig. 2

Fig. 3

Fig.4

Figs. 2 to 4. Diagrams showing Tooth Pressures and Angle Necessary for Continuity of Action

It may be suggested that the sliding action can be eliminated by shortening the teeth so that they engage only the phase of rolling contact. This has been tried with a certain measure of success in the stub-toothed gear, but it cannot be carried far enough without curtailing the arc of contact so that continuity of engagement is lost.

Action of Herringbone Gears

Herringbone gears completely overcome all these difficulties, but only when they are accurately cut. If we take two exactly similar pinions with straight teeth and place them side by side on one shaft, with the teeth of one pinion set opposite the spaces of the other, then we have what is known as a stepped-tooth pinion. If this pinion is meshed with a composite gear made up in a similar manner, the action is modified so that there are always two phases of engagement taking place simultaneously. Such gears are commonly used for rolling mill work, because they stand up to heavy shocks better than the plain type. Still better action can be secured by assembling a number of narrow pinions with the last of the series one pitch in advance of the first and the others advanced by equal angular increments. As a practical proposition, however, gears made on these lines would be costly and difficult to produce.

The helical gear is the logical outcome of the stepped gear carried to its limit, and built up from infinitely thin laminations. Since the steps have merged into a helix, there must be a normal component of the tangential pressure on the teeth, producing end thrust on the shafts. To obviate end thrust, the helical teeth are made right-hand on one side and left-hand on the other. (See Fig. 1.) Such gears, with double helical teeth, are known as herringbone gears.

The fundamental principle of the action of herringbone teeth lies in the circumstance that *all phases of engagement take*

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* Abstract of paper by Percy C. Day, Milwaukee, Wis., read before the meeting of the American Society of Mechanical Engineers, under the auspices of the sub-committee on machine shop practice, at New York, December 5-8, 1911.

place simultaneously. This holds good for every position of pinion and gear, provided only that the relationship between pitch, face width, and spiral angle is such as will insure a complete overlap of engagement. Since all phases of engagement occur together, it follows that the load is partly carried by tooth surfaces in sliding contact and partly by surfaces in rolling contact. The result is curious and interesting.

Those portions of the teeth farthest from the pitch line, which engage with sliding action, tend to wear away more rapidly than the portions nearest the pitch line. But the pitch line portion is always carrying part of the load, and the effect of wear on the ends of the teeth merely tends to throw more load on the center portions; in other words *there is a tendency to concentrate the load near the pitch lines.* The ends of the teeth, instead of wearing away to an ever-increasing extent from their original involute form, are relieved of some of the load from the moment that wear commences to take place. As soon as the load on these ends has been partially relieved and transferred to the middle portion, the wear becomes equalized all over the teeth and they do not tend to distort further from their original shape.

As the teeth keep their involute form, motion is transmitted from pinion to gear in an even manner, without jar, shock, or vibration. Although herringbone teeth may be intrinsically stronger than straight teeth, the elimination of shock renders them capable of transmitting heavier loads. Since all phases of engagement occur simultaneously, the transference of the load from one pinion tooth to the next takes place gradually instead of suddenly. This is the second principle of herringbone gearing, and may be termed *continuity of action.* In straight gears the continuity of action is a function of the number of teeth in the pinion. In herringbone gears continuity depends on the relationship between the face width and the number of teeth in the pinion. Pinions with as few as five teeth have been used with success by merely increasing the face width to suit such extreme conditions. This feature, which is peculiar to herringbone gears, has made practical the adoption of extremely high ratios of reduction hitherto considered impossible.

The third principle of herringbone gearing is that the bending stress on the teeth does not fluctuate from maximum to minimum as in straight gears, but remains always near the mean value. This feature is of special importance in rolling-mill driving and work of a similar nature.

To summarize the foregoing statements: The action of herringbone gears is continuous and smooth; there is no shock of transference from tooth to tooth; the teeth do not wear out of shape; the bending action of the load on the teeth is less than with straight gearing and does not fluctuate to anything like the same extent; the gears work silently and without vibration; back-lash is absent; friction and mechanical losses are reduced to a minimum; herringbone gears can be used for higher ratios and greater velocities than any other kind.

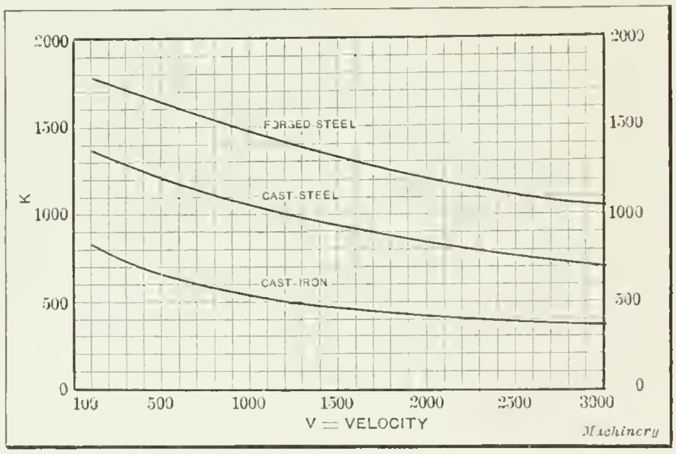

Fig. 5. Shearing Stress with Relation to Pitch Line Velocity

The Production of Herringbone Gears

Herringbone gears may be produced in a variety of ways. Until a few years ago all gears of this type were molded. The limitations of molded gearing are analogous to those which would be experienced if a journal were set to run in a molded bearing. Just as the bearing would touch the shaft only in spots, so molded gears utterly fail to give the intimate contact all along the teeth which is necessary to secure true helical gear action. The herringbone gear must have cut teeth if its advantages are to be realized.

Cut herringbone gears may be broadly divided into two classes, two-piece and one-piece gears. The difficulty in the way of cutting double helical teeth in a single blank gave rise to the two-piece variety. The same methods of cutting may be used for both kinds. The disadvantages of the two-piece type are obvious. There is the expense of two complete gears, the difficulty of assembling the gears so they are in accurate register with each other, and the necessity for very thorough fastenings if they are to perform hard service without getting out of register. High ratios are not within the scope of the built-up gear, because the pinions must be assembled on a separate shaft and the pitch line must be far enough from the surface of the shaft to allow room for the necessary bolts or rivets used in fastening the two portions together. The one-piece pinion, however, may be cut solid with its shaft, so that its pitch diameter need be but very little larger than the latter.

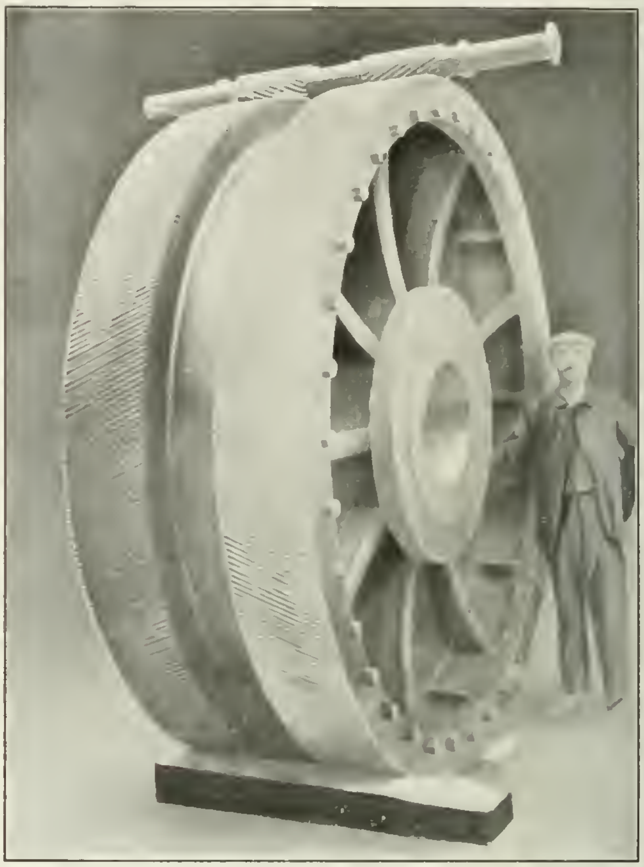

Fig. 6. Gear and Pinion for 500 H.P. Marine Turbine

The methods of cutting helical gears may be divided into four classes: (*a*) milling by formed disk cutters; (*b*) milling by end-mills; (*c*) generating by shaping or planing methods; (*d*) generating by hobs.

Milling by formed disk cutters is unsatisfactory, because, in addition to the usual errors of step-by-step division, there is the difficulty of making the cutters to the *normal* tooth shape with sufficient accuracy. This difficulty is increased by reason of the fact that a disk cutter cannot cut its own shape in a spiral groove. Worst of all, two different cutters must be used for a gear and pinion.

The use of end-mills is open to all the objections to disk cutters, with the single exception that the cutter does leave a fair approximation to its own shape in the groove which it cuts; but the end-mill has a host of disadvantages peculiar to itself which render it even less efficient than the disk cutter for general work. In the first place, it is a small tool with very little wearing surface and no capacity for dissipating the heat generated at its cutting edges. The great variation in diameter between point and base renders it difficult to arrive at a cutting speed which will satisfy the conditions at both ends of the cut. The mills quickly become clogged with cuttings, overheat and burn. To complete one fair-sized gear by the end-mill process requires quite a number of cutters. This not only makes the expense heavy, but must necessarily result in an inaccurate gear.

End-milled herringbone gears are usually made in one piece with the teeth joined at the center. Since the cutter is shaped to the normal pitch, it follows that, in changing over from right- to left-hand helix, it leaves a thick wedge in the center of the face that must be removed by a subsequent operation. The teeth of end-milled herringbone gears do not bear over the center portion.

Generating processes of the shaping and planing type, while successful for straight-cut gears of relatively small size, are not used to any extent for large diameters or heavy pitches. The reason for this may be found in the nature of the processes. The gear blank is required to make a quick angular movement after each stroke of the cutting tool and to come to rest again before the next stroke. Such methods are difficult to apply to large gears on account of the inertia of the gear blank and its support and the consequent difficulties of controlling the short intermittent movements. These difficulties are much increased when such methods are applied to cutting helical teeth because the blank must make definite and rapid angular movements during each stroke in addition to the motion between strokes.

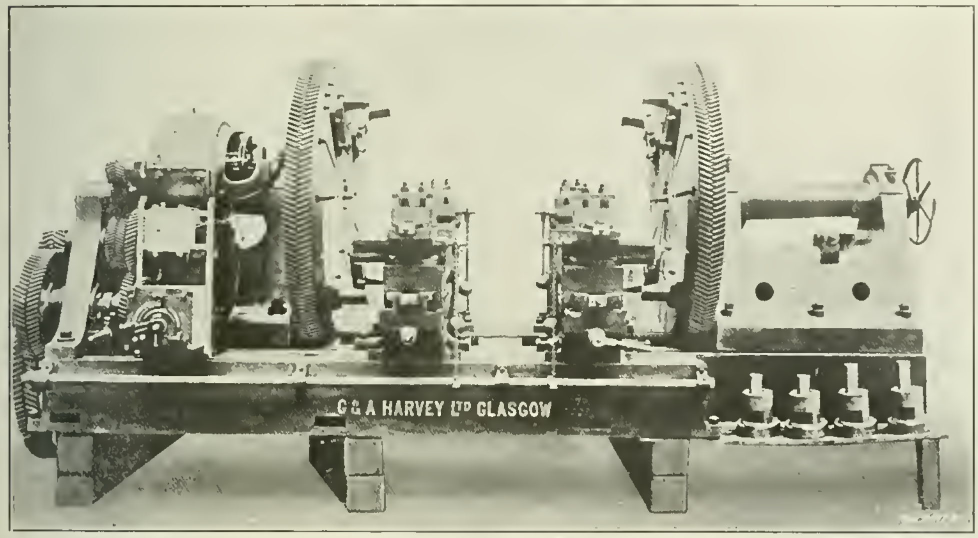

Fig. 7. Tire-turning Lathe with Herringbone Gears

The hobbing process as applied to straight-cut gears has proved so successful as to arouse adverse criticism from those who are interested in other methods of gear production. The shape of the teeth is generated from spiral hobs, the threads of which are cut to a plain rack section. One hob will cut any gear or pinion of one pitch. This feature alone eliminates many errors which are characteristic of gears produced by milling methods. The hob revolves continuously while cutting, as does the gear blank. The feed is also continuous. There are no cutting and return strokes, no intermittent starting and stopping of gear blanks, as in other generating processes. These features do not necessarily insure the production of accurate gears, but they offer greater facilities to the designer for the achievement of the desired result.

Wuest Herringbone Gears

It has been explained that the teeth of the Wuest gears are so designed that those on the right- and left-hand sides of the gears are stepped half a space apart and do not meet at a common apex at the center of the face, as in the usual type of herringbone gear. It has often been argued that the ordinary herringbone tooth is stronger than the Wuest tooth, because the latter lacks the support given by the junction of the teeth at the center. This argument would be sound if gear teeth were ever stressed to anywhere near their breaking point. But it has been found in practice that considerations of wear so far outweigh those of mere breaking strength that a gear which is designed to give reasonable service will carry anywhere from ten to twenty times the working load without fracture. A point of vastly greater importance is that the stepped form will wear more evenly under extreme loads than the ordinary type. The reason for this is shown in Figs. 2 and 3. The resultant tooth pressure is always normal to the teeth and tends to bend them apart. The stepped form offers a uniform resistance along its whole length, carrying the load from end to end (Fig. 2). The teeth of ordinary herringbone gears tend to separate more at the sides than near the supported center, causing the load to be concentrated toward the center (Fig. 3).

The standards which have been adopted for Wuest gears are the result of experience gained in Europe during the last six years. The spiral angle of the teeth is about 23 degrees with the axis. Since the nature of the action eliminates shock, it follows that the pitch required for given conditions will be much finer than would be chosen for spur gears. On the other hand, the face width will not be less, because there is as much necessity for wearing surface with one kind of tooth as with the other. Spur gears are usually made with a face width equal to three or four times the pitch. Herringbone gears may conveniently have a face width equal to six times the pitch, not because the width of this type need actually be greater, but by reason of the pitch being proportionately less.

Starting with a width equal to six times the pitch, and allowing one times the pitch as the non-bearing portion in the center, there remains two and one-half times the pitch available for the teeth on each side. To insure continuity of engagement under all ordinary conditions, each tooth is inclined so as to cover an advance of one times the pitch within its length. The angle of 23 degrees satisfies this requirement (see Fig. 4).

The pressure angle which has been adopted for standard gears is 20 degrees. The teeth are shorter than the usual standards. The high ratios used with these gears call for an average pinion diameter which is less than is used with straight spur gears for similar duty. The teeth are generated by hobs, and the short addendum combined with wide angle gives satisfactory tooth shapes, without undercutting of teeth, for small pinions.

The dimensions proposed for an interchangeable system for these gears are as follows:

Tooth shape ....Involute
Pressure angle .... 20 degrees
Spiral angle .... 23 degrees

$$\text{Pitch diameter (20 teeth and over)} = \frac{\text{Number of teeth}}{\text{D.P.}}$$

$$\text{Blank diameter (20 teeth and over)} = \frac{\text{Number of teeth} + 1.6}{\text{D.P.}}$$

$$\text{Pitch diameter (under 20 teeth)} = \frac{0.95 \times \text{Number of teeth} + 1}{\text{D.P.}}$$

$$\text{Blank diameter (under 20 teeth)} = \frac{0.95 \times \text{No. of teeth} + 2.6}{\text{D.P.}}$$

Addendum .... $\frac{0.8}{\text{D.P.}}$

Dedendum .... $\frac{1.0}{\text{D.P.}}$

Full depth .... $\frac{1.8}{\text{D.P.}}$

Working depth .... $\frac{1.6}{\text{D.P.}}$

Standard face width for gears with pinions of not less than 25 teeth, 6 times circular pitch; face widths for high-ratio gears with small pinions, 6 to 12 times circular pitch.

When a pinion of less than 20 teeth is used with a standard gear, the center distance must be slightly increased to suit the enlargement of the pinion. If it is desired to keep the center distance to the standard dimensions, the gear diameter may be reduced by the amount of the enlargement given to the pinion. For example: If a pinion of 10 teeth, 5 diametral pitch is to mesh with a gear of 90 teeth at 10-inch centers,

$$\text{Pitch diameter of pinion} = \frac{0.95 \times 10 + 1}{5} = 2.1 \text{ inches.}$$

$$\text{Enlargement over standard pinion} = 0.1 \text{ inch.}$$

$$\text{Pitch diameter of standard gear} = \frac{90}{5} = 18.0 \text{ inches.}$$

$$\text{Reduced pitch diameter of gear} = 18.0 - 0.1 = 17.9 \text{ inches.}$$

$$\text{Center distance} = \frac{17.9 + 2.1}{2} = 10 \text{ inches.}$$

The important factor in determining the proportions of the teeth is the relationship between pitch line velocity and the permissible specific tooth pressure; in other words, the total tooth pressure divided by the area of all the available simultaneous contact along the teeth. Theoretically, this contact has no area since it should consist of lines without breadth. Actually, an area exists, due to the elastic compression of the teeth in contact, in a similar way in which an area of contact exists between a car wheel and a rail. The area of contact is indeterminate, but the specific tooth pressure is proportional to the driving stress on the teeth.

In order to obtain a simple rule for finding the proper dimensions, the results of experience in the matter of safe working loads under given conditions have been reduced to a relationship between pitch line velocity and the shearing stress on the pitch line thickness of an imaginary straight tooth, assuming only one tooth in engagement at a time. The shearing stress is a measure of the specific tooth pressure, and the relationship referred to affords a convenient means of arriving at reliable dimensions. The curves, Fig. 5, give values of shearing stress K in pounds per square inch on pitch line section of an imaginary single tooth for corresponding pitch line velocities V in feet per minute. The values are entirely empirical, but they are based on the results of extended experience, and lead to dimensions which are safe and reliable. Different curves are given for different materials, and it is necessary to use that curve which corresponds to the lowest grade material of the combination. The dimensions of gears can be derived from the curves in the following manner:

H.P. = brake horsepower transmitted,
N = revolutions per minute,
D = pitch circle diameter, inches,
p = circular pitch in inches (use nearest diametral pitch),
W = total width of face, inches,
V = pitch line velocity, feet per minute,
P = total tooth pressure at pitch line, pounds,
K = stress factor (from curve).

Then

$$V = \frac{\pi D N}{12} \qquad P = \frac{\text{H.P.} \times 33{,}000}{V} \qquad P = \frac{p W K}{2}$$

$$P = 3p^2 K \left\{ \begin{array}{l}\text{in normal gears of moderate ratio, and face} \\ \text{width equivalent to six times the circ. pitch}\end{array} \right\}$$

$$p = \sqrt{\frac{P}{3K}}$$

For high ratio gears take $W = Rp$ (R = ratio) up to maximum of $W = 10p$.

$$p = \sqrt{\frac{2.5P}{RK}}$$

In normal gears it is safe to aim at pitch line velocities between 1000 and 2000 feet per minute, with 1500 feet as a fair average. If the pinion is to be fixed to a motor shaft without external support, the diameter must be greater than when it can be supported on both sides. Cast iron is preferable to cast steel for gears of large diameters and moderate power, but the latter will be found more economical for high tooth pressures. Pinions are usually made from steel forgings of 0.40 to 0.50 per cent carbon. Soft pinions should never be used for herringbone gears.

There are two special cases where the ordinary methods of calculation should not be used. Rolling-mill gears are subjected to stresses which are so far in excess of the average working load that it is necessary to consider carefully the strength of the teeth in regard to possible overloads. Extra high velocity gears, such as are used for steam turbines, require additional wearing surface and are characterized by extreme width of face combined with abnormally fine pitch.

Application to Steam Turbines

Direct-connected steam turbines for marine propulsion have been only partially successful in a very limited field. It is only when the power required is very great and the speed of the vessel unusually high that the direct-connected turbine can be applied, and even then the application does not do full justice to either turbine or propeller, while the first cost is much higher than it need be. The use of direct-coupled turbines is confined to ocean fliers and warships. Ordinary vessels of commerce cannot be adapted to turbine power in this form. Mr. Parsons attacked the problem of applying the turbine to an ordinary freight steamer of moderate power. To this end he purchased the S. S. Vespasian, a modern tramp with triple-expansion engines of about 1000 H.P. and a speed of 11 knots with propeller running at 75 R.P.M. As a preliminary to the installation of geared turbines on this vessel, the original engines were overhauled, and a series of coal consumption trials made under regular sea-going conditions.

The engines were then removed and for them were substituted a pair of steam turbines connected to the propeller by the herringbone gears illustrated in Fig. 6. Each turbine develops about 500 H.P. at 1500 R.P.M. The propeller runs at the original speed of 75 R.P.M. Each turbine is coupled to a herringbone pinion with teeth cut solid on a shaft of soft-grade chrome-nickel steel. The two pinions mesh with rolled-steel gear rings mounted on a cast-iron spider which is keyed to the propeller shaft. The whole gear system is enclosed in a case, and the teeth are kept lubricated by oil jets. The great width of the pinions in proportion to their diameter made it necessary to provide room for bearings between the right- and left-hand teeth. The proportions of this remarkable gear unit are as follows: Pinions, 20 teeth; gear, 398 teeth, 4 diametral pitch; teeth of involute form, 20-degree pressure angle, 23-degree spiral angle; over-all face width, 34 inches, including 10 inches space for bearing; actual face width, 24 inches; ratio of reduction, 19.9 to 1. This gear has now been running regular voyages for more than a year and has covered over 20,000 miles. The results have been interesting and satisfactory. The efficiency of the gear is fully 98 per cent, including the losses in the bearings on the gear case. The geared turbine shows a sustained all-around saving in fuel consumption of more than 25 per cent over the original engines. The wear on the teeth is negligible after 20,000 miles, being only 0.002 inch at the pitch lines of the pinions.

Herringbone Gears for Machine Tools

The field for accurate herringbone gears in connection with machine tool driving is too extended to be considered in detail. For individual motor drives this gear gives a positive transmission which is free from vibration and less noisy than so-called silent chains or rawhide pinions, while there is no trouble from slipping belts or slack chains; but the real advantage of these gears lies in the better finish that can be obtained when they are used for the entire main transmission, and in the higher output combined with reduced maintenance which they give to heavy machine tools. Chatter is eliminated. Even the speeding up to the wheels of grinding machines has been successfully accomplished. Reversing gears for heavy planers are a revelation to those familiar only with the ordinary spur drive.

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A German scientist, Dr. R. Wegener, states in the *Chemische Zeitung* that studies of the outer layers of the earth's atmosphere have led him to the conclusion that in these outer layers there exists a hitherto unknown element lighter than hydrogen.

TOOLS AND METHODS OF THE GOODMAN MFG. CO.

By EDWARD K. HAMMOND*

Although attractive grounds have no direct bearing upon the operation of a plant, it cannot be denied that the attention given to the approach to a factory must tend to create higher standards among the employes in the shops; and as one walks up the path to the entrance of the Goodman Mfg. Co.'s factory, observing the neatly cut lawn, the beds of flowers, and the vine covered building, remembering meanwhile that one is in the heart of the manufacturing district of Chicago, one is bound to feel that this care for outward appearances is an indication of the attention given to the work in the shops. The Goodman Mfg. Co. is engaged in building electric coal mining machinery, and it is the purpose of this article to describe a few of the shop and tool-room methods which are in vogue in its shops.

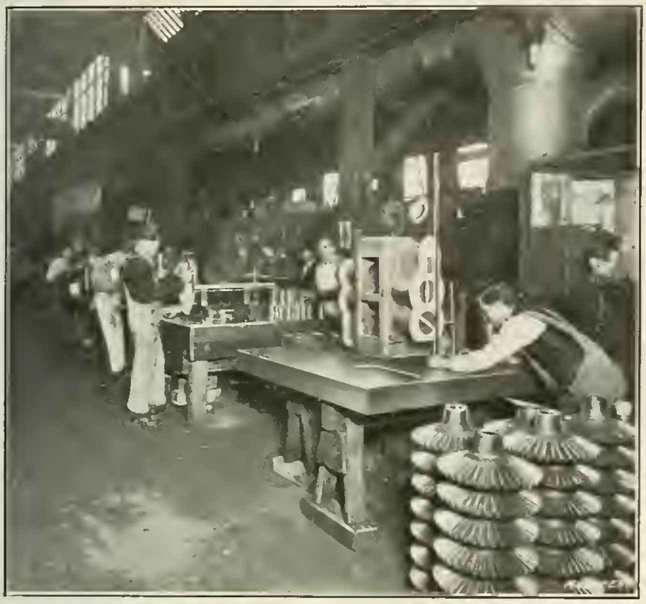
Fig. 1. General View of the Laying-out Department

Passing through the offices and drafting-rooms at the front of the building, one arrives at the factory office, from which the operation of the plant is directed. One of the noticeable features of the equipment of this office is a bulletin board upon which all orders are recorded in the order in which they are received. The different types of machines built by the company are designated by numbers, and the bulletin board is laid out with spaces for the order number, the name of the company for which the work is being done, the number which indicates the type of machine, and the date upon which delivery is required. Upon receiving an order for the construction of a given machine, the foreman comes to the shop office and consults the bulletin board in order to ascertain the date upon which delivery is required. He then issues his orders accordingly, work on certain orders being delayed, if necessary, in order to complete machines which are required for delivery at an earlier date. This system of recording each order also enables the foreman to use parts from a similar machine, which is not in a particular hurry, if he finds that there is a shortage in the store-room on parts that are required to fill a rush order. Bills of material are used which show all of the material that is required for the construction of each type of machine.

A somewhat unusual feature in the Goodman factory is that of having all of the work laid out in a separate department, instead of having it done by the individual mechanics. A general view of this laying-out department is shown in Fig. 1, from which it will be seen that high-class surface plates are used. The men working in this department become so expert through their wide experience in this work that the highest precision is attained.

Each drawing used by the Goodman Mfg. Co. shows but a single part. In issuing drawings to the workmen, a check board is used that has a hook on it under each man's number. When a man takes out a drawing, a check bearing its number is placed on his hook and this check is removed when the drawing is returned. This system makes it possible to immediately locate any drawing that is out in the shops in case it is required; the method also eliminates the loss of drawings, as a man is held responsible for a drawing that is checked against his number. The drawings are filed in cabinets, when not in use.

The Tool-room

The old-fashioned tool-room system of having one man start a piece of work and follow it through to completion, meanwhile working with great deliberation, owing to the impression that slow work and accurate work are necessarily akin to each other, has been eliminated as far as possible. On the contrary, the Goodman tool-room is operated practically along the lines of a modern manufacturing plant. A tool-order is issued by the tool-room foreman for each tool that is made; this order bears the tool number, a description of the tool, and the date. The different operations, such as milling, grinding, etc., are assigned to different men who work with the accuracy and rapidity acquired through specialization in given operations. When the tool is completed, the stub of the tool order is sent to the office where the tool is inventoried with all charges against it.

The finished tools are kept in cabinets which are 10 feet high, 10 feet wide, and 24 inches deep. Each of these cabinets is subdivided into sixteen units, which are again subdivided into cells of convenient size. Each cell is numbered to correspond with the number of the tool that is kept in it, and these numbers are also stamped on the tools. Some of the units are equipped with drawers in which the finer tools are kept. The different sizes of milling cutters, hobs, and saws are carried on hooks which have the size of the tool marked above them.

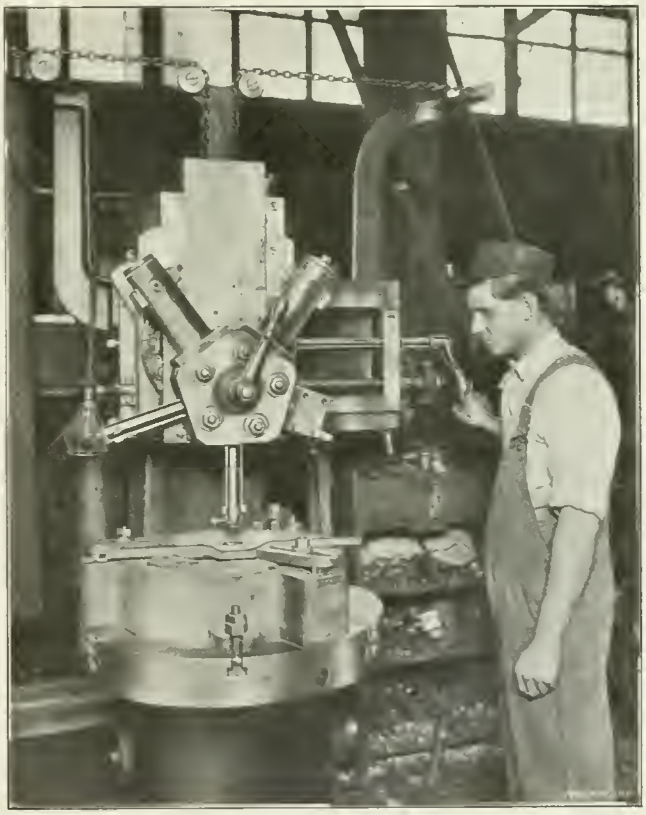
Fig. 2. Boring and Facing Wheels on a Bullard Vertical Turret Lathe

When damaged tools are returned to the tool-room, they are placed on a separate shelf which is reserved for this purpose. These tools are then examined by the toolmaker who has been assigned to this work, and they are ground or redressed as required. After the tools have been restored to working condition, they are put into their respective places in the tool cabinets. This system of repairing tools does away with the loss of time caused through having men waiting for their tools to be repaired, the sight of several men waiting for their turn at a tool grinder being almost too common to require mention.

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In issuing tools to the workmen, brass checks are used to keep a record of the tools that are out in the shop. These checks bear the numbers of the respective workmen, and a check is put in the place of each tool that is taken out. These checks are given back to the men when they return the tools. The tool-room foreman has a card catalogue which gives a complete account of every tool in his department.

The Storage of Jigs and Fixtures

The jigs and fixtures used by the Goodman Mfg. Co. are stored in a separate room which is always kept locked, and when one of the jigs or fixtures is needed, it is given out on receipt of the foreman's signed order. This room is equipped with cabinets that are subdivided into lettered and numbered cells. Each jig or fixture is stamped with the cell letter and number, tool number, drawing number, and mark number of the part on which it is used. A short description of the jig is also included. Thus one jig is stamped: "A-13, T-1376, Drawing-15,437, Mark 15,437, Jig Used for Milling Chain Straps." This gives a complete identification of the tool, showing the cell in which it is kept, the number of the tool, the drawing from which it was made, the part which is manufactured on it, and the character of the work for which it is used. This complete identification makes it impossible for any confusion to occur.

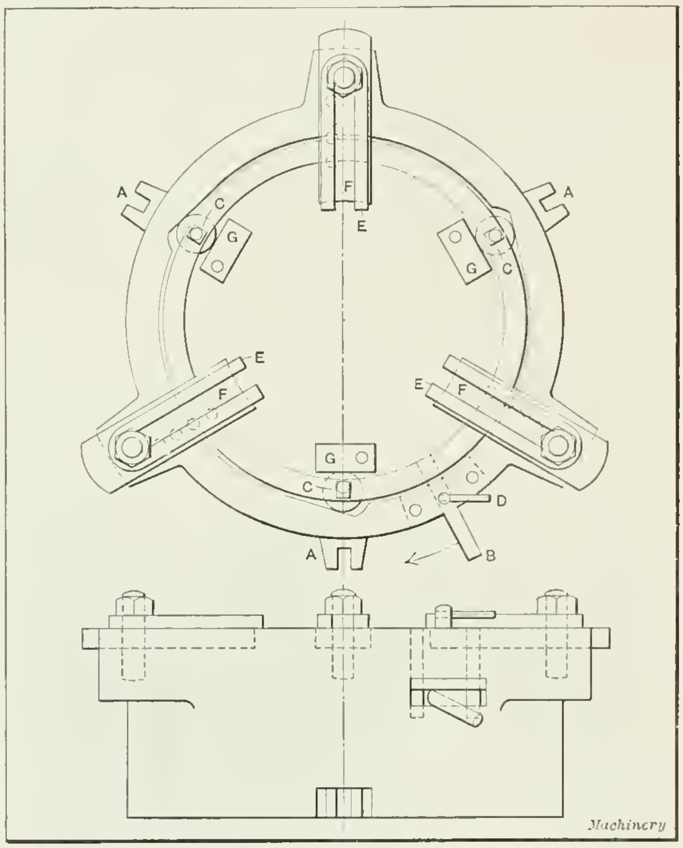


Fig. 3. Jig used in Machining Wheels on Bullard Vertical Turret Lathe

On those jigs and fixtures where the work is held in a recess, a system known as the "three piece jig" has been adopted. This consists of making the ends and one side of the jig in one piece; a piece of angle stock is then used for the other side and the bottom, while the top is attached to meet the requirements of the jig in question. This method enables the jigs to be made far cheaper than if the recess were contained in a single piece of metal, which is the practice in some shops.

In looking over the jigs and fixtures used in this shop, so many interesting devices were brought to the writer's attention that it became a difficult matter to make a selection for description in this article. The devices described were finally chosen, not necessarily because they were the most ingenious, but because their design included ideas that can readily be adopted in other shops.

A Jig for Boring and Facing Locomotive Wheels

A particularly good jig is used in this shop for boring and facing the hubs of electric locomotive wheels. This jig, which is the design of Mr. Theo. Colby, general machine foreman of the company, is illustrated in Figs. 2 and 3. It will be seen from Fig. 3 that the jig consists of an outer body or shell provided with three lugs *A* for bolting it to the table of the Bullard vertical turret lathe. A second shell fits loosely inside of the first one and may be rotated in relation to the body of the jig by means of lever *B*. This inner shell carries three rollers *C* which engage with inclined planes cut in the body of the jig. These rollers are carried on pins that are fitted freely in the transverse slots cut in the inner shell. A rotation of lever *B* in the direction of the arrow causes the rollers to be forced inward, through the action of the inclined planes, thus centering and chucking the wheel under the boring bar. Owing to the inclined planes, a moderate pull on lever *B* provides an ample grip on the wheel; when the jig has been tightened in this way, it can be locked by means of bolt *D* that clamps down on the lever. The grip afforded by the rollers is not, however, depended upon to furnish all of the holding power upon the work, the horseshoe clamps *E* being used to hold the wheel down to the jig.

The jig is made to carry a 16-inch wheel, and in machining work of this size, the plates *F* support the wheel on the under side of the flange, thus providing for having the journal box in proper alignment with the face of the hub. Wheels 14, 12, and 10 inches in diameter may also be machined in the same jig. When machining the smaller sizes, the rollers hold the work through the action of the auxiliary blocks *G* shown in position in Fig. 3. Different sized blocks are provided to hold the different sizes of wheels. The plates *F* are adjusted to the proper position by means of pins fitting into any of the four holes shown, each hole securing the plate in the correct position for one size of work.

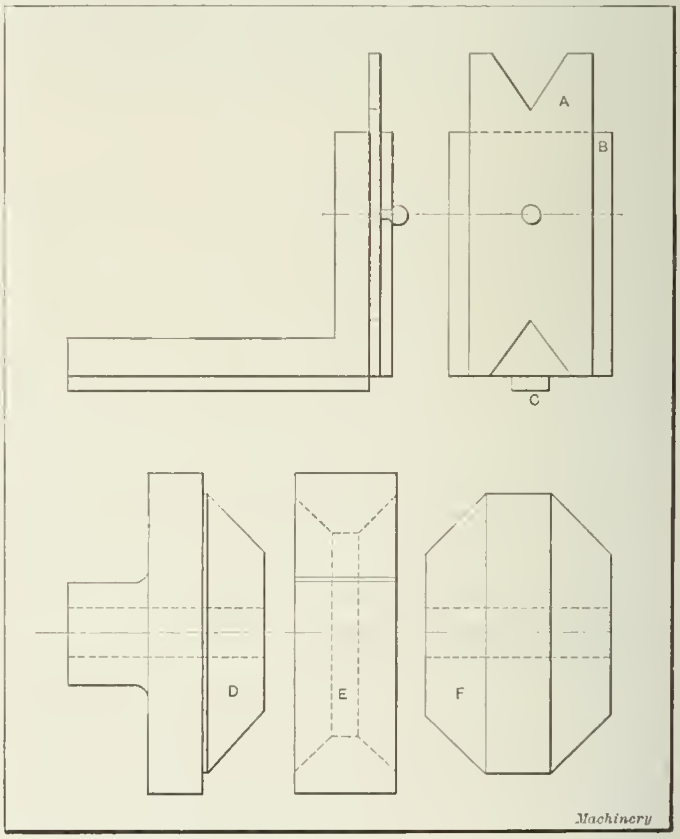


Fig. 4 Centering Device for Gear Cutter, and Fixture for Cutting Teeth in Steel Rims

The first machining operation consists of facing the hub of the wheel, this work being done by the forming tool shown in the turret of the Bullard vertical turret lathe in Fig. 2. The face of the hub is machined so that it is in alignment with the inner surface of the wheel-rim, and the gage shown lying across the wheel in Fig. 2 is used to determine when the work has been reduced to the desired point.

The Davis adjustable boring-bar shown in the illustration is used for boring the journal box. As most mechanics know, this bar, made by the Matthews-Davis Tool Co., St. Louis, Mo., has two cutters which may be adjusted to 0.001 inch by means of a key fitting into the center of the micrometer dial shown. Before taking a cut with the Davis bar, it is the practice in this shop to take a preliminary cut with a rough boring-bar (not shown in the illustration) so that any irregularity in the castings will not damage the finer tool. A roughing cut of 0.500 inch is then taken with the first Davis boring-bar, which is followed by a finishing cut of 0.015 inch with the second bar in the turret. It has been possible, by the equipment shown, to machine one hundred wheels in a ten-hour day.

Fixture for Cutting Gear Teeth in Steel Rims

Gears are used on some of the machines built by the Goodman company which have a steel rim, in which the teeth are cut, shrunk onto an iron center. When the teeth of these wheels become worn, new rims are supplied, to be used on the original iron centers. In cutting the teeth in these rims, the fixture shown in Fig. 4 is used to hold the work. The two parts *D* and *F* are mounted on the work arbor of a Brown & Sharpe automatic gear cutter, and the split collar *E* is held between them. The rim in which the teeth are to be cut fits on the collar *E*, and when the nuts on the arbor are tightened, the tapers cause this split collar to expand and hold the work securely in position. This system of mounting insures having the work in proper alignment, as the tapers adjust it automatically into position.

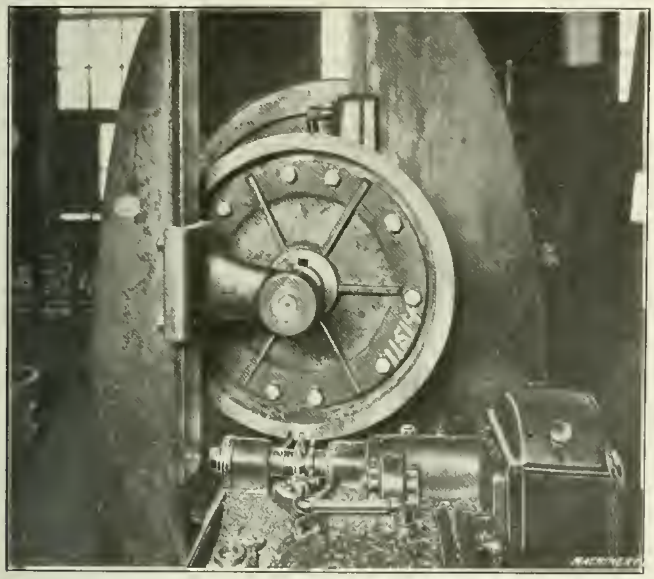


Fig. 5. Stocking Cutter used on Cutter Arbor ahead of the Gear Cutter

In cutting gears on the automatic gear cutters in this shop, the method of mounting a stocking cutter on the arbor ahead of the regular gear cutter is used. The preliminary cut taken by this cutter relieves the strain on the gear cutter, and, as a result, heavier feeds may be taken without impairing the accuracy of the work. Fig. 5 illustrates a rig of this kind, a three-pitch cast-steel gear being cut. The machine is operated at the rate of 38 R.P.M. with a feed of 2¼ inches per minute.

A Device for Centering Gear Cutters

A special centering device is used for centering the gear cutters used on milling machines. One of these centering devices is illustrated in the upper part of Fig. 4, where it will be seen that the tool is held on the table by means of a tongue fitting in the T-slot. The plate *A* is held against the shoulder *B*, and then pushed along the table until it comes into contact with the cutter. If both edges of the cutter touch the edges of the notch at the same time, it shows that the cutter is properly centered.

A Clamp for Holding Tapered Copper Segments

In Fig. 7 a clamp is illustrated which is used for holding tapered copper segments in the milling machine vise. These segments are used in motor commutators, and the clamp is used to hold them while a slot is being sawed across their upper edges. The jaws of this clamp pivot on two cylindrical pieces which are divided at *D*, one jaw being secured to each piece. The two cylinders are held together by means of the central bolt shown in the illustration. One of the jaws is secured to the vise by means of screws entering the tapped holes *C* and the other swings free, the set-screws *E* being used to adjust it so that the work is held in a perpendicular position. When the vise is tightened, the work is held over its entire surface by these jaws.

Cutting off Copper Contact Tips

The fixture illustrated in Fig. 8 is used for cutting off copper contact tips, such as are used on the controllers of Goodman electric locomotives, from the bar stock. The stock is fed up to a stop at the end of the fixture and the work is then fed up to the eight saws held on the arbor of the milling machine, the saws entering the slots *G* which are of sufficient depth to allow ample clearance below the stock. After the cut has been made, the jaws are released and the stock is then fed up to the stop ready for another cut. The fixture is secured to the vise by means of screws entering the tapped holes *F*.

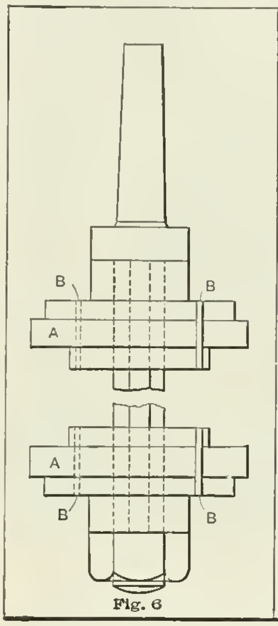


Fig. 6. Arbor used for Splitting Bushings

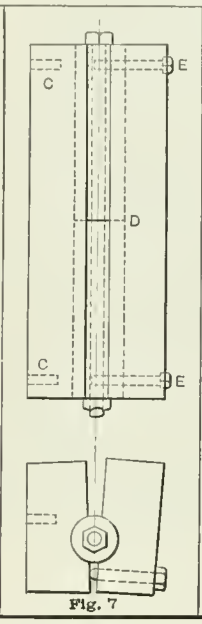


Fig. 7. Holding Tapered Segments

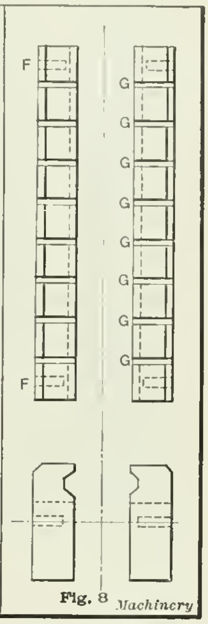
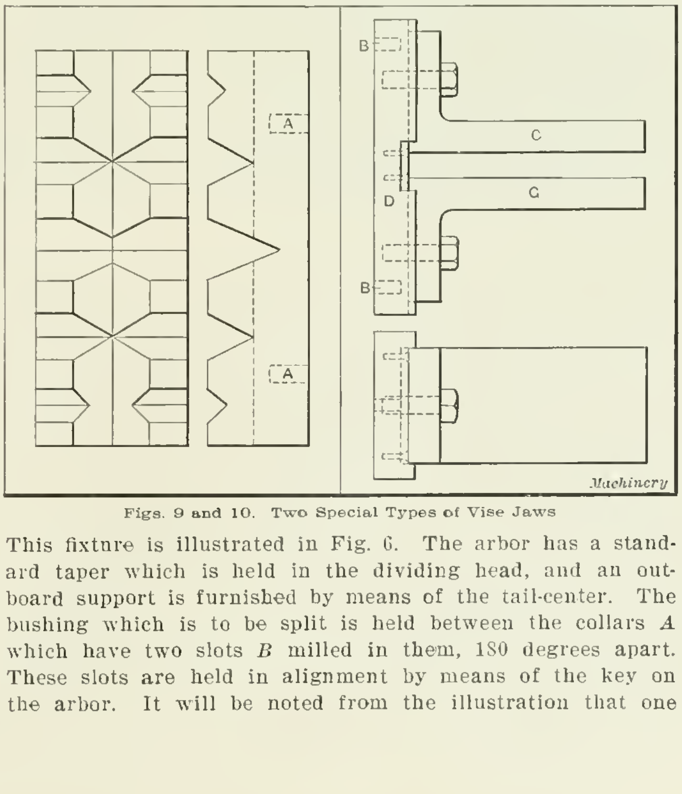


Fig. 8. Cutting off Commutator Tips

An Arbor for Splitting Bronze Bushings

A special type of arbor has been designed in this shop for use in splitting bronze bushings into exactly equal halves. This fixture is illustrated in Fig. 6. The arbor has a standard taper which is held in the dividing head, and an outboard support is furnished by means of the tail-center. The bushing which is to be split is held between the collars *A* which have two slots *B* milled in them, 180 degrees apart. These slots are held in alignment by means of the key on the arbor. It will be noted from the illustration that one



Figs. 9 and 10. Two Special Types of Vise Jaws pair of collars is arranged to hold two sizes of bushings by simply reversing the collars on the arbor. In using this fixture, the first cut is made and the work is then rotated 180 degrees and the second cut is taken, which parts the bushing into equal halves.

A Special Vise Jaw

The special vise jaw shown in Fig. 9 requires little description to make its use evident to any mechanic. One of these jaws is secured in the milling machine vise by means of two screws entering the tapped holes *A* and work may be held either in the horizontal or the vertical position. The horizontal V has been found particularly useful in performing milling operations on small shafts and other similar work, while the vertical V's find application in milling such work as studs and screws.

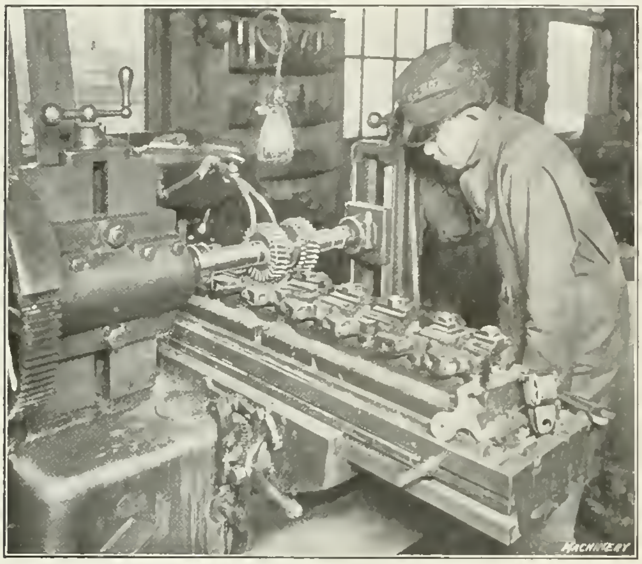


Fig. 11. Machining Chain Blocks for Coal Cutting Machines

Method of Rounding the Ends of Keys

A special vise jaw used for holding keys while their ends are being rounded is shown in Fig. 10. This device is held in the milling machine vise by means of screws entering the holes *B*, as in the preceding case, and the jaws *C* are adjustable for different sizes of work, the jaws being held in any desired position by means of the set-screws shown in the illustration; *D* is a plate of hardened tool steel that prevents the pressure from wearing the fixture at this point.

A Jig for Milling Coal Cutter Chain Blocks

One of the coal cutting machines built by the Goodman company has the cutting tools, used to loosen the coal, carried on a sprocket chain. The chain used for this purpose has lugs at the sides of the links which run in guides on the machine. Fig. 11 shows the method of machining these lugs to the proper size. The jig used for this purpose consists of a plate which is bolted to the table of a Lincoln milling machine. This plate has two rows of fourteen studs mounted on it, which carry fourteen chain blocks in two rows of seven each. Each block is held in the jig by means of two studs which fit into the holes in the block. The work is then held down by means of small plates which are bolted in position, each plate holding a pair of chain blocks as shown in the illustration.

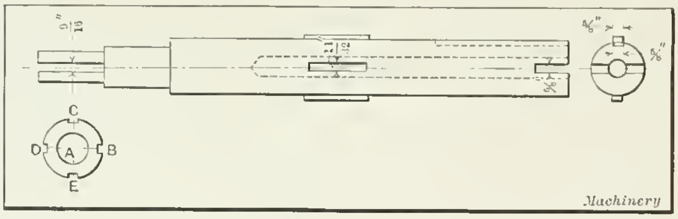


Fig. 12. Feed Shaft for Coal Cutting Machine

One of the finished blocks is shown standing on the table of the machine at the end of the jig. The machined flanges are plainly shown in this illustration, and it will be seen that the four milling cutters on the arbor of the machine finish the flanges on one side of the blocks at one traverse of the table. The jig is then opened and the work is secured with the machined sides down; a second traverse of the table then completes the machining operation. One of the gages used to test the accuracy of the finished work is also shown on the table of the machine. The chain straps which hold the blocks together are machined in a jig similar to the one just described. This jig, like the one used for the blocks, holds fourteen pieces of work at a time.

Milling Operations on Coal Cutter Feed Shafts

The line engraving Fig. 12 illustrates the feed shaft used on coal cutting machines. Seven milling operations are performed on these shafts, and the jig illustrated in Fig. 13 enables all of these operations to be done with only one setting of the work. It will be noted from the illustration that the shaft is held in the jig in bearings; the bolted cover shown at the front of the illustration provides for securing the shaft in such a way that any rotary movement is impossible.

The shafts have a boss left on them and the cutter shown on the arbor of the machine reduces this boss to the size of the shaft. This cutter does not extend quite half way around the shaft and, as a result, more than half of the boss is left on the shaft after the first cut is made. The jig is now opened and the shaft is turned over and located at 180 degrees from its former position by means of the blocks shown at the side of the shaft on the table. These blocks fit under the shoulder made by the cut just taken, thus locating the work in the desired position. A second cut is now taken which completes the double key shown in the line drawing.

The cutter on the arbor is next replaced by a plain milling cutter of 11/32-inch face, which makes the preliminary cut for the slot in the center of the shaft. After this operation is finished on one side, the shaft is turned over as previously described, and a similar cut is taken on the other side of the shaft. These slots are then squared up at the ends by means of the slotting attachment on a Cincinnati milling machine, the blocks and keys being used to locate the work as in the preceding cases.

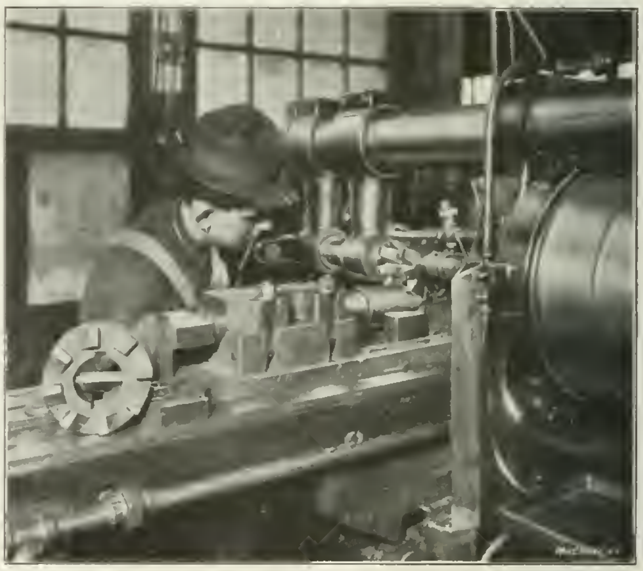


Fig. 13. Jig for Milling Feed Shafts for Coal Cutting Machines

A 9/16-inch cutter is now mounted on the arbor and with the blocks still in position under the keys, the slot is milled at the left-hand end of the shaft. The index plate *A* is now mounted at this end of the shaft. It will be seen that this plate has four slots milled in it, 90 degrees apart. These slots receive keys that are located against blocks in the same way as those at the center of the shaft are. The index plate is now adjusted so that the keys in the slots *C* and *E* rest properly on the jig blocks, and the plate and shaft are then secured in this position. The slot at the right-hand end of the shaft is then milled by means of the 5/8-inch cutter which has replaced the one used in the preceding operation. The shaft is then rotated 90 degrees, and located by means of the index plate and blocks. The keyway is then milled, which completes the machining operations.

MANUFACTURE OF TUBING BY AUTOGENOUS WELDING*

By J. F. SPRINGER†

The trend of industrial processes, today, is in the direction of continuity. There is no doubt but that enormous losses are often entailed by the necessity of slowing down or stopping machinery for the disengagement of completed, and the attachment of new, work. If a process can be made continuous, a great advantage is gained, other things being equal. The rolling mill was an extraordinary advance over previous non-continuous methods, and to-day, in fact, an effort is being made to form short pieces, such as railway tie-plates, on the rolling mill. It is no wonder then that in consequence of the enormous demand for water, gas and steam piping, very determined efforts have been made to produce tubing by the process of rolling. The efforts have been successful, and steel tubing is now made in large quantities by this method. Strips of flat steel are rolled longitudinally between successive pairs of rolls until the edges meet or overlap. They are then butt- or lap-welded. This welding process, while more continuous, differs but little from that of the blacksmith.

In Germany, tubing is being made by the rolling of sheet metal and the subsequent welding with oxygen and acetylene, the process being continuous, and a special welding machine being used. Of course the welding machine can be used as an adjunct to any method of rolling, but in the particular case referred to, the rolling machine is of the type shown in Fig. 1. This machine receives the metal in long flat strips, which have either been specially rolled or cut to the required width. The first operation is accomplished by a pair of rolls which bend the longitudinal edges upward. These bent-up edges will ultimately form the "roof" of the tube. It is important that the degree of curvature of the bends shall be precisely that of the finished tube. Another pair of rolls just ahead receives the strip and bends it into a U-shaped form; the upper ends of the U-curve, however, are bent toward each other because of the side bends formed by the previous pair of rolls. Another pair of rolls is now employed to receive the U-shaped strip and cause it to approximate still more closely the tube-shape. Finally, another pair of rolls completes the bending to shape; a mandrel is employed with this pair. In case very elastic material is employed, it is advisable in the first pass to bend the axial portion so that when the tube is shaped it will point in toward the inside of the tube. In the last operation, this bend will be eliminated by the mandrel. The object is to obtain a joint with no tendency to open.

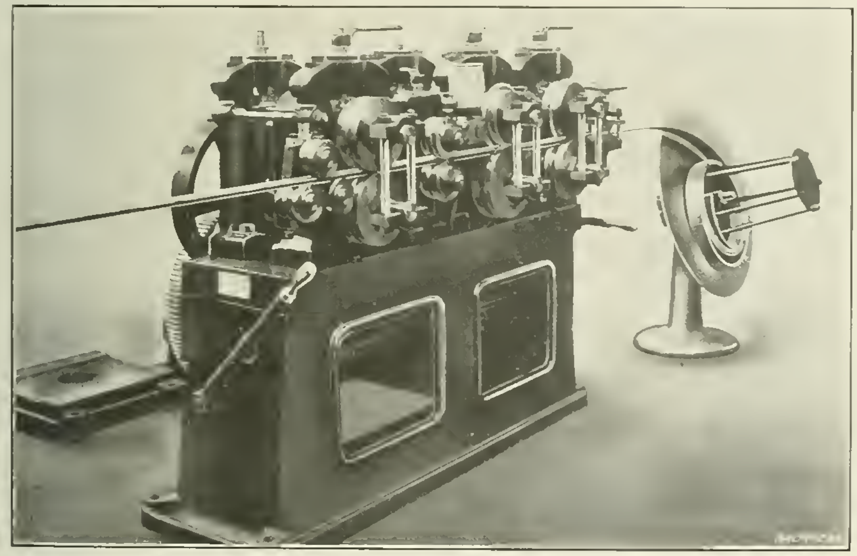


Fig. 1. Tube Rolling Machine built by August Schmitz, Dusseldorf, Germany

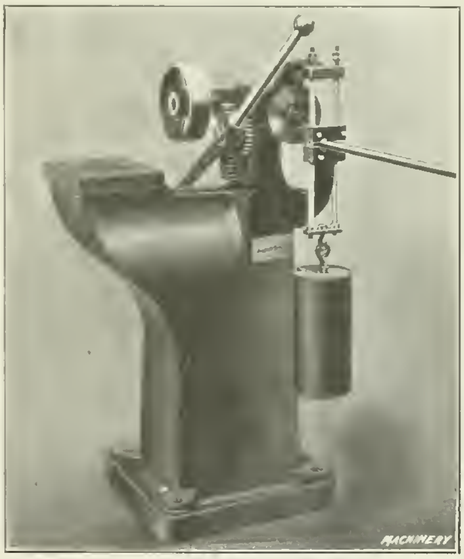


Fig. 2. Machine for Cutting-off the Welded Tubes

When a strip which has been cut from a sheet in the ordinary way is thus bent together, there will be a V-shaped groove along the joint. The reason for this is that the external circumference of an annular ring is longer than the internal one. The strip is of the same width on both sides, so that when one side is bent to form a complete inner circle, there is not enough material for the outer circle. The weld can still be made, but as machine welds use no additional metal, the section at the weld will be thinner than it ought to be. If the tubing is made of quite thin metal, no especial difficulty will arise from the formation of a groove; but when the wall is rather thick, strips which have been especially rolled to provide a greater width on one side than on the other should be used. When such a strip is bent to the final shape, we have a narrow V-shaped groove with ridges on each side. A narrow groove is advisable, because it admits the flame to the entire depth of the joint.

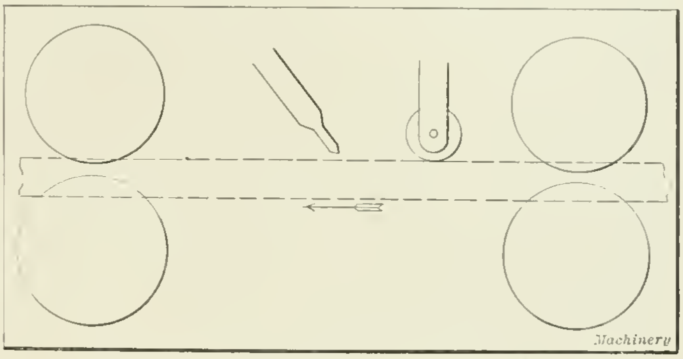


Fig. 3. Principle of Autogenous Tube Welding Machine

The welding machine is rather simple. Two pairs of compression rolls are placed a short distance apart, as indicated in the diagrammatical view, Fig. 3. These rolls carry the tube along, the one pair receiving it from the tube rolling mill. Between the two pairs of rolls a standard is placed to which is secured the device which holds the torch. This latter has its tip directed downward and toward the unwelded joint. The angle of inclination is about 45 degrees. The tubing, as it is fed along by the first pair of rolls, can scarcely be depended upon to keep its unwelded joint in a constantly uniform position. It is, however, necessary that the working flame of the torch and this joint shall be in an exact relation to each other. Therefore, a holder is provided which carries a roll or wheel having a thin edge or projection on its periphery. This edge enters into the groove at the joint and controls its position just before it reaches the torch. This machine is made of the duplex type, so that two welding operations may be handled at the same time; a torch and the necessary rolls are arranged on each side of the bed. Comparatively thin tubing, say 0.04 inch in thickness, can be welded at the rate of about 8 inches per second, or about 40 feet per minute. The rolling of the strips to the cylindrical form can be done at, perhaps, twenty times this rate.

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* The following articles on autogenous welding and kindred subjects have previously been published in MACHINERY: "The Oxy-acetylene Process and the Steel Car," May, 1911; "Goodyear Oxy-acetylene Equipment," December, 1910; "Dangerous Oxy-acetylene Apparatus," May, 1910; "Autogenous Welding as a Means of Repairing Cylinders," April, 1909. See also other articles referred to in the note accompanying the one last mentioned.

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It is frequently the custom in the bicycle industry to draw tubing to an oval or elliptical section. The most severe stresses to which such elliptical tubing is subjected would tend to injure the weld if the latter should be located at the end of either axis of the ellipse. It has been found advisable, therefore, to locate the seam to one side of the "sharp" end of the ellipse. A Swedish charcoal iron, containing very little carbon, is said to be most suitable for this class of work.

In the rolling of tubes of small diameter, it is permissible to roll in a longitudinal direction, but when we come to greater diameters, it becomes necessary, or at least advisable, to discard the continuous method and use rolls or other devices whose axes are parallel with that of the tube. Machines specially built for this service bend the sheets quickly to the required cylindrical form. Diameters of 3 to 10 inches are readily handled, the material having a thickness up to ¼ inch. The forming process requires from 7 to 12 minutes for each section of tubing, according to the length. The writer understands that machines for forming tubing of still larger diameters are built by the firm of August Schmitz, Düsseldorf, Germany, the maker of the machines illustrated in this article.

Large tubes are usually welded autogenously, by hand, but it is necessary that the operator shall not have to contend with any movements of the metal edges when the work is subject to the effects of the high temperature of the working flame, and a guide of some kind must, therefore, be employed. In dealing with the mechanical welding of rather heavy material, it becomes necessary to provide for something more than a mere relative movement in a straight line of work and torch. In one or more of the German machines there is a device which communicates a kind of circular motion to the welding torch and flame, in order to increase the heated area. Just why the same result could not be attained by the use of two torch tips side by side, is not very clear.

That large pipe made by the oxy-acetylene process is reliable is indicated by the following test: Two sections of such pipe, each about 39 feet long and 35 inches inside diameter had their flanges bolted together to form a single length of nearly 80 feet. The supports were placed at the ends so that the full length between them was unsupported. Then the double length of tubing was loaded with about thirty men, or, in other words, a load of more than two tons was supported. Of course this test does not take into account the question of the "water-tightness" of the weld. However, a test was carried out upon another piece of welded tubing—this time a bend—of about 2 feet inside diameter. The tube did not leak under a pressure of about 365 pounds per square inch. Another piece of tubing about 31 or 32 inches in diameter has been made by the welding process from material which was about 0.4 inch thick. A drainage system for a lock of the Kaiser-Wilhelm canal contains about 2000 feet of pipe welded by the autogenous process. One German firm is manufacturing hot water heaters by the same process. These heaters are made in lengths up to 9 feet, and diameters up to 39 inches.

* * *

TO PREVENT DISCOLORATION OF CEILINGS OVER BELTS

In shops of the factory type having windows at the sides only, the difficulty of lighting in the center has been largely overcome in modern construction by using steel window sash and making the window openings upwards of eighty per cent of the wall space, and by painting the ceilings and pilasters a light tint. But it is one thing to paint ceilings a light tint and another to keep them from quickly becoming grimy. It is common experience that the ceiling areas immediately over belts quickly become discolored and in a short time black with dirt. The dust of the shop is heated and electrified in the vicinity of the belts, and being attracted by the ceiling clings to it. The trouble can be largely overcome, it is claimed, by stringing a parallel wire over the belt with short pointed wires attached and hanging down close to it. The wire must be grounded to act as an efficient conductor. The electrified particles of dust are atttracted to the wires and cling to them instead of to the ceiling. They can be cleaned off periodically with little labor and expense.

HARD VS. SOFT CAST IRON FOR MACHINE TOOLS

By ROBERT GRIMSHAW*

In the August, 1911, number of MACHINERY, the opinions of a number of German machine builders, relating to the use of hard vs. soft cast-iron ways for machine tools, were recorded. In the following are given the opinions of a number of well-known English and French builders of machine tools and general machinery.

Bradbury & Co., Ltd., makers of sewing machines, cycles, and tools for electricians, Oldham, say that in their experience they have found a coarse-grained cast iron to wear best.

Joseph Evans & Sons, makers of pumps and pumping machinery, Wolverhampton, say: "We consider that the argument on the part of the American contingent of machine builders as to the lubricant being retained in soft iron, is entirely a matter of 'begging the question.' The chief complaint with regard to American machine tools is that the metal they are made of is so soft that it wears rapidly. Some few years ago we had occasion to buy a number of American machine tools. In these the cast iron was so soft that the slides and beds wore rapidly, and so soft and weak was the metal that failures of numerous parts took place. For instance, when the jaws were screwed up, they pulled bodily out of the faceplate of the chucks. Portions of the slides on the saddle, and other parts also broke off, and these things happened though we were working very much under the rated capacity of the lathes for the amount of cut and speed that was guaranteed (or, rather, set forth) as the capacity of the lathes and tools in the catalogues. Our opinion is, therefore, that the harder the slides and wearing surfaces are, the better they are."

R. & W. Hawthorn, Leslie & Co., Ltd., engineers and shipbuilders, Newcastle-on-Tyne, consider hard cast iron to be the best for the purpose. "Soft metal is more porous, and, in addition to retaining the oil, it retains grit and foreign matter, and these form a grinding medium which produces rapid wear on the surfaces."

Alfred Herbert, Ltd., machine tool makers, Coventry, write: "We may say emphatically that we believe hard cast iron to be the best for the slides of machine tools. One of the chief causes of wear of such slides is the grinding-in of fine dust between the sliding surfaces, which must obviously wear the slides more if soft than if hard. Our own practice is to cast all beds from a very hard metal; the metal must be as hard as possible, only it must not be too hard to machine. All the bodies and beds of our machines are cast in dried sand molds, thoroughly baked before pouring."

John Lang & Sons, lathe manufacturers and special machine-tool makers, Johnstone, near Glasgow, say: "We have found that it is better to make lathe beds and other parts which are to be used as guides for a saddle or slide, of hard metal, and with as little porosity as possible. We find this tends to durability and accuracy of guides for carriages of lathes and the like."

Société Anonyme des Anciens Etablissements Panhard & Levassor, Paris, writes: "We are of the opinion that it is best to employ a soft quality of iron, especially for slowly moving parts; further, if we consider the various machines in the shops, we find that those of soft iron have less tendency to bind through friction, which proves that lubrication is better assured."

Les Fils de A. Piat & Cie, operating foundries and machine-shops in Paris and Soissons, say: "Our decided opinion is that the rubbing parts of the carriages of machine tools should be made of the hardest material possible; the cast iron should be very dense and also very homogeneous. When in use, the rubbing parts then become glazed and polished and acquire an exceptional hardness; as a result, the wear is less than with soft iron; and even if the lubrication should become less than would be desirable, the resulting inconvenience is less, because the coefficient of friction is lower. From another point of view, the use of a hard cast iron permits more readily the redressing of the surfaces by scraping, and a greater degree of accuracy can be retained. Other things being equal, and when the pressure per unit of surface is the only thing to be considered, hard iron surfaces can be less in area than soft ones, which diminishes the resistance due to adhesion and the power necessary to move the carriages."

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A. Ransome & Co., Ltd., engineers and iron founders, Stanley Works, Newark-on-Trent, say: "Our experience is that cast slides of hard quality wear infinitely better and remain true longer than those made of soft cast iron. We note that some manufacturers hold a contrary view, maintaining that when the iron is porous the lubricant remains longer between the rubbing surfaces. The fact that slides are made of hard material should present no difficulty with the lubrication if the machines are properly constructed with this end in view. We have a large number of machine tools in use at our works here, manufactured by British, Continental and American firms. There is a marked difference in the quality of the cast iron used by different makers, but in every instance where the machines are made of soft material, the wear on the working parts is more rapid and the machines require more frequent adjustment. Our rule with the goods we manufacture ourselves is to invariably make the iron castings of a material which is sufficiently hard to wear well without being too hard to machine economically."

Scriven & Co., machine tool makers, say: "It seems to us that the best wearing surface is to be obtained by the use of a hard, tough iron. So far as concerns soft guides remaining true for a long period, due to their porosity helping the lubricant to remain longer between the rubbing surfaces, we think this advantage is more than counterbalanced by the fact that this same porosity will insure grit also being kept longer between the rubbing surfaces, and will rather cause excess of wear than otherwise."

The management of the Société des Etablissements Singrün, Golbey (Vosges), is of the opinion that "hard cast iron is preferable to soft. If the oil can lodge in the pores of the soft material, grains of dust and sand can lodge there equally well, and cannot be removed—hence, rapid wear. In this connection we have not only our experience with various machine tools, but also with the journals of turbines, which resist wear only when of hard cast iron; and the harder it is the longer they last."

John I. Thorncroft & Co., Ltd., Southampton, say: "In our opinion a hard bed is an advantage, and has a longer life than a soft."

H. W. Ward & Co., Ltd., Birmingham, say: "We do not think that there can be the slightest doubt but what hard cast iron is the most durable. We note the ingenious suggestion of the supporters of soft cast iron, to the effect that being porous, it will retain the lubricant longer; but it is obvious that if it is sufficiently porous to retain the lubricant the pores will also absorb fine grit, and so cut the slides. As a matter of fact we do not think that there is any real difference between the oil-retaining qualities of hard and soft cast iron; and if the surfaces are properly lubricated, the harder guides will certainly wear the longer."

Thomas Shanks & Co., Union Iron Works, Johnstone, near Glasgow, say: "We do not believe a coarse-grained iron holds the lubricant any better, so as to result in a better wearing surface remaining longer true."

Messrs. Willans & Robinson, Ltd., Victoria Works, Rugby, say: "In our opinion a hard, close-grained iron, with properly designed lubricating arrangements, is preferable."

H. Bollinckx, builder of Corliss engines, etc., Brussels, says: "In our opinion, soft cast iron is the better, for we notice that our Flather and Reed lathes wear less in the guides than lathes from other countries, and we note that these latter are of a harder cast iron."

Ludwig Loewe & Co., of Berlin, have published a pamphlet on foundry work in which they say that American cast iron has better resisting qualities, especially in bending; that is, it bends more without breaking.

The La Seyne department of the Société Anonyme des Forges et Chantiers de la Méditerranée, ship builders, etc., say that of all the machine tools in their shops, those of hard iron have generally given better results than those of soft iron. The latter wear much more rapidly, despite liberal lubrication.

Vickers Limited, Sheffield, writes: "We think it is generally admitted in engine and machine construction, that two metal pieces rubbing together should be dissimilar in character; and that the most expensive part to replace should be the hardest. For the same reason, in the best work, shafts are made of hard steel, and the bearings of relatively soft white metal."

The Bateman Machine Tool Co., Ltd., Balm Road, Hunslet, Leeds, say: "Our experience prompts us to say that hard guides and slides are superior to soft ones. The suggestion about soft guides retaining the lubricant does not appeal to us. It is the duty of the tool-builder to see that the lubrication is efficient, whether he employs hard materials or soft. It may be argued that soft slides are more easily corrected than hard ones; but on the other hand hard slides remain reliable for much longer periods. In the event of a machine being allowed to wear seriously out of truth, it will probably be easier to restore to accuracy soft materials than hard ones, but this is a remote contingency, and does not interest the better class of machine-tool users. We find there is a general feeling amongst users of machine tools in favor of fairly hard slides; and in fact, much of the decline in general favor of American tools is ascribed to the soft metal. Furthermore, soft slides on a table (planer or milling machine table) necessarily imply soft T slots and general weakness and yielding when clamping work."

* * *

TESTING STEEL FOR GEARS

The requirements of the automobile makers in the gear line have caused many a sleepless night, and days of anxiety for those who have endeavored to make alloy-steel hardened and heat-treated gears to their satisfaction. A concern in the automobile zone of Michigan found, after one costly experience, that absolute knowledge of the chemical and physical characteristics of every bar of steel used in making gears was necessary. It has installed a chemical laboratory in which a sample from every bar is tested and a record made for future reference. That the practice pays is attested by the fact that the cost of the experience referred to would have paid the expenses of the laboratory and chemist for a year.

The company not only records the characteristics of all steel used in gears, but makes records of failures which occur in the shop or outside. The data thus being accumulated become of greater and greater value. The point to be fully understood and appreciated is that guesswork is reduced to a minimum by eliminating unknown factors. It is but another phase of what has come to be known as scientific management.

* * *

REMOVING SEIZED SCREWS

When a screw "seizes" in a casting the mechanic generally twists it off, sets up an "old man" and ratchet drill, laboriously drills out the core of the screw, carefully chips out the shell with a hammer and cape chisel, and taps out the thread to a larger size. In the shop of the Cleveland Planer Co., Cleveland, Ohio, a different and far more effective method is employed. When a screw twists off a small hole is drilled with an electric breast drill into the casting at right angles, if possible, or to other angles so as to reach the cavity under the point of the screw. The hole is filled with kerosene, which is left for a few minutes to work its way into the screw threads. The chips and dust that have been collected by the tight screw are quickly loosened so that the screw can be easily backed out. On heavy erecting work the saving of time as compared by the common method is important. Mr. Dornbirer says: "It never fails."

* * *

Upon the recommendation of the Bureau of Standards of the U. S. government, a number of the principal wire manufacturers have agreed to designate in the future the "American Steel & Wire Co.'s gage," which is the same as the "Washburn and Moen gage," by the name "steel wire gage." In cases where it may be necessary to distinguish this gage from the British wire gage it may be designated as the "United States steel wire gage."

THE FORMS OF LATHE BEDS—1

By JOSEPH G. HORNER[*]

THE SECTIONS OF BEDS

All the early lathe beds were made of wood. Engravings showing some of these wooden beds may be seen in old works on turning. They are to be found now only in some of the lathes used by wood-turners, and in some pattern-shops, although in the latter case, lathes with iron beds are now almost exclusively used. Fig. 1 shows a wooden lathe bed or stand. Different methods were used for attaching the bearers or shears to the uprights. At a very early date the wear of the top surfaces of the wooden bearers was prevented by screwing thin flat iron plates onto them. Strips of wrought iron were also fitted, having curved edges chipped and filed to shape, as shown in Fig. 2. There was not a great deal of durability in these shears, but the chief objection to this construction was that when the timber warped, as it was bound to do in the course of time, it pulled the iron strips with it, and threw the headstock, tailstock, and rest out of alignment.

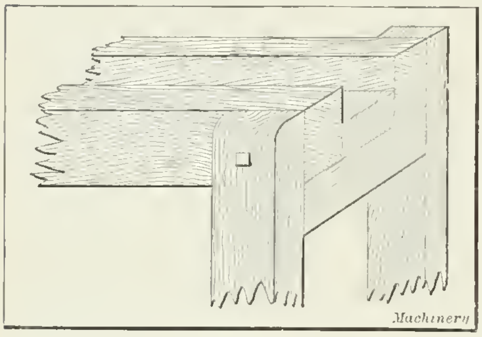

Fig. 1. A Common Type of Early Wooden Lathe Bed

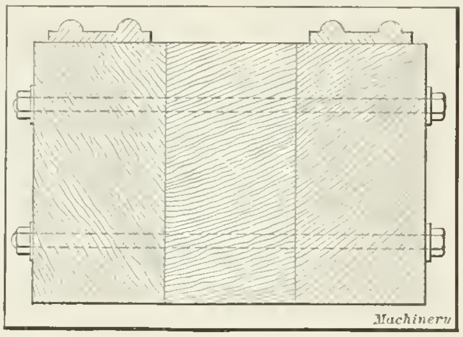

Fig. 2. Built-up Wooden Lathe Bed provided with Iron Ways

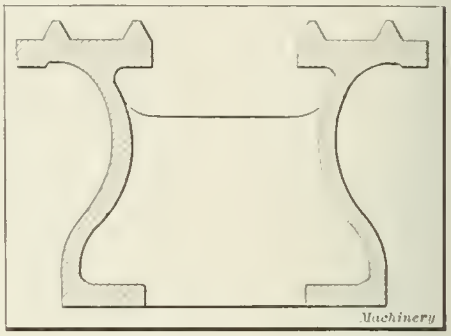

Fig. 3. Early Type of American Lathe Bed with Double Vee Guides

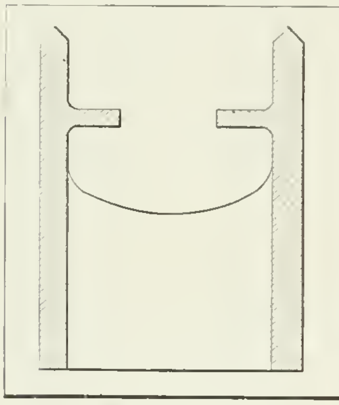

Fig. 4. Early Type of Lathe Bed with Double Vee

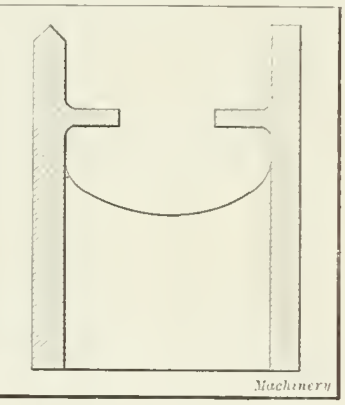

Fig. 5. An Early Lathe Bed with a Vee and a Flat Way

The first all-iron beds were of triangular section, the form probably originating with Henry Maudslay. A lathe designed by him at a date previous to 1800, now in the South Kensington Museum, was illustrated in MACHINERY for September, 1909, in an article entitled: "Chapters in the Early History of Machine Tools." The bed was built of two bars of triangular section, secured in brackets bolted onto the legs. There was a very good reason for the adoption of this form of bed in preference to any other. There were no planing machines at that period—in the latter part of the eighteenth century—so that it was an important consideration to be able to reduce the chipping and filing to a minimum on a single bar. Besides, if the two upper faces were true, it made no difference whether the bottom one was true or not, because there was clearance between it and the tailstock and rest.

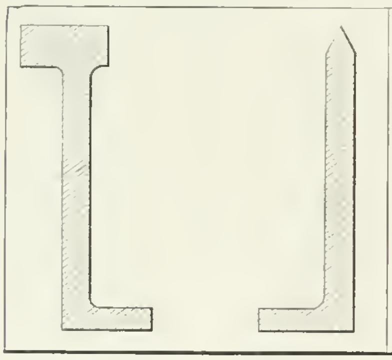

Fig. 6. Another Type of Lathe Bed with One Vee and One Broad Flat Shear

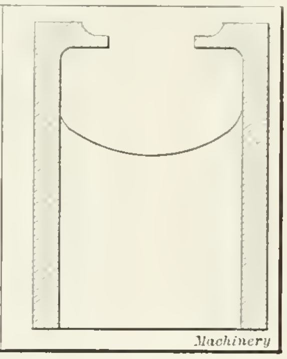

Fig. 7. Lathe Bed with Two Flat Ways

Lathe beds with a single shear of triangular section have often been built, although they are seldom seen now, except in the lathes used by watch- and clock-makers. These beds are sufficiently rigid for light duty, and chips do not lodge on them. The triangular-section lathe bed also possesses the virtue of insuring self-alignment of the tailstock and rest, which bear on the upper edges only. The essentials of the triangular bar section have been revived and perpetuated in the Pittler bed—referred to later—but in a modified and stronger, stiffer, and steadier form. The Pittler bed consists of a bar of trapezoidal section. The bar is hollow, and the lead-screw, passing through the hollow section, is thus protected. In some watchmakers' lathes, the essential features of the triangular bed are retained, but the lower side is of convex form. Some lathe beds are of cylindrical cross-section, either solid or hollow. All these types are simply variations of the single bar type, and are illustrated later in this article. Mention may also be made of square and rectangular beds, the latter being employed in a few of the peculiar French lathes used for screw making.

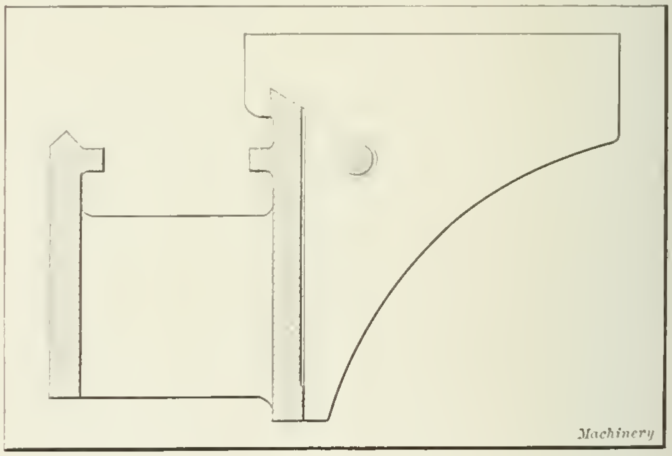

Fig. 8 Early Type of the Richard Roberts Lathe Bed with Front Slide

Early Development of Lathe Beds

Since a single triangular bed was not stiff enough to resist the torsional stresses of heavy cuts, which produce vibration and cause the bed to spring, an early development was that of using two deep parallel bars or beam sections, cast separately and bolted together. In the next stage the two bars were cast in one piece with connecting ribs. It was still, however, necessary to reduce the labor of chipping and filing to the least amount consistent with the practical requirements of the time; hence the form shown in Fig. 4, in which the top vees of the triangular bars were still retained, represented standard practice, with or without the internal stiffening ribs which were cast to increase the rigidity in the lateral direction. Then modifications of the design in Fig. 4 were introduced as shown in Fig. 5, where one vee is dispensed with, but the other retained for guidance. In Fig. 6, the width of the flat bearing surface is increased. This type of bed also made it easier than with two vees to fit the parts to a nicety. This construction is, for the same reason, employed instead of two vees in many lathes and grinding machines today. At last both bearing faces were made flat as shown in Fig. 7, and the longitudinal means for guidance offered by the vees was, therefore, abandoned. The lateral play was then prevented by making tenons on the heads fit between the edges of projecting internal ribs, as shown in Fig. 7. All finished surfaces were still kept narrow, however, until, after the invention of the planer, they developed into the present forms.

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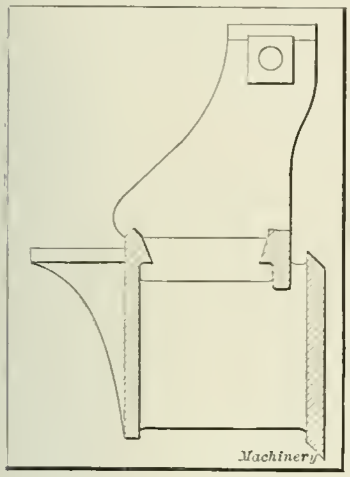

Fig. 9. Another Front Slide Lathe Bed

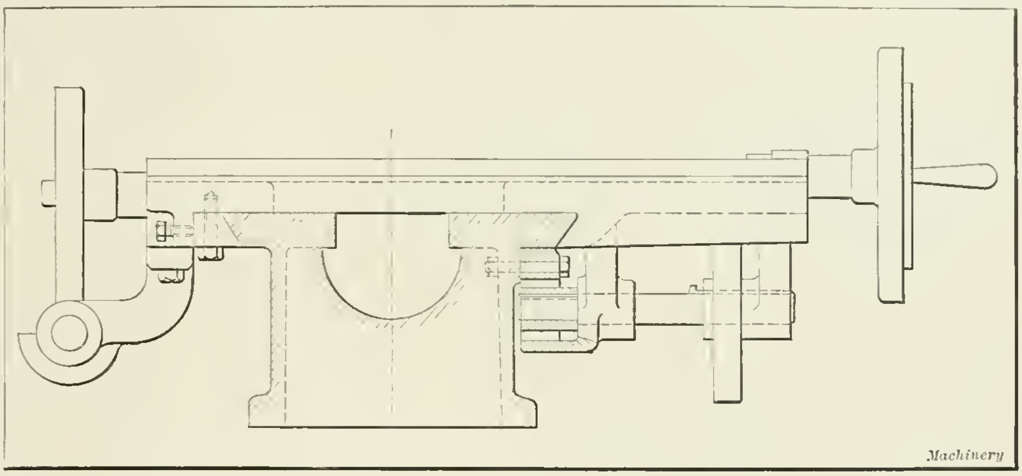

Fig. 10. An Ordinary English Type of Lathe Bed

As the slide-rest developed, the battle of the vees and flats became intensified. The older upstanding vees are still retained—with modifications—as the only guiding elements in standard American practice. At a comparatively recent date slight modifications have been made in some forms, in which a flat is combined with the vees; but the principal difference which exists even now is that of using either two or four distinct vee-ways. In the latter design, Fig. 3, the two inner vees guide the sliding tailstock, and the two outer ones, the carriage or saddle of the slide-rest. The inner vees are frequently sunk below the level of the outer ones to increase the swing of the lathe, and to enable a greater thickness of metal to be put into the carriage. Both vees are truncated or flattened more or less on the top. The type having two vees only, serving both for the carriage and the tailstock, is now chiefly used for the smaller classes of lathes.

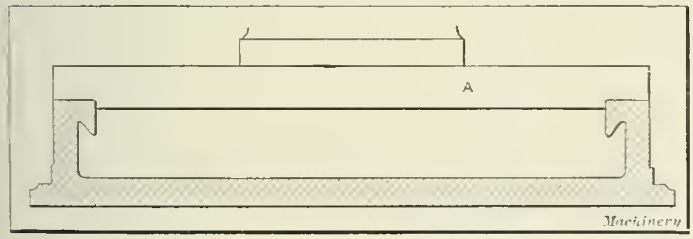

Fig. 11. Early Type of Bed for Heavy Lathes

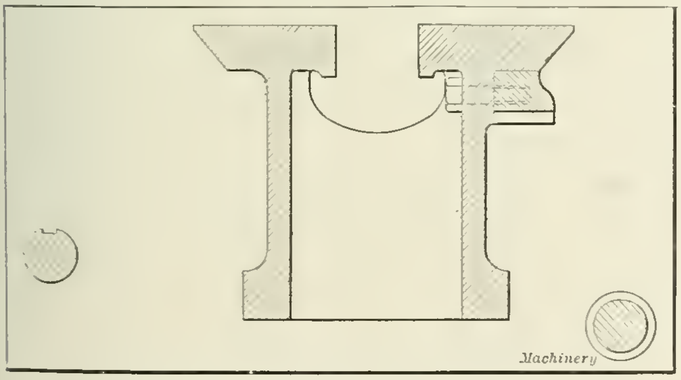

Fig. 12. Type of English Lathe Bed, Standard for a Long Period; Lead-screw and Feed-rod in Unsatisfactory Positions

In England, the vee-beds have been long since abandoned, except in a very few cases where an Anglo-American design is aimed at. The writer, however, remembers seeing some of the ancient lathes of that type, as shown in Fig. 4, and also in Figs. 5 and 6, still in use in the early years of his apprenticeship, and others which were at that time just being consigned to the scrap heap. The beds were extremely light in comparison with modern designs. The headstock pulleys were driven with ropes, not with belts. Both headstock and tailstock were very skeleton-like. The screw of the tailstock was not concealed in the barrel, but exposed. The largest of these lathes were, perhaps, of 24- or 28-inch swing, and the beds might have been twelve feet long.

Some of the early lathes with vees anticipated the modern forms of front-slide lathes. Figs. 8 and 9 illustrate beds of this type, as constructed by Richard Roberts, of Manchester, from about 1817 to 1820. They were probably the first of that type, and they do not differ essentially from modern lathes of a similar kind. In these illustrations two variations are shown. In one, dependence is placed on the guidance of one vee only, and the lower edge of the front slide bears against a plain face. In the other, a bottom vee is included, with a setting-up strip. Note in Fig. 9 that the centers of the heads are brought forward in front of the bed center. The remainder of the design is in harmony with the practice of that period.

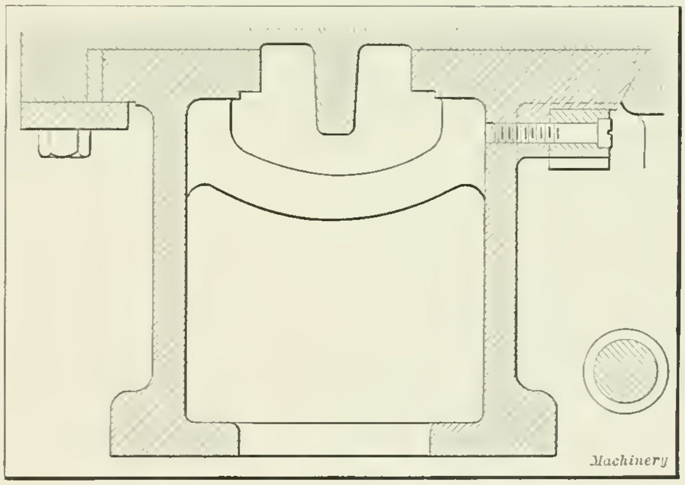

Fig. 13. Another English Lathe Bed of Standard Design

Fig. 11 illustrates the section of the bed of a large lathe which also was designed to perform the function of a boring mill; it was built by a Dundee firm before 1847. In this case the bed is very shallow, and its ways flat, with internal inverted vees. The plate A represents both the base of the tailstock and the carriage of the slide-rest. Hook-bolts embracing the vees and passing up through the plate, were used for clamping. In this machine, as in some others of that period, no power feed was available to the carriage, but only a hand traverse of the tool-holder. The carriage was adjusted by hand through a pinion and rack. In this lathe, the movements of the carriages of fifty years earlier were thus retained.

In the usual type of English lathe bed, Fig. 12, the vees are abandoned for ways having broader surfaces, and their place as guides is taken by the edges of the ways. The inner edges take care of the alignment of the headstock and tailstock, and the outer ones take care of the slide-rest or carriage. The outer guides may either both be in the form of vees, as in Figs. 10 and 12, or one may be square and one vee-shaped, as in Fig. 13. In some cases both edges may be square. These types have long been standardized, but there are many variations. It is from this starting point that we propose to consider the forms of lathe beds as they are designed today.

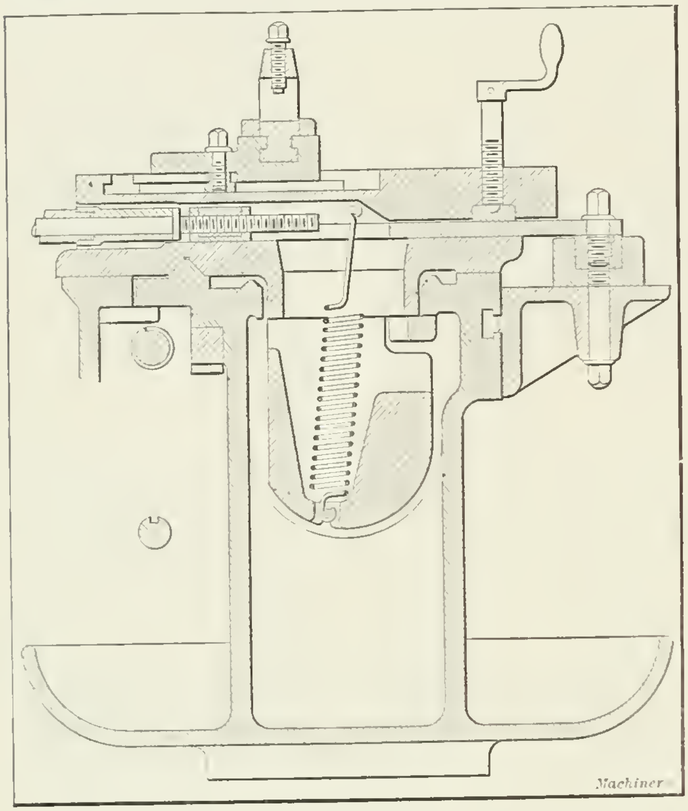

Fig. 14. Bed of Tool-room Lathe built by the Pratt & Whitney Co., Hartford, Conn.

Flat vs. V-shaped Lathe Shears

The transition from the upstanding vees to the flat ways has been a gradual one. The adoption of one flat with one vee, which dates a century back, has gone through various phases of development, besides those shown in previous illustrations. In America, an old type of bed by the Brown & Sharpe Mfg. Co. (who do not now make ordinary turning or "engine" lathes) was substituted for the beds with four vees. In this case the vee was employed for guidance, in conjunction with a suspended weight. The carriage was also gibbed on the square edge, which was situated at the back of the lathe. The Pratt & Whitney Co.'s tool-room lathe has a bed of the vee and flat type, as shown in Fig. 14. This design is also interesting because of the use made of a coiled spring in place of the suspended weight, which, through its inertia, is liable to cause vibration.

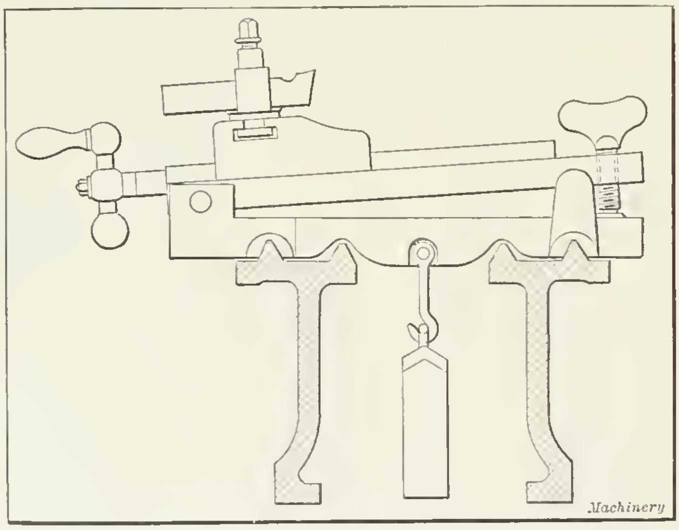

Fig. 15. Lathe Bed with Weighted Carriage

The battle between the vees and flats has given occasion to much fruitless controversy, since both types are retained tenaciously. There is much to be said in favor of the guiding qualities of an upstanding vee, and much also for the greater durability of a broad flat surface, and of the solidity of the carriage employed in conjunction with the latter. That these differences were recognized at an early period is evidenced by the frequent combination of a vee with a flat, and also by the use of two sets of vees, the outer set being reserved for the slide-rest or carriage. This not only divides the wear due to the movements of the tailstock and the carriage between two sets of vees, but also affords a broader base for the carriage, with corresponding gain in its stability. The self-aligning property of the vees is too obvious to require demonstration. In the flat beds self-alignment is absent. If the tenons of the tailstock wear, a loose fit results. In many lathes, however, provision is incorporated for clamping the tongue of the tailstock against the edge of one way only, thus not attempting to make a fit against the other. As a rule, the headstocks are then not fitted at all, but are adjusted by means of screws passing through the tenons.

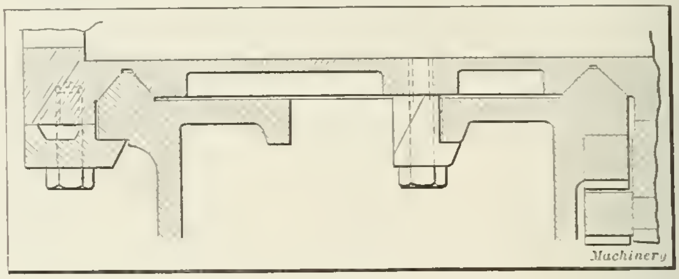

Fig. 16. Example of Gibbed Vee Bed

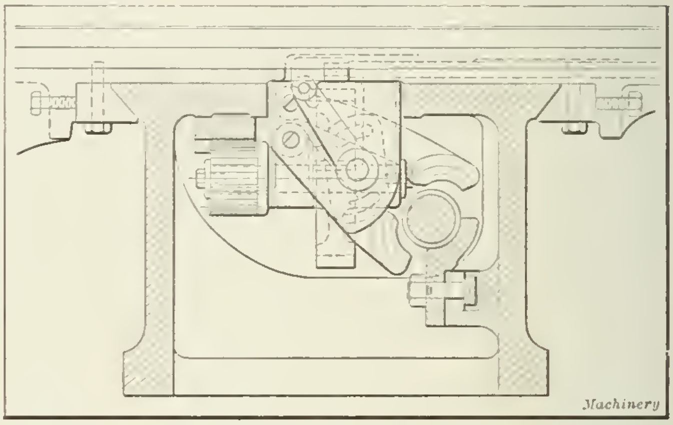

Fig. 17. The Whitworth Bed used in Lathes built by W. G. Armstrong, Whitworth & Co., Manchester, England

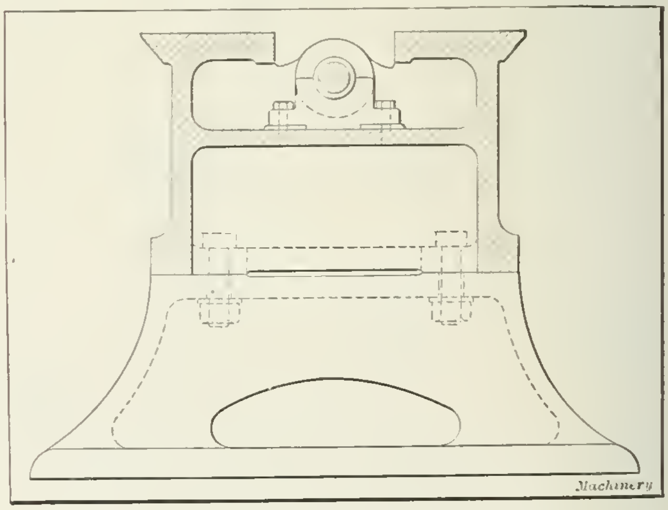

Fig. 18. A Whitworth Lathe Bed with a Central Lead-screw and Web

Though the wear on the vee-ways is uniform, they lack the advantage which the flat ways with vee-edges possess, namely, that of preventing the saddle of the slide-rest from being lifted during cutting. Hence all the early beds were commonly united only at the ends, leaving the entire length clear for a holding-down device. This frequently consisted of a center-weight suspended from the carriage, and traveling with it, as shown in Fig. 15. When increased duty was demanded, and the beds were tied together with cross-ribs, the suspended weight could not be used. Then clamping or gib-plates were introduced underneath the edges of the bed, as in those English designs which have square edges. Sometimes the gib or gibs are fitted underneath the internal edges. An example of this, taken from an Italian lathe, is shown in Fig. 16, where one gib strip is located on the under lip of the back shear, and another on the inner lip of the front shear, this arrangement being adopted because the construction of the carriage does not provide room for a strip at the front edge. Gibs bearing against both the inner and outer lips are also employed.

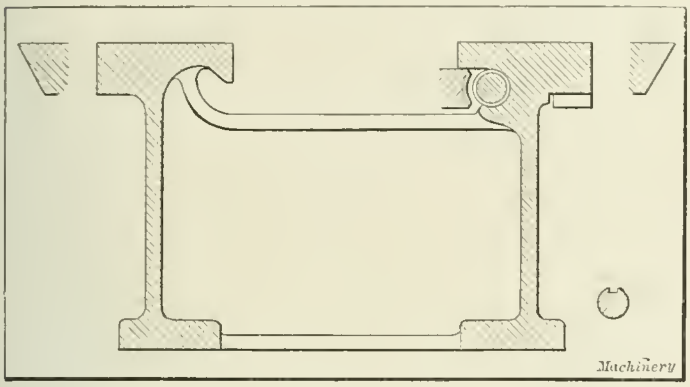

Fig. 19. A Type of Bed used in a Lathe built by Wm. Sellere & Co., Inc. Philadelphia, Pa.

The points in favor of vee-shears may be summarized as follows: The wear is uniform, and loose fits cannot develop as in flat ways with square edges; the chips fall off freely; the rapidity of the wear can be largely minimized by increasing the length of the carriage; and the clamping of the heads on the vees helps to tie the sides of the bed together and stiffen them. The risk of damage to the edges of the vees, which might be mentioned as an objection to vee-shears, can be lessened by rounding them. The arguments in favor of flat ways and against vees are briefly: Wear is so long delayed that little account need be taken of it; its effects can be counteracted by fitting the tenons of the tailstock to the edge of one shear, and as regards the saddle by the setting-up of the gibs; the elevation of the vees permits of less swing than do the flat ways.

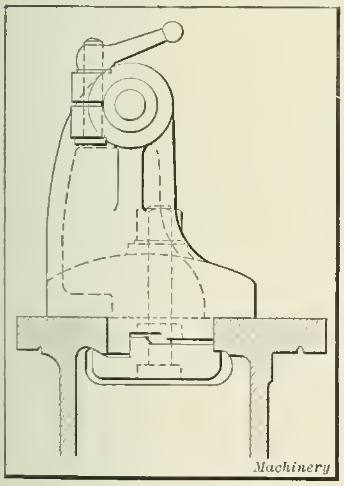

Fig. 20. Lathe with Inverted Vee for Clamping, built by G. Birch & Co., Manchester, England

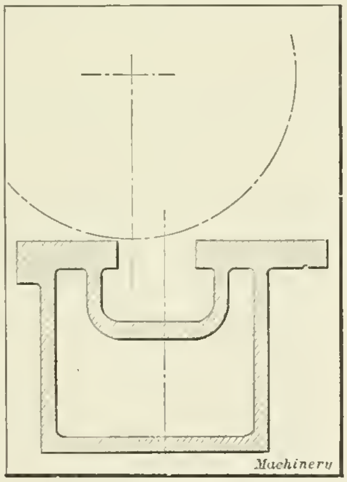

Fig. 21. Closed Box Lathe Bed of a Type Manufactured by Thomas Ryder & Son, Bolton, England

Location of Lead-screw and Feed-rod

Inseparable from the design of the bed sections are the problems of the location of the lead-screw and feed-rod. It is an interesting fact that the old eighteenth-century lathe of Maudslay's has the lead-screw enclosed within the shears of the bed, thus anticipating the Whitworth design of nearly half a century later. The Whitworth bed, with the location of the lead-screw, is shown in Fig. 17. In this the divided clasp-nut is retained, operated by cam plate and levers through pulling or pushing a rod which passes to the front of the saddle. The supporting bearings for part of the circumference of the lead-screw should be noted. The position of the rack is not always as shown; frequently it is placed at the front of the bed. Fig. 18 shows a special Whitworth bed having the lead-screw placed exactly in the center, supported around nearly half its circumference by bearings located at intervals.

Several firms manufacture lathes with lead-screws protected in various ways. In standard English practice the lead-screw has long been placed outside at the front, and the feed-rod or "back-shaft" outside at the back. (See Fig. 12.) As a result of the influence of American practice many lathes are now built with lead-screw and feed-rod both in front and close together, and both with the rack traverse operated by gears enclosed in an apron. This is in harmony with the idea of obtaining the motion required for screw cutting and feed from a gear box on the bed in front of the headstock; it also permits a more compact arrangement of the carriage. It may be stated as a general rule that the best English makers now place the feed-rod in front in preference to placing it at the back, and there seems to be no doubt but that in a short time the old "back-shaft" will disappear.

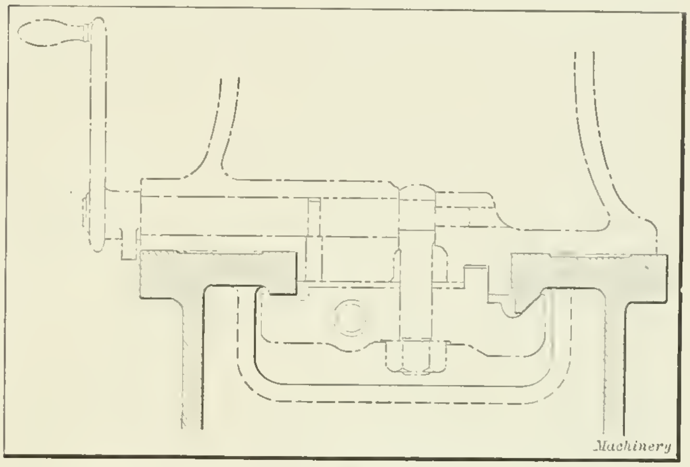

Fig. 22. Inverted Vee Lathe Bed for Clamping Turret Base, made by De Fries & Co., Dusseldorf, Germany

Development of the Sellers Lathe Bed

The section of a bed used in lathes built by Messrs. William Sellers & Co., Inc., as shown in Fig. 19, illustrates the transitional form which under different modifications appears in many lathe beds of the present day. The vee-sections at the sides in the illustration represent the earlier, and the central portion, the later type. The earlier design is similar to the standard English bed, in so far as the fitting of the sliding parts to flat ways and vee-edges at front and back is concerned; but the lead-screw is protected under the front shear in a recess provided specially for it. An inverted vee underneath the back shear is used to clamp the tenon of the tailstock against the vertical edge of the back shear, instead

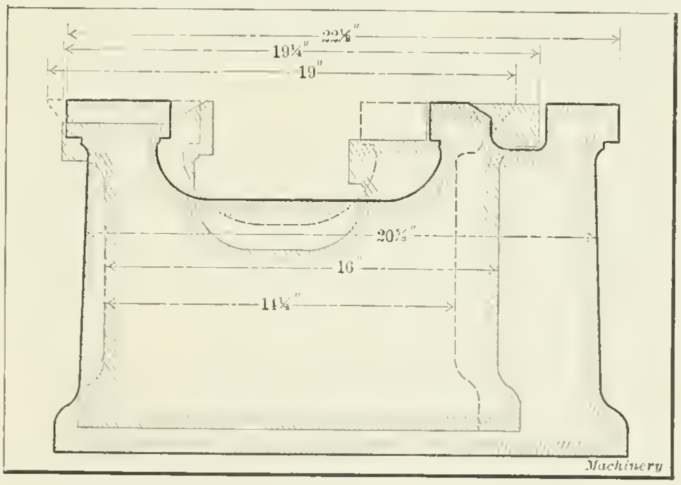

Fig. 23. The Evolution of the Lang Bed

of trying to make its tenon fit between both shears permanently, which is not practicable. Messrs. Sellers & Co. adopted this method in order to retain the same advantage of alignment (notwithstanding wear of the tenon or tongue of the tailstock) as is secured by the use of vee-ways, thereby taking advantage of the durability of the flat ways without suffering from the disadvantage due to the wear of the tenons.

The experience with the beds having vee-edges at front and back, as shown at the sides in Fig. 19 demonstrated that almost the only wear which occurred took place on the top faces, and not on the beveled edges; hence the abandonment of the vees in favor of square edges which maintain the traverse of the carriage parallel with the axis of the live and tailstock spindles, while the inverted vee maintains the tailstock spindle in alignment with the live spindle. The later type, therefore, provides for the permanent retention of the accuracy imparted to the lathe when new, and also provides for the protection of the lead-screw. The advantages of this design have been recognized, and it has been imitated in numerous later lathes.

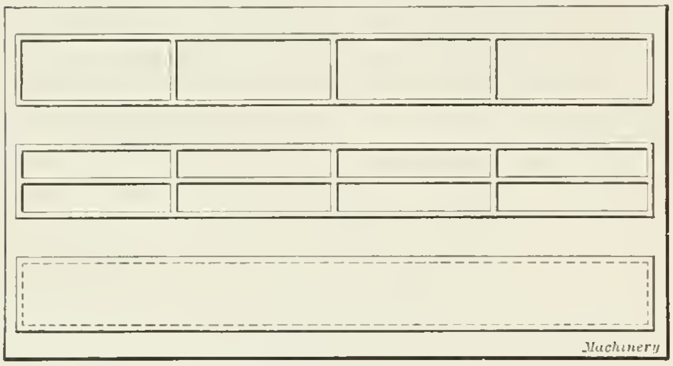

Fig. 24. Experimental Beds investigated by Prof. Sweet

The protection afforded to the lead-screw is so important a matter that many devices for this purpose have been adopted since the time when Whitworth placed it within, instead of outside, the shears. The Sellers' design embodies a decided improvement, for in it the lead-screw is supported along its entire length by the recess which is provided for it, and, therefore, it cannot be deflected. But the half-nut is single, and only extends around a rather small arc of the circle. These Sellers' beds also were among the first American make which embodied the use of cross-ribs.

Two examples of the employment of the inverted vee are seen in Figs. 20 and 22, the first showing the arrangement of the clamping plate in relation to the tailstock tongue, and the second a somewhat similar construction on a German chucking lathe. The base of the turret in this latter case is always pulled over toward the inner edge by the action of the clamping plate, which is pulled upwards by means of an eccentric bolt and lever.

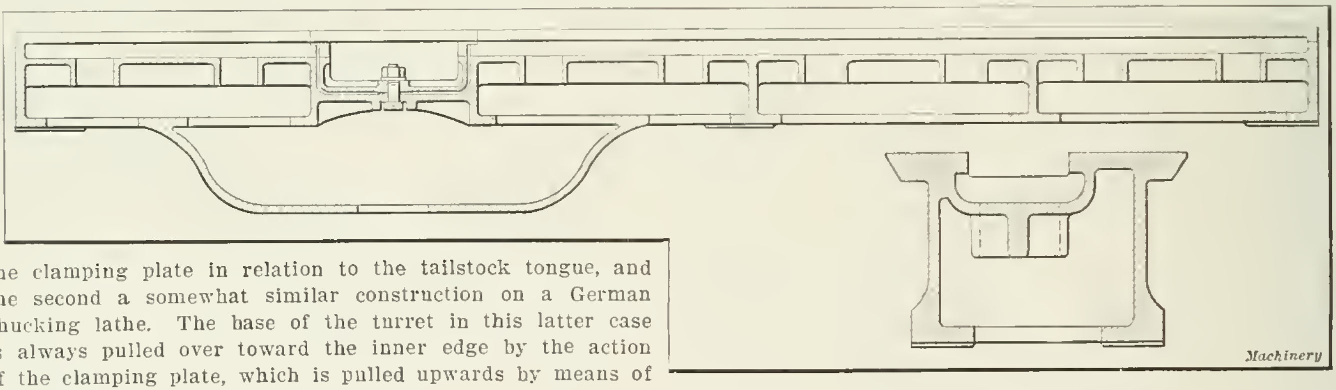

Fig. 25. The Richards Box Bed

Strength of Lathe Beds

Another development is that of the stiffening and strengthening of lathe beds. All the old types were mere skeletons, although some of them were stiffened laterally as shown, with ribs placed internally or externally. Gradually, the thickness of the metal was increased, and the ways widened; fillets were cast along the bottom edges in addition to the cross-ribs. Many of the American beds were of a highly molded section, as shown in Fig. 3, with the object of imparting stiffness chiefly in the lateral direction, and so help to compensate for the absence of cross-ribs.

Lathe beds must always be made much stronger than they would have to be in order to merely prevent fracture. The stresses to be resisted are in the first place flexure; but it is fully as important that the design be stiff enough and heavy enough to resist the tendency to torsion and to vibration—to chattering. The massing of the metal may solve the problem, but it must be done judiciously. Flexure may be met by increasing the depth, because the strength increases as the square of the depth. Torsion is more difficult to prevent, while resistance to vibration demands a mass of metal obtained only by considerably increasing the dimensions which are required to prevent flexure and torsion. Experiments have been undertaken at various times from which certain broad deductions have been made; but lathe beds are, notwithstanding, mainly evolved from previous practical experience. Although the general movement has been going on for a century, this evolution has been especially noteworthy since the advent of high-speed steel.

The flexure of a lathe bed is more than allowed for by the proportions given to it for general strength. A very light bed might possibly be bent by the placing of a very heavy piece of work between the centers, or by the stress of heavy cutting near the center of the bed. In some American beds the standards or legs have been set a certain distance inwards from the ends in order to shorten the length of the unsupported portion. Sometimes the beds are cambered or fish-bellied; long beds have legs in addition to those at the ends; or in heavy lathes, the bed is continuous and rests on foundations located at intervals. An unsupported length which will not bend, provided the bed is of a box section, is given by Mr. Richards as one which is not more than twelve times its depth.

An interesting example of the gradual increase in bed dimensions for one size of lathe is shown in Fig. 23. This engraving illustrates the evolution of the lathe bed of Messrs. John Lang & Sons, of Johnstone, Scotland. The ordinary English type is seen in dotted outline; this type was employed by the firm previous to 1900. The thin full lines show the first narrow guide type of bed of 1900, and the thick full lines the present type.

Lathe Beds of Box Section

Torsion can be best avoided, as far as the shape of the bed is concerned, by making it of a box section. Comparatively few lathe beds are, however, constructed in that manner, the general design being that of two shears connected by cross-bars or ribs, thus leaving the top and bottom edges unconnected. That this is a poor design is admitted, but it is one which is more easily molded than a box shape. Long ago Prof. Sweet had some castings made for a test, as indicated in Fig. 24. These castings represent, respectively, the open-frame and the box type of beds, with the same amount of metal in each. The box casting proved much stiffer laterally, and thirteen times more rigid against torsion.

Several firms now construct beds which are wholly or partially boxed. It is, of course, necessary to leave some provision in the form of openings for the escape of chips and oil. Messrs. George Richards & Co., Ltd., of Manchester, England, though they have now given up the manufacture of ordinary lathes, were in the field when this departure was made. Their first lathe beds were made as shown in Fig. 25. The beds were practically encased along the top, and well tied to the cross-ribs along the bottom with broad flanges. Holes cast in the top casing permitted the chips to fall through. The holes were surrounded by a rib to prevent loss of strength due to the cutting of the holes. Otherwise, in its general design, the bed is of ordinary English type, with flat ways, vee-edges, and a gap.

In Fig. 21 is shown a section of the beds of the lathes manufactured by Messrs. Thos. Ryder & Son, of Bolton, England. These beds are of solid box section. In this design the practice of bringing the lathe centers considerably behind the center of the bed is adopted, in order to afford additional support to the cutting tool when turning large diameters. The depth of the rear guide strip of the bed is also deepened to increase its durability.

Dr. Nicolson has stated that if the same amount of metal put into the ordinary beds were put into the box-shaped or the circular form, these types would be from six to ten times as strong to resist twisting. This is not so high an estimate as that given many years ago by Prof. Sweet, but it is amply high enough to justify that departure from the old practice which several lathe makers now have adopted. The solid box form is practicable, and easily manufactured; but the circular form is not, except in light lathes, such as those used by watch- and clock-makers, amateurs, and scientific workers. For such purposes, several examples of this type are built. The circular bed must have a longitudinal guide or guides for the headstock and slide-rest or carriage, and it is here that the difficulty arises in massive designs. In fact, for heavy designs, the circular bed may be dismissed as nearly impracticable, or/at least undesirable, in face of the fact that boxed beds of rectangular section can be and are constructed better and more cheaply, and of equal strength.

* * *

TWO-STAGE AIR CYLINDERS*†

PRESSURES AT WHICH WORK IS EQUAL IN EACH CYLINDER

By J. WILLIAM JONES‡

Until about ten years ago the average terminal gage air pressure required of an air compressor did not exceed seventy or eighty pounds per square inch; consequently single-stage compression was almost universally employed. The use of higher pressures in compressed air service brought about the employment of stage compression which has proved to be more economical and practical for all pressures exceeding seventy pounds per square inch. It is safe to state that about eighty to ninety per cent of all the compressors sold in this country during the past five years have what is called compound or two-stage air cylinders. The majority of these were probably built for discharge pressures of about one hundred pounds per square inch, but there seems to be no uniformity among the users of compressed air as to what constitutes a standard pressure for a certain line of work.

The different purposes for which compressed air is utilized, naturally demand various discharge pressures. The constantly increasing application of compressed air to the numerous purposes for which it is adapted at the present day requires air pressures in two-stage machines varying all the way from seventy to five hundred pounds per square inch. Where one shop uses eighty pounds pressure per square inch for the operation of pneumatic tools it will be found that another uses ninety pounds, and still another one hundred pounds; one contractor will want to carry a line pressure of one hundred pounds for operating his rock drills and another will insist that he must carry one hundred and ten pounds. In the oil fields, for pumping oil, pressures ranging all the way from one hundred and fifty pounds up to five hundred pounds are required. New fields requiring higher pressures than those used heretofore for the ordinary lines of work for which compressed air has been the chief motive power are constantly presenting themselves.

In perusing the catalogues of the larger builders of compressed air machinery, it will be noted that they are now listing medium duty and high duty compressor sizes, the former having the cylinders proportioned correctly for pressures ranging from eighty to one hundred pounds and the latter for pressures ranging from one hundred to one hundred and twenty-five pounds. In addition to the above they carry a line of cylinder sizes which can be readily applied to the various compressor types for pressures ranging all the way from one hundred and fifty to five hundred pounds per square inch.

To know just what compound cylinder combination should be used for a specified terminal gage air pressure, requires some knowledge of the theory of air compression as well as a somewhat complicated arithmetical computation. The theory is not always easily remembered and errors are liable to occur in making lengthy computations. The accompanying Data Sheet Supplement solves the problems at a glance, requiring no knowledge of the theory of compression and no computations whatever.

Referring to Sheet I, the curves of which have been plotted for sea level conditions, let it be assumed that it is desired to know at what terminal gage air pressure the total work will be equally divided between two compound air cylinders of certain dimensions. Assuming that the compressor has a low pressure air cylinder twenty inches diameter and a high pressure cylinder ten inches diameter, the stroke being common to both cylinders, the low pressure cylinder diameter, twenty inches, will be found along the left-hand margin. Now projecting this point along the horizontal line in the direction shown by the arrow until the dotted line intersects with the curved line marked ten inches, and thence in a vertical direction until the upper margin is reached, the answer is found which in this case is two hundred twenty pounds per square inch; that is, an air compressor having a low pressure cylinder twenty inches diameter and a high pressure ten inches diameter with the stroke the same in both cylinders will have the total horsepower equally divided between the two cylinders when compressing to a final gage discharge pressure of two hundred twenty pounds per square inch, assuming the initial temperature to be the same in each cylinder which is equal to perfect intercooling between the two stages.

On the other hand, if it is desired to know what cylinder combination should be used for a specified terminal pressure, it is only necessary to first compute the diameter and stroke of the low pressure cylinder in relation to the desired piston displacement and then, starting at the upper border line at the required discharge pressure and at the left-hand border line at the correct low pressure cylinder diameter, note near what high pressure cylinder curve these two points cross when projected towards the curves. The above rules apply for any cylinder combination which the charts show and on any one of the three charts which have the curves plotted for sea level, five thousand and ten thousand feet altitude, respectively.

The formula for determining the final gage air pressure per square inch of any two-stage compressor in order to have the total horsepower required divided equally in each cylinder, is as follows:

$$P_3 = \left[\left(\frac{D^2}{d^2} \right)^2 \times P \right] - P$$

in which

P = atmospheric pressure in pounds per square inch.
P_3 = terminal gage air pressure in pounds per square inch.
D = diameter of low pressure air cylinder in inches.
d = diameter of high pressure air cylinder in inches.

Example: Having a low pressure cylinder 20 inches diameter and a high pressure cylinder 10 inches diameter, it is required to find the terminal gage air pressure per square inch (P_3) at which the work is equal in each cylinder at sea level; the atmospheric pressure being 14.7 pounds per square inch.

$$P_3 = \left[\left(\frac{20^2}{10^2} \right)^2 \times 14.7 \right] - 14.7 = 220.5 \text{ pounds.}$$

In the accompanying table are given the values of $\frac{D^2}{d^2}$ for various gage pressures from 75 to 500 pounds inclusive. This information is of value in computing cylinder sizes when the terminal gage air pressure is a settled fact. The diameter and stroke of the low pressure cylinder having been first determined relative to the required piston displacement, the diameter of the high pressure piston required to divide the load equally between the two cylinders is found by dividing the factor opposite the known gage discharge pressure into the area of the low pressure piston, to obtain the area of the high pressure. For 200 pounds final discharge pressure at 5000 feet altitude, the factor in the table is found to be 4.17. Assuming that a 25-inch diameter low pressure cylinder is required to give the necessary piston displacement, the area of the high pressure cylinder would be equal to the area of the low pressure, or 490.87 square inches, divided by 4.17 which gives a high pressure cylinder having an area of 117.6 square inches. This area is equal to a diameter of approximately 12¼ inches.

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* With Data Sheet Supplement.

† The following articles on this and kindred subjects have previously been published in MACHINERY: June, 1911, engineering edition, "Air Compressor Design"; December, 1910, engineering edition. "Horsepower required to Compress Air"; August, 1910, engineering edition, "High-pressure Cylinder Diameters for Air Compressors"; March, 1910, engineering edition, "Air Compressor Testing"; November, 1909, engineering edition, "Compressor Designing—The Distribution of the Load." See also MACHINERY'S Data Sheets No. 133, "High-pressure Cylinder Diameters for Air Compressors"; and No. 137, "Horsepower required to Compress Air."

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In theory the cylinders should be proportioned exactly in accordance with the above, all of which is based on the assumption that the intercooler reduces the temperature of the air to the original between the two stages. The intercoolers of the present day, however, can not be relied upon to do this, which means that, with the cylinders proportioned as above stated, the low pressure or intake cylinder would be required to do more than its share of the work due to the higher mean pressure in the cooler, on account of the thermal conditions not being perfect. It is, therefore, good practice to make the high pressure cylinder diameter a little in excess of the actual figures which the theoretical conditions show; that is, if the computation for the high pressure cylinder should result in a diameter of 9½ inches it would be good practice to call this diameter 10 inches.

Although the rules already mentioned are theoretically correct, it is possible to vary the proportions of the cylinders to some extent for any specified pressure without unbalancing the work to any appreciable amount. To show the actual relations between the horsepower, etc., in the two cylinders, the curves in the accompanying chart have been plotted. These curves show the theoretical horsepower required in either the high or low pressure cylinder when compressing to 100 pounds terminal gage pressure with different cylinder ratios. Also a curve for this pressure has been plotted showing the combined horsepower of the two cylinders with these different cylinder ratios. It will be noticed that the minimum horsepower is required when the ratio of compression is the same in both high and low pressure cylinders. In this case the ratio of compression should be 2.79, which requires 7.72 horsepower in each cylinder when compressing 100 cubic feet of free air per minute to 100 pounds gage pressure, or the minimum total of 15.44 horsepower in the two cylinders. This ratio of compression when the same in both cylinders, is also the theoretical ratio of cylinder volumes. The values $\frac{D^2}{d^2}$ already referred to in the accompanying table, are nothing more nor less than the correct cylinder ratios for the pressures listed and at the different altitudes specified in this table.

VALUES OF $\frac{D^2}{d^2}$ (CYLINDER RATIOS) COMPOUND AIR CYLINDERS

Initial Temperature in Both Cylinders 60° F.

Gage Pressure, Pounds	Sea Level	5000 Feet	10,000 Feet	Gage Pressure, Pounds	Sea Level	5000 Feet	10,000 Feet
75	2.47	2.67	2.91	185	3.69	4.01	4.41
80	2.54	2.74	2.99	190	3.73	4.06	4.46
85	2.60	2.82	3.08	195	3.77	4.11	4.52
90	2.67	2.89	3.16	200	3.82	4.17	4.57
95	2.73	2.96	3.24	210	3.91	4.26	4.68
100	2.79	3.03	3.31	220	3.99	4.36	4.78
105	2.85	3.09	3.39	230	4.07	4.45	4.89
110	2.91	3.16	3.46	240	4.15	4.54	4.99
115	2.97	3.22	3.53	250	4.23	4.63	5.08
120	3.02	3.29	3.60	260	4.32	4.72	5.18
125	3.08	3.35	3.66	270	4.39	4.81	5.28
130	3.14	3.41	3.74	280	4.47	4.89	5.37
135	3.19	3.47	3.81	290	4.54	4.97	5.46
140	3.24	3.52	3.87	300	4.62	5.06	5.56
145	3.29	3.58	3.93	325	4.80	5.25	5.77
150	3.35	3.65	3.99	350	4.98	5.44	5.98
155	3.40	3.70	4.06	375	5.14	5.62	6.18
160	3.45	3.75	4.12	400	5.30	5.80	6.38
165	3.50	3.80	4.18	425	5.46	5.98	6.57
170	3.55	3.86	4.24	450	5.62	6.15	6.75
175	3.59	3.92	4.30	475	5.77	6.31	6.94
180	3.64	3.97	4.36	500	5.92	6.48	7.12

D = diameter low pressure air cylinder.
d = diameter high pressure air cylinder.
Atmospheric pressure at sea level = 14.7 pounds per square inch.
Atmospheric pressure at 5000 feet = 12.2 pounds per square inch.
Atmospheric pressure at 10,000 feet = 10.07 pounds per square inch.

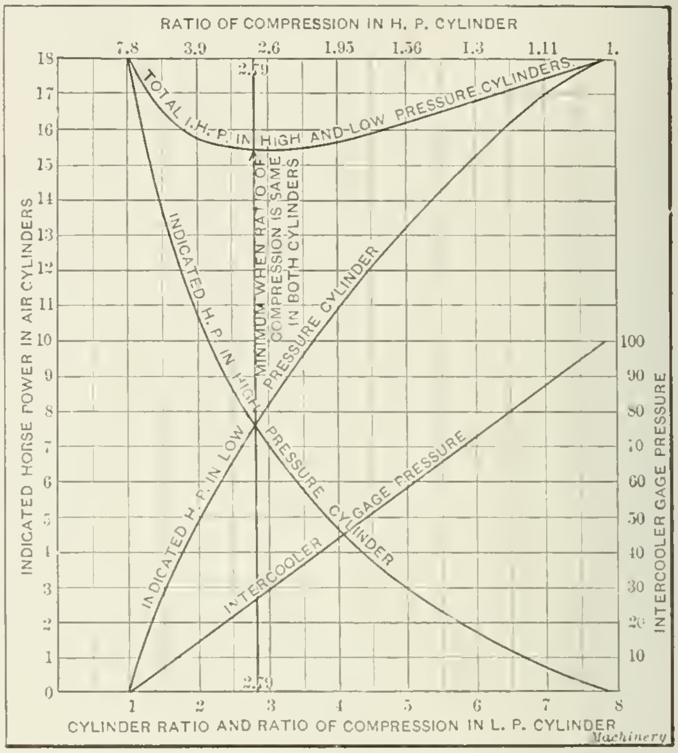

Chart showing the Horsepower required in Two-stage Air Cylindere with Different Cylinder Ratios when Compressing 100 Cubic Feet Free Air per Minute to 100 Pounds Gage Pressure at Sea Level

In observing the curve showing the total horsepower in the chart it will be noted that it is very flat at the point of minimum horsepower. This means that it is possible to vary the cylinder ratio to a greater or less degree than the theoretical conditions shown without affecting the total horsepower to any great degree. A safe figure would be about ten per cent above or below the theoretical, preferably below for the reasons already assigned to imperfect intercooling. A good rule for compressors delivering air at 100 pounds gage pressure is to make the area of the low pressure piston two and one-half times the area of the high pressure.

The intercooler pressure naturally varies according to the cylinder ratio; to show these pressures, a curve for the different cylinder ratios has been included.

* * *

WHEELBARROW AND TRUCK SPRINGS

The idea of fitting springs to a wheelbarrow may seem novel and ridiculous, but it is neither new nor unsound. A springless vehicle draws or pushes harder than if provided with springs, the reason being that the load must be lifted instantly whenever the wheels roll over obstructions. If the load is spring-supported the wheels roll over obstructions and transmit the impulse through the springs to the load, but not instantly. The time element reduces the peak of the traction load which is important in its influence on the endurance of the muscular system of men or horses. Wheelbarrows with springs were made by local wheelwrights years ago, but the modern contractor prefers to buy a cheap wooden affair costing a dollar-and-a-quarter to paying fifty cents more and getting a barrow that might increase the efficiency of his labor ten per cent. The increase of efficiency of laborers and the reduction of jar is particularly noticeable in the use of warehouse and factory hand trucks provided with springs.

DOUBLE-ANGLE COLUMNS*

By EDMUND B. LA SALLE†

A common type of column used for supporting water tanks is that built up of two angles, apex to apex, tied together at various points by a plate or angle, four such built-up columns being used to support the tank. These double-angle columns make a very simple construction, for but little shop work is required. Not only are they used for elevated water-tank construction, but they are also equally well adapted to numerous lines of general structural work.

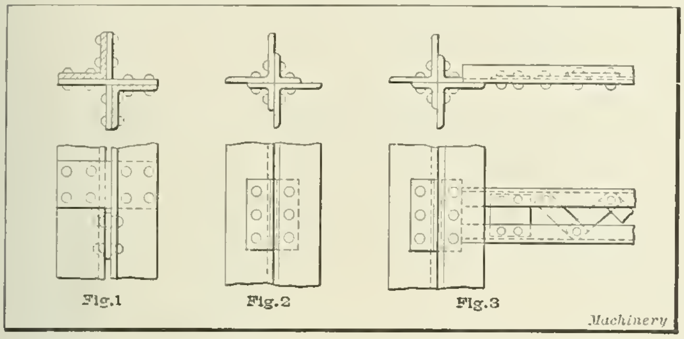

Fig. 1. Cross-plate Tie for Double-angle Column. Fig. 2. Angle Tie for Double-angle Column. Fig. 3. Method of Butting Struts to Angle Tie on Double-angle Column

The two angles of a column are tied together, as indicated in Fig. 1, by two short cross-plates riveted to the angles, or as illustrated in Fig. 2, by two short pieces of angle about half the size of those used in the column. These ties are located from two to four feet apart, depending on the size of the angles to be tied together.

The cross-struts between the members are located a distance apart depending upon the size of angles and the method of tying; these two factors determine the radius of gyration. The table in the Data Sheet Supplement, "Properties of Double Angle Columns," gives all the data necessary to determine the size of angles for a given strut spacing, or *vice versa*.

UNIT STRENGTH COLUMNS

$17100 - 57\frac{L}{R}$								$16000 - 70\frac{L}{R}$											
$\frac{L}{R}$	Str'gth	$\frac{L}{R}$	Str'gth	$\frac{L}{R}$	Str'gth	$\frac{L}{R}$	Str'gth	$\frac{L}{R}$	Str'gth	$\frac{L}{R}$	Str'gth	$\frac{L}{R}$	Str'gth	$\frac{L}{R}$	Str'gth	$\frac{L}{R}$	Str'gth	$\frac{L}{R}$	Str'gth
91	11913	121	10203	151	8493	181	6783	41	13130	71	11030	101	8930	131	6830	161	4730	191	2630
92	11856	122	10146	152	8436	182	6726	42	13060	72	10960	102	8860	132	6760	162	4660	192	2560
93	11799	123	10089	153	8379	183	6669	43	12990	73	10890	103	8790	133	6690	163	4590	193	2490
94	11742	124	10032	154	8322	184	6612	44	12920	74	10820	104	8720	134	6620	164	4520	194	2420
95	11685	125	9975	155	8265	185	6555	45	12850	75	10750	105	8650	135	6550	165	4450	195	2350
96	11628	126	9918	156	8208	186	6498	46	12780	76	10680	106	8580	136	6480	166	4380	196	2280
97	11571	127	9861	157	8151	187	6441	47	12710	77	10610	107	8510	137	6410	167	4310	197	2210
98	11514	128	9804	158	8094	188	6384	48	12640	78	10540	108	8440	138	6340	168	4240	198	2140
99	11457	129	9747	159	8037	189	6327	49	12570	79	10470	109	8370	139	6270	169	4170	199	2070
100	11400	130	9690	160	7980	190	6270	50	12500	80	10400	110	8300	140	6200	170	4100	200	2000
101	11343	131	9633	161	7923	191	6213	51	12430	81	10330	111	8230	141	6130	171	4030	201	1930
102	11286	132	9576	162	7866	192	6156	52	12360	82	10260	112	8160	142	6060	172	3960	202	1860
103	11229	133	9519	163	7809	193	6099	53	12290	83	10190	113	8090	143	5990	173	3890	203	1790
104	11172	134	9462	164	7752	194	6042	54	12220	84	10120	114	8020	144	5920	174	3820	204	1720
105	11115	135	9405	165	7695	195	5985	55	12150	85	10050	115	7950	145	5850	175	3750	205	1650
106	11058	136	9348	166	7638	196	5928	56	12080	86	9980	116	7880	146	5780	176	3680	206	1580
107	11001	137	9291	167	7581	197	5871	57	12010	87	9910	117	7810	147	5710	177	3610	207	1510
108	10994	138	9234	168	7524	198	5814	58	11940	88	9840	118	7740	148	5640	178	3540	208	1440
109	10887	139	9177	169	7467	199	5757	59	11870	89	9770	119	7670	149	5570	179	3470	209	1370
110	10830	140	9120	170	7410	200	5700	60	11800	90	9700	120	7600	150	5500	180	3400	210	1300
111	10773	141	9063	171	7353	201	5643	61	11730	91	9630	121	7530	151	5430	181	3330	211	1230
112	10716	142	9006	172	7296	202	5586	62	11660	92	9560	122	7460	152	5360	182	3260	212	1160
113	10659	143	8949	173	7239	203	5529	63	11590	93	9490	123	7390	153	5290	183	3190	213	1090
114	10602	144	8892	174	7182	204	5472	64	11520	94	9420	124	7320	154	5220	184	3120	214	1020
115	10545	145	8835	175	7125	205	5415	65	11450	95	9350	125	7250	155	5150	185	3050	215	950
116	10488	146	8778	176	7068	206	5358	66	11380	96	9280	126	7180	156	5080	186	2980	216	880
117	10431	147	8721	177	7011	207	5301	67	11310	97	9210	127	7110	157	5010	187	2910	217	810
118	10374	148	8664	178	6954	208	5244	68	11240	98	9140	128	7040	158	4940	188	2840	218	740
119	10317	149	8607	179	6897	209	5187	69	11170	99	9070	129	6970	159	4870	189	2770	219	670
120	10260	150	8550	180	6840	210	5130	70	11100	100	9000	130	6900	160	4800	190	2700	220	600

These data may be used with either of the formulas given, the strength per unit of cross-sectional area in the case of the Carnegie equation being $17{,}100 - 57\frac{L}{R}$, and in the Maintenance of Way specifications recommended for railway work $16{,}000 - 70\frac{L}{R}$; in both cases L is the length between struts in inches, and R the least radius of gyration. The accompanying table "Unit Strength Columns", reduces the necessary column calculations, the unit strength being readily determined when the slenderness factor $\frac{L}{R}$ is known. In the Carnegie formula, when this factor is below 90 it is customary to assume a unit strength of 12,000 pounds per square inch.

In the construction employing short tie plates, it is necessary to make special connections for the struts by means of attached gusset plates. In the type where the angle tie is used, the inner tying angle, as shown in Fig. 3, is milled along one edge in order to form a good bearing support for the end of the strut, which is also milled.

Double-angle columns are preferred to the latticed channel column on account of their openness which leaves them clear at all times for inspection and painting. Another decided advantage is the low cost of construction as compared with columns of other types.

* * *

ENTERING WEDGE FOR METRIC SYSTEM

The annular ball bearings made abroad, which are being so largely used in America in automobiles and other machinery, are made to metric measurements. As a result the users must provide metric gages and work to them when fitting the bearings to their machines. If the metric system has inherent advantages, the use of it in this work should to some extent demonstrate the fact to American shop managers. It will familiarize draftsmen, toolmakers and machinists with the system, removing the distrust of something unknown, and thus place it on a parity with the English or inch system of measurement.

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* With Data Sheet Supplement.
† Address: 159 Harrison St., Batavia, Ill.

THE PRINTING PRESS IN THE DRAFTING ROOM

By H. W. WEISGERBER

As a mechanical appliance to relieve manual labor and at the same time to increase the output a million-fold, the printing press stands as the oldest of the so-called "modern" inventions. By its aid, mankind has advanced farther in the arts and sciences, and toward universal education, during the last four hundred years than in all the centuries preceding.

Old as the printing press is, it is strange that there are so many concerns employing high-priced draftsmen, who still adhere to the older art of hand-lettering for printing titles on drawings; these firms spend enough in that way every year to purchase a title printing outfit. The title printing outfits have been on the market for more than a decade; yet, it is surprising to see the number of blueprints coming from all over the country that have hand-lettered titles. Why is it? The only reason the firms do not use presses, it seems to me, is that they imagine an outfit too costly, or that it would require a high-priced printer to do the work. This is not so. There are hundreds of little boys every year who are presented with toy printing presses and who have no further instruction than a few simple directions; yet, these little fellows do respectable jobs. Therefore, it is unnecessary to have had a printing office experience; besides, some of the printers' "tricks" are done away with or reversed. In title printing it is only necessary to change certain lines, so that after a title is once put into form, that form remains standard, and it is only necessary to change the scale, date, and size or name of machine. The firm's name, the spacing, etc., remains as it is. The work can he done rapidly; the writer has printed titles at an average rate of a minute for each. Some draftsmen require that much time to rule off the space when getting ready to letter by hand.

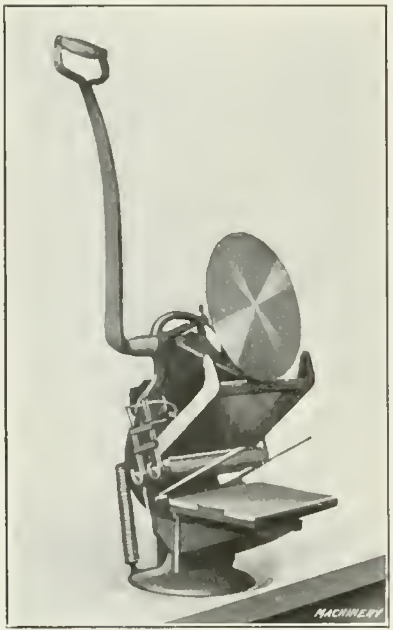

Fig. 1. Printing Press suitable for Title Printing in the Drafting Room

There are many other uses for a title press, such as printing shipping tags, index cards, shop cards, shop notices, and job or order numbers on blueprints going into various departments. There are also many small jobs that would never be sent to a regular printer on account of the cost, that can be done in this way at the cost of but a few cents, the price of a man's time. A press soon pays for itself where many tracings are made; no extra help need be hired, for the blueprint department does the work.

26-52x36 CROSS COMP. L. P.
BUCKEYE ENGINE CO., SALEM, O.
APR., 13, 1907 SCALE 6 IN. TO 1 FT
147 F 86

Fig. 2. Example of Title Printing. Forty-five Titles were Printed in Forty-two Minutes. The Drawing Number was changed for every Title

The press is, perhaps, the most expensive part of the outfit. Two, three or four fonts of type are all that are necessary to start with; they should, however, all be of Gothic face, for Roman face type is too fine to reproduce well in blueprinting, and the "tails" wear off too soon. Then, there are a few essentials such as slugs, leads, wood furniture, an extra chase or two, quoins, ink and the type cases or a small type cabinet; these are enough to begin with, and more can be added as the work for which the press is used, grows. The accompanying illustrations, if compared with the lettering of the average draftsman or tracer, show the superiority of the printed title.

The essential part of an outfit is the press. It should be strong and durable, convenient and easy of operation. While a good press is expensive to start with, it will last a lifetime and thus pay for itself, whereas a cheap one might soon become useless. A small press can be bought for one-third the price of one twice as large; yet, it is better to buy one that is larger than the titles for which it is intended, for it will be found that other printing can be done on it; do not economize on the press.

ORDER NO. 6137.
20x42 BUCKEYE ENGINE,
ORDERED BY
Robinson, Cary & Sands Co., St. Paul, Minn. for the
SHEVLIN-CLARKE CO., Ltd. FT. FRANCIS, ONTARIO, CANADA.
BUCKEYE ENGINE CO., SALEM, OHIO.
APR., 13, 1911 SCALE· ½ IN TO 1 FT
45 C 74

Fig. 3. Example of Title Printing

There are numerous small "job presses" on the market, and doubtless one make is as good as another, and for equal quality, the prices are about the same. The Golding Mfg. Co., of Franklin, Mass., has in its "Official Printing Press" for drafting-room use, a press that meets all the requirements for a title press. It has a stationary, level platen, free from moving or stationary parts at the sides, so that large or small tracings can be printed with equal ease, as the tracings lie flat while receiving the impression. This press is made in two sizes, No. 9 with a 6- by 9-inch chase, and No. 12 with an 8- by 12-inch chase; the prices are $45.00 and $80.00 respectively.

ORDER NO. 5907.
18 x 24 S. A. T. Natural Gas Engine,
ORDERED BY
THE QUEEN CITY PRINTING INK COMPANY.
Bert L. Baldwin & Co., Consulting Engineers, Cincinnati, Ohio.
BUCKEYE ENGINE CO., SALEM, OHIO,
JUNE. 25, 1909. SCALE: ½ IN. TO 1 FT.
36 C 23

Fig. 4. Another Example of Title Printing

This company also makes the regular "Official Jobbing Presses" with the moving platen, ranging from the No. 1, 3- by 4½-inch chase, at $10.00, to the No. 12, 8¼- by 12½-inch chase, at $60.00. Through mistake, our company purchased the regular No. 4 press; but by a clever arrangement whereby the two front adjusting screws were replaced by studs, and a steel bar placed across, the press was clamped to the table with the bottom of the platen resting on the table top, and so we have a "level platen" press with the foot of the press doing the "swinging."

Any make of standard type can be used. The type can be secured through the Golding Mfg. Co., Thos. E. Kennedy & Co., of Cincinnati, and numerous other firms. Besides the type and the case for each font of type, an assortment of accessories is necessary, such as two-point leads, for spacing between lines. The "point" is the unit of measurement. All type bodies are cast on the "point" system. Four "points" equal about one-sixteenth inch in thickness. The leads can also be had in other thicknesses, but they are not necessary, for several two-point leads can be used. Leads cost about 16 cents per pound. Instead of thicker leads, the so-called

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* Address: 56 Chestnut St., Salem, Ohio.

"wood furniture" is much cheaper, as well as lighter in weight. Instead of buying much high-priced lead, buy, therefore, an assortment of the smaller thicknesses of "wood furniture." It comes in about three-foot lengths, and can be cut to proper size. Each size is sawed to equal thickness and all thicknesses are of an equal width. They are made of seasoned and oiled cherry wood and cost from two to ten cents per yard, according to thickness. A pair of tweezers and bodkin are almost necessary, especially if small type is used; a combined bodkin and tweezers costs from forty cents to a dollar each; while a wooden handle bodkin costs ten cents.

An imposing stone on which to place the "form," as the chase with its type is called, is necessary; it usually consists of a white marble or metal slab, slightly larger than the chase. All of the type setting for titles is done on the stone instead of using a printer's "stick." As a general thing there are enough of the smaller spaces and "en" quads in each font of type, but a scarcity of the one-, two-, and three-"em" quads for title work; so, in order to save time in picking up a number of the smaller ones, and to have all that one may need, it is best to buy an extra font of quads and spaces, which cost about 65 cents per font for the smaller sizes. Likewise the fractions are an unknown quantity in the small type, and they are useful, especially in the line of the title for the scale of the drawing; they, too, are quite inexpensive, costing about 50 cents per font.

If a few odds and ends in the line of letters or figures in large characters, brass rule, leaders, leads or slugs, are needed, they can be procured from local printers, who usually have an abundance of such supplies. Where several sizes of type are used in a title it will be found that there are characters enough so that several chases may be set up, thus avoiding "dropping" an entire form to set up another.

Type prices vary according to their size. A font of 20-A (meaning that each font has 20 capital letter "A's," and other letters in proportion to their use), 10-point Gothic costs $1.00, while a font of 9-A, 20-point Gothic costs $1.25; these prices are for all-capital-letter fonts, with figures, points, spaces, and quads. The same size type in capital and small letters, called upper and lower case, costs over three dollars a font. These prices are from the catalogue of Barnhart Bros. & Spindler's, Chicago, Ill. Do not be misled into buying fancy letters. The large-faced, plain and substantial Gothic type, in broad or condensed shapes, will wear longer and give better blueprint reproductions than the hair line Roman or other fancy styles.

Printer's ink will not work on tracing cloth; so a tracing cloth ink must always be used. The Queen City Printing Ink Co., of Cincinnati, Ohio, makes a satisfactory ink, at $3.00 per pound. It is not necessary to buy everything to be found in a printer's supply catalogue. It is surprising with what few things title printing can be done.

A summary of the outfit is as follows: Press; one type case for each font of type; type; quoins and key; imposing stone; ½ pound of ink; about 10 pounds 2-point leads; extra spaces and quads; wood furniture; extra fractions, if necessary; extra figures; bodkin and tweezers.

* * *

One of the most common misconceptions of the principles of apparatus is perhaps that of the way an electric dynamo generates electricity. Probably one-half the men who pretend to know something about machinery, but who have really never studied it, imagine that electricity is generated by the friction of the brushes on the commutator. They have the common knowledge of the generation of static electricity by rubbing a glass rod with a silk handkerchief or by the brushes of a Wimshurst machine, and jump at the conclusion that the mighty generators in the power stations work on the same principle.

* * *

An experimental road covering a stretch of 6900 feet is being constructed near New Eltham in England. The experimental road consists of 23 sections, each 300 feet long, and on each section a different method of construction is employed so that after a certain period of use it will be possible to determine the relative advantages of the various types of road.

BRIQUETTING OF METAL BORINGS[*]

One of the latest developments in the metal industry in connection with the utilization of metallic waste is the process of briquetting under enormous pressure without the use of a binding medium. The process was orginated by Arpad Ronay, of Budapest. He employed extreme pressure, allowing a sufficient time to permit the individual particles to come into intimate contact, excluding thereby spaces filled with air which would have a tendency to weaken the bond. When metal particles, as well as ores or other fine materials, are subjected to ordinary pressures, sufficient air is entrapped to cause trouble when the briquettes are heated; the air expands, thereby breaking the briquette.

When the writer was first asked to investigate the process professionally for American interests, and before going to Europe, he melted one of the German cast-iron boring briquettes in his cupola. It was found that the briquetted borings melted similarly to pig iron, and the briquette maintained its shape until the final softening and dropping to the bottom. A visit to the several briquetting installations in Europe showed this industry to be in a flourishing condition and ten plants are now in operation.

The process may be briefly described as follows: Cast iron, steel, brass, bronze, aluminum, copper chips, borings, filings and metallic slimes after drying coal, graphite, ore, flue dust, etc., can be satisfactorily briquetted. Borings, before being dumped into the hopper above the press, have the dust and dirt removed by an exhaust fan. This operation likewise removes rust which has become loosened by the rubbing of the particles against each other during transit, and the quality of the briquette is thereby greatly improved. In the case of steel turnings, these are passed through a set of disintegrating rolls to reduce their bulk. After cleaning, the borings are passed over a magnetic separator to remove any brass from the iron. The cleaned and separated borings are then delivered to the feed hopper of the press. The bunker is filled with borings by a bucket elevator. The borings flow by gravity into the plunger of the press and then into the die. As the plunger descends, the borings receive their first compression. The air is forced out as the borings are compressed, the separate particles curling into each other. The partially completed briquette in the die is then carried by the revolving table to the next stop, where plungers, both from above and below, apply pressures of 35,000 pounds per square inch. The die containing the briquette is free to move up or down at this point, permitting the compressed material freedom to adjust itself. When the pressure is released, the revolving table makes another turn and the die with the finished briquette, which is slightly conical in shape, is passed under another plunger which forces the briquette out of the die and onto a conveyor by which it is carried away from the machine. All of these movements are entirely automatic, the operation of the press being in charge of one man, a second carrying away the briquettes, while a third has charge of filling the hopper with borings. The briquettes become quite hot during this operation.

A large press installed in a Chemnitz plant has a capacity of six tons per hour, and the cost of briquetting, exclusive of royalty, has been reduced to about 50 cents per ton. The cost of a press of this size with conveying apparatus and all accessories, is about $35,000.

The use of briquettes in the cupola is similar to the use of pig iron and heavy scrap, and although the briquettes, in spite of the enormous pressure to which they are subjected, are not as solid as pig iron, melting somewhat more rapidly, their handy shape and weight makes them an ideal cupola charging and melting material. In Germany these briquettes are actually sold at pig iron prices, and at the Borsig Locomotive Works, the regular charges for steam and gas engine cylinders, refrigerating machinery castings, and castings for hydraulic machinery, air compressors, superheated steam and steam turbine apparatus, contain 40 per cent of briquettes.

* * *

A little knowledge may be a "dangerous thing," but it is almighty handy on occasion.—*Exchange.*

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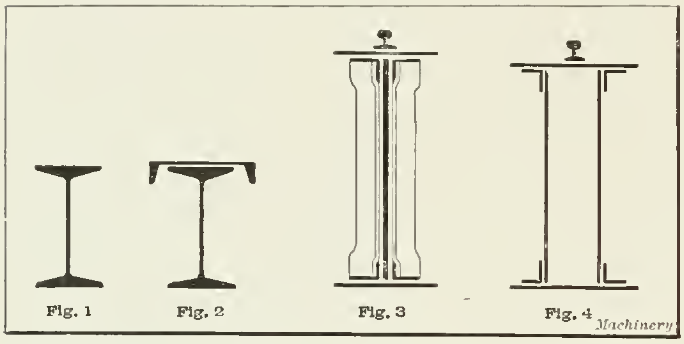
[*] Abstract of a paper by Mr. Richard Moldenke, read before the Pittsburg convention of the American Foundrymen's Association.

POINTS IN CRANE CONSTRUCTION AND DESIGN*

By OTTO ABDT

In the following article are given a number of suggestions for the design of overhead cranes. It has not been intended by the writer to present a complete treatise on crane design, or even on crane girder design, but merely to call the attention of designers to some points in crane design which may be useful to them in their work.

In Fig. 1 is shown the common I-beam girder section used in single- and double-girder hand-power and light-power type of crane bridges for short spans. In Fig. 2 the same type of girder is shown reinforced by a channel for longer spans. Figs. 3 and 4 show sections commonly used for all-power cranes of spans above 25 feet and above three tons capacity. As regards Fig. 1, there is nothing special to note, except that the beam should withstand the load with a factor of safety of 6 for power, and at least 4 for hand-power devices, and that the length of span in any case should not be more than 20 times the flange-width of the beam.



Figs. 1 to 4. Examples of Sections of Crane Girders

In Fig. 2 the channel is added to increase the transverse stiffness of the beam and also the compressive strength of the top flange. However, this addition reduces the deflection very little, and is a poor substitute for the designs shown in Figs. 3 and 4, unless a channel of suitable section is added on the lower flange, which, again, under certain conditions, brings forth another consideration in the liability of the web to cripple.

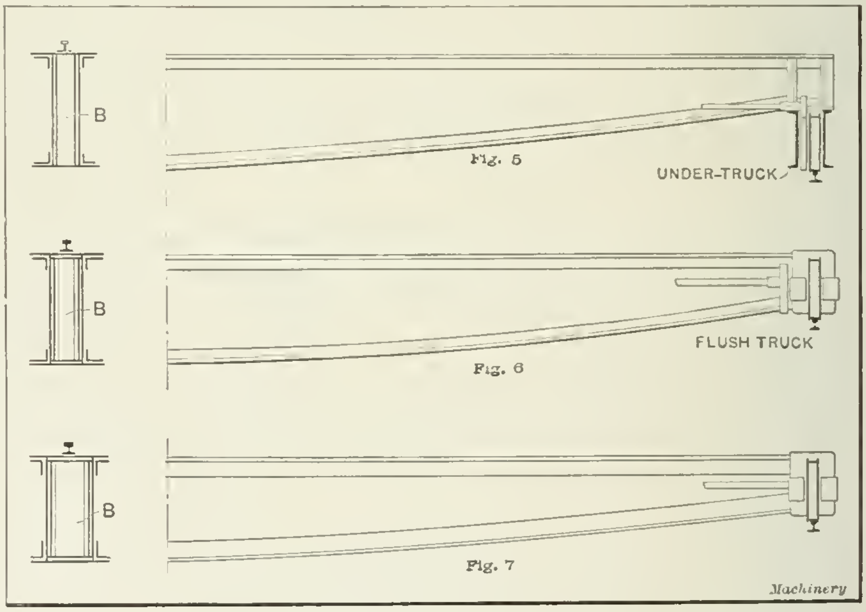
Fig. 3, or the single-web girder, is an improvement on the girders previously mentioned, and is often placed on hand-power cranes of unusual span and capacity. These girders are generally provided with a rail for the trolley, the section of which is seldom, if ever, considered in the strength of the girder. Fig. 4—the box type—is the type of girder for indoor power traveling cranes, and is almost universally used in this country.

Figs. 5, 6 and 7 are sections and outline elevations of three girders from cranes of the same capacity and span but of different design. The illustrations are made to about the same scale and thus show the variation in proportions of the top and bottom chords to the length and width between webs. These girders all have a factor of safety of about 6, but they differ materially in every other respect.

In Fig. 5 the diaphragms or separators *B* are standard channels, riveted to the webs and supporting the top plate at intervals, thus acting as support to the bridge rails and also imparting stiffness to the webs. In fact, they act as posts and ties, and add generally to the stiffness of the girders, both from the standpoint of deflection and transverse strains. The riveting of the angles along the sides of this girder varies in pitch from two and one-half inches at the ends, to five inches in the center, on both the top and bottom members. The web splice plates are riveted in a single row, spaced at three inches, and take care of the shear. The rails are of the same size as in Fig. 7. The top plate is spliced with a plate on each side of the rail, and one under the top plate between the webs, thus allowing the rail to rest on the top plate proper. Sufficient riveting and plate are allowed to take care of the compression in this member. The bottom chord is also economically spliced, on the strong side, and allowance is made for rivet holes in the plate, etc. It is also notable that the web splice is in the center. The top chord splice is near one end and the bottom chord splice near the other, thus "breaking" splices.

In Figs. 6 and 7 similar methods of construction and engineering are used. The diaphragms, stiffeners or separators are built up of plate and angles. The web plates and diaphragms lack about one-quarter inch of touching the top and bottom plates. Thus a heavy plate is required to support the rail. In Fig. 7 there is an extremely heavy top plate, and the design is extremely wide between the webs, but it seems as if this elaboration is rather extreme and expensive. These girders are closely riveted, a spacing of 3 inches being the maximum.

Probably no two designers of crane girders agree except in a few details of their construction, and yet their variations are based on logical conclusions, which seem to be correct when taking account of their separate views. One builder investigates his customer's needs, and if the crane is only to be used under ordinary service (and to full capacity only occasionally), the girder is designed for full load stress, including live and dead vertical loads, but the side strain is not considered for full loads. As the handling of a full load will, in all probability, occur very seldom, it is assumed that the operator will be unusually careful in such a case and the side strain will then easily be taken care of by the stiffeners, diaphragms, etc. Another considers full loads at full speed with wheels locked and skidding taking place at a speed of 300 feet per minute, for which he adds a side strain of 20 per cent of the vertical stresses. The proportions of his girders are such that they will approximately double the strength of the former for vertical loading, and this design is applied to all cranes. The usual stiffeners are added, but not considered in the calculations. The first-mentioned designer would almost duplicate the latter's girder under conditions of severe service, and although his method of handling ordinary cases may seem somewhat risky, fifteen years of this economical practice have demonstrated from a manufacturing and practical standpoint that this method of girder design is satisfactory.



Figs. 5 to 7. Crane Girders of Same Capacity but Different Design

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* For additional information on this and kindred subjects, see the following articles previously published in MACHINERY: May, 1911, "Rail Fastenings for Crane Runways"; September, 1910, "Power Required to Drive Cranes"; September, 1909, "Calculation of Pillar Cranes". See also the note accompanying the last mentioned article, and MACHINERY'S Reference Book No. 23, "Crane Design"; No. 47, "Electric Overhead Cranes"; and No. 49, "Girders for Electric Overhead Cranes".

Miscellaneous Hints on Crane Design

A bridge-travel motor should not be placed at the center of a crane girder, because the overhang and vibration from it causes undesirable stresses. It should be placed near the end and be accessible from a platform which would also be useful for overhauling the trolley. A foot-walk across the bridge is handy for oiling shaft bearings, and also the axles on the end of the crane opposite the operator's cage.

There is always deflection in a girder and consequently bending of the cross-shaft, thus causing considerable loss of power in the operation of the crane. Hence, a system of flexible joints would increase the efficiency and eliminate some of the gear troubles.

Crane bridge and trolley wheels give better service if they have chilled cast-iron treads, than they do if made of cast steel, because, owing to the uncertainty of cast steel, a hole very near the surface may not be noticeable until the wheel has developed a flat spot or two in service. This is a case comparatively rare with cast-iron chilled tread wheels.

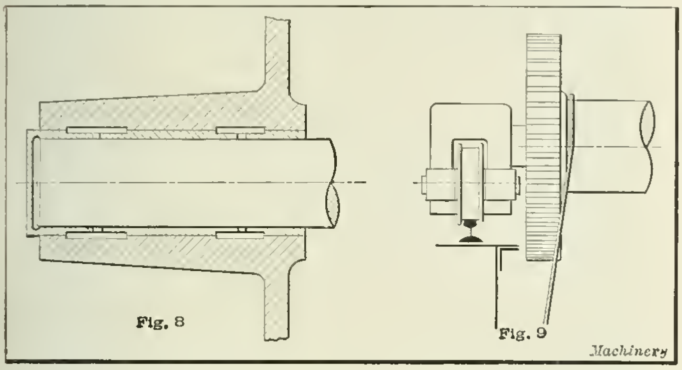

Fig. 8. Dust-proof Bushing for Bearings

Fig. 9. Showing Danger of Gear Teeth Severing the Cable

Cross-shafting can be made from cold-rolled stock, if babbitted bearings are used, and is just as serviceable as turned shafting. Rails should not be riveted to girders, as they sometimes prove defective, and are then quite difficult to remove and replace.

There is nothing gained by close riveting in a girder; the conditions should be examined, and a spacing determined according to some accepted formula such as given in handbooks. Webs closely placed, with liberal overhang of top and bottom plates, will guard service wires from contact with the hoisting ropes. This condition is aided by using unequal leg angles with long legs in the horizontal plane, which again increases the strength and stiffness of the girders by throwing out the center of gravity of the angles in all directions.

The selection and placing of electrical apparatus is mainly a matter of opinion, but where the resistance is placed under the cage floor, the air circulation is better and more room is left in the cage for the operator; it also facilitates wiring. By covering and using hinged openings for the passage of air and a grating in the bottom of the cage, the operator may be protected from heat in the summer and cold in the winter, if the crane is in constant use.

A reliable stop for preventing a crane from hoisting too far, and yet not prevent lowering, is essential, and should never be overlooked. Steel hoisting ropes are preferable to chains, as a rope gives warning of wearing out, and accidents may be prevented by buying a new rope. A chain requires occasional annealing, and failure to attend properly to this matter means danger, to say nothing of the additional clumsiness. noise and extra cost for chain trolleys. A crane trolley should always be equipped with electrical as well as mechanical brakes, and each should be of sufficient capacity to stop and hold the full load in event the other fails to work. The strength of the gears should be ample. A wide-faced and moderate-pitch gear has many advantages over a coarse-pitch and comparatively narrow-faced one.

The ideal place for the drum gear is at the center of the drum. A band could be turned larger in diameter than the drum face, and a rim gear shrunk on and properly keyed. When drum gears are placed at the end of the drum, the torque produced constitutes an undesirable condition. If the gear is keyed to the shaft, the difficulties are multiplied several times, and a shaft of abnormal diameter is required to withstand the strain. Besides, when the loads are down and are swinging in the direction of the crane travel, it has happened that the teeth of the drum gear have severed the cables, as indicated in Fig. 9.

Special attention should be given to the bearings. A pressure of about eight hundred pounds per square inch of projected area seems to be a fair average in general practice, but a decrease in this allowable pressure will certainly increase the life of the crane and cause less expense for renewals, and the need of an adjustable bearing would be minimized. A good bronze alloy is preferable to the soft molded bearings; it should be well fitted and scraped.

Special care should be taken in providing as nearly automatic lubrication as possible. Cranes are the most neglected of any expensive machines, mostly because the oil holes are either concealed or require an acrobat to reach them. This most important feature should be handled properly by the designer. A ring-oiled bearing for the cross-shaft and liberal waste oilers for the axles require but occasional attention. These devices, however, do not seem to work on the trolley, and a gear case is relied upon to do the oiling, by being partially filled, the gears being expected to splash sufficiently to supply the bearings with oil. The result is the oil is beaten over and over again, is exposed considerably to the air in this process, and consequently thickened. Sometimes grease cups are supplied which have the disadvantage first mentioned. By copying the idea of automobile lubrication, central lubricators or pots could be used and copper tubing run from them to each bearing, insuring lubrication, and eliminating a good deal of dissatisfaction among purchasers. As dust sometimes ruins bearings, a bushing such as shown in Fig. 8 has advantages.

A sliding collector shoe seems to be a very poor means of gathering current. No doubt the contact is more perfect and better than when using the collector wheel, but we have yet to learn of an instance where the trolley wheel did not do the work it was intended for, and it will outlast the shoes several times over.

Prospective crane buyers should consider their crane proposition before constructing the runways in new buildings. They could thereby save considerable by having runways constructed for cranes of under- or through-truck type, as shown in Fig. 5. This makes the runway considerably lower, but at the same time allows a maximum hoisting range. The crane mechanism is not so cramped, and, in general, a far superior crane is obtained. The extra cost of a crane of this type depends on the maker; it would be reduced somewhat by the difference in cost of the runway for under-truck or flush-truck (Fig. 6) construction.

* * *

Many a machinist has found out how difficult it is to cut quick-pitch worms on an engine lathe not designed for such work. The lead-screw has to be geared up to run several times faster than the spindle, the result oftentimes being that the change gears will not stand the strain. A common "stunt" is to mount a belt pulley on the lead-screw beside the change gear, belt it to the countershaft and drive the spindle through the change gears. The power required for the cut is less than that needed to overcome the friction of the screw and carriage. A similar condition is found on the milling machine when milling worms of fine pitches using the common form of dividing head. In this case the difficulty, however, is to rotate the work rapidly enough. Suppose, for example, an 8-pitch worm is to be milled, using the common dividing head and vertical attachment. The table screw is 4-pitch and in moving the table one inch it turns four times, but the index head must turn eight times and the worm driving it $40 \times 8 = 320$ times. To overcome this difficulty, the Kempsmith Milling Machine Co., Milwaukee, Wis., provides means for dropping out the worm and driving the dividing head spindle direct from the table screw. In the foregoing example the ratio of change gears would be 2 to 1 instead of 80 to 1.

USE OF THE SINE BAR FOR MEASURING ANGLES

By WILLIAM S. ROWELL*

The impossibility of measuring angles accurately with protractors has led to the use of other methods, when close measurements are necessary. The sine bar described in the following has been found convenient by the writer and may be of interest to others. A sine bar of the dimensions given at *A* in Fig. 1 was used. A longer bar tends to give greater accuracy of measurement, but may at times be less convenient. Ten inches between the plug centers would give a dimension easily reduced to corresponding sine. This bar is made of tool steel, hardened and ground all over, and is made as straight, parallel, and with angles as near ninety degrees as is possible The ¼-inch lapped holes *a* should be at right angles to the sides of the bar and exactly 4 inches from center to center. The slotted openings *b* are for convenience in clamping only, and should be made of a width most suitable for that purpose. The lapped holes in the bar are superior to permanent projecting plugs, as this allows the bar to be used for other purposes, where projecting plugs would be in the way.

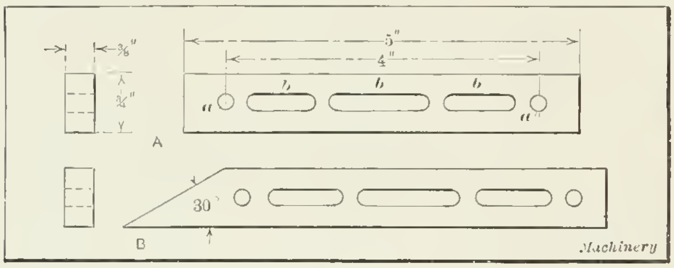

Fig. 1. A. Sine Bar for Ordinary Work; B, Sine Bar for Obtaining Angles in Difficult Places

The bar shown at *B* in Fig. 1 is an improvement, one end being formed to a 30-degree angle, making it easily inserted in narrow openings. (See Fig. 5.) The many uses of such a bar will be suggested by the following. The sine bar is always used in a measurable relation to a true surface, such as a surface plate. The distance from the center of one plug to the center of the other is always considered a radius. To find the angle *EFG*, Fig. 2, clamp the sine bar *A* in contact with one side of the angle *B* as shown, and then obtain the heights of plugs *C* and *D* from the surface plate. Now shift the sine bar to the opposite side of the angle *B*, and again find the heights of the plugs.

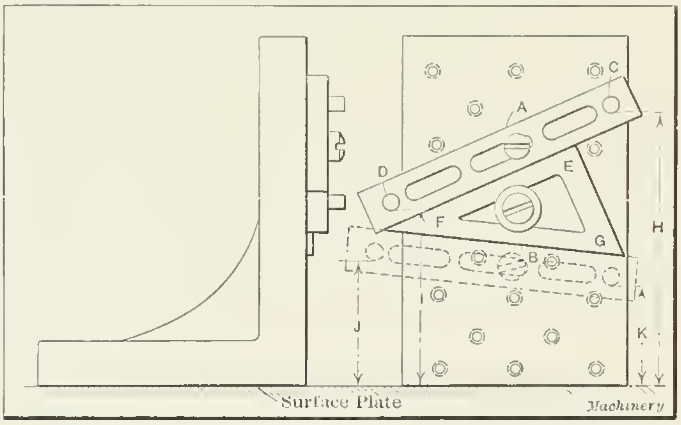

Fig. 2. Application of the Sine Bar for Measuring a Small Angle

The difference between the heights of the plugs obtained at each setting of the bar is 4 times the sine of the unknown angle. Hence this dimension divided by 4 gives the sine of the angle. By referring to a table of sines, the angles can be found; the sum of the two angles gives the angle *EFG*.

For example, let distance *H* equal 4.5803 inches and *I* equal 2.9375 inches. Subtracting *I* from *H*, we have 4.5803—2.9375 = 1.6428 inch. Now shift the sine bar to the position shown by the dotted lines in Fig. 2, and let distance *J* equal 2.0879 inches, and *K* equal 1.6875 inch. Subtracting *K* from *J*, we have 2.0879 — 1.6875 = 0.4004 inch. Dividing 1.6428 and 0.4004 by 4, we get 0.4107 and 0.1001 as sines of the angles. Referring to a table of sines, we find that 0.4107 is the sine of 24 degrees 15 minutes, and 0.1001 the sine of 5 degrees 45 minutes. The sum of these two angles is 30 degrees, which is the angle *EFG*.

Some may prefer to carefully set one side of the angle *B* to be measured, parallel with the surface plate, as shown in Fig. 3, and thus obtain the plug heights but once; however, as a small angle is more accurately found by the foregoing method than by having one side horizontal this method is given.

At *A*, in Fig. 4, is shown a small countersink gage which defied measurement by any other means. As the shank *a* was not true with the gage it could not be used for setting to obtain the desired angle. The method used in setting the piece is shown in Fig. 4, where the lower side *b* of the angle is set parallel with the surface plate by a height gage, the finger surface of which is reduced to about 0.020 inch. The gage *A* was projected beyond the angle-plate to get the best light conditions. Fig. 5 shows a case where the improved sine bar shown at *B* in Fig. 1, is used advantageously.

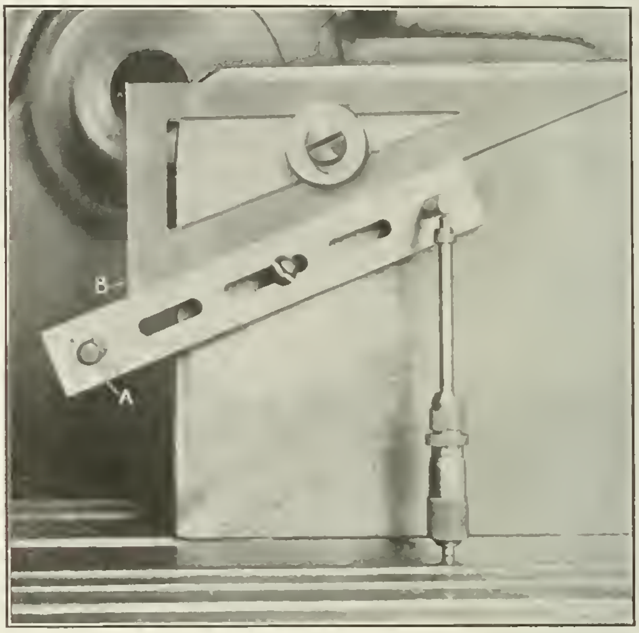

Fig. 3. Obtaining an Angle when One Edge of the Work is set Parallel with the Milling Machine Platen

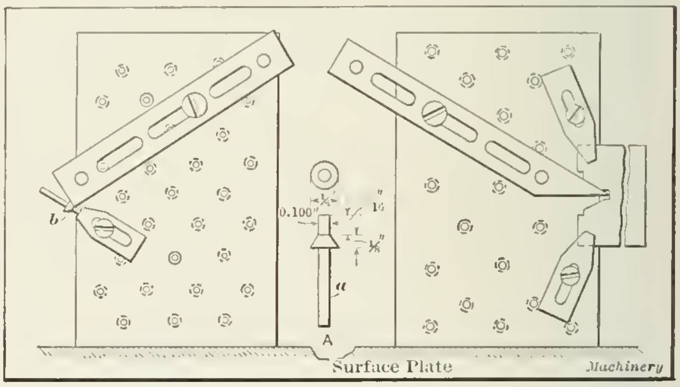

Fig. 4. Obtaining the Angle of a Small Gage. Fig. 5. Application of the Sine Bar shown at B in Fig. 1

Other numerous uses of the sine bar for setting up work will readily suggest themselves. It may also be set in the correct relation to a straightedge and used as a gage for taper plugs, etc.

* * *

A steel mill, recently put into operation for making seamless tubing, was equipped with twenty-six straightening machines. Not long after it started into operation an inventor of a straightening machine demonstrated that his invention was superior to those in use, and the twenty-six machines were displaced by two of the improved machines. This is but one example of the scrapping of machinery that is constantly being done in the effort to secure higher efficiency.

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* Address: Care of Hooven, Owens, Rentschler Co., Hamilton, Ohio.

FOUNTAIN PEN MANUFACTURE[*]

MAKING L. E. WATERMAN GOLD PENS

By DOUGLAS T. HAMILTON[†]

The life of the ordinary steel pen is of short duration as compared with the gold iridium-tipped pen point used in Waterman's Ideal fountain pens. The reason for this is that gold does not corrode or oxidize like steel, and that its wearing qualities are increased by iridium, which is the hardest known metal. Other interesting facts concerning the manufacture of this fountain pen, especially the gold pen point, and the ink used in it, are given in the following article.

Alloying and Melting the Gold for Pen Points

The gold for the pen point is received from the United States assay office in bricks 24 carats fine, measuring about 2½ inches long by 1½ inch wide by ¾ inch thick. Each of these bricks is worth anywhere from $500 to $1000, depending on the size. Twenty-four carat[‡] gold is far too soft to use for fountain pen points, so it is necessary to alloy it somewhat, to make it harder and stiffer. The fine gold is melted with the alloy in a crucible, as shown in Fig. 1. Here the proper proportions of gold, silver and copper are mixed in, the amounts being 233½ pennyweights of fine gold (24 carat), 92 pennyweights of fine silver and 76 pennyweights of fine copper. This, when cast, produces a block 10 inches long by 1 inch wide by ¼ inch thick, weighing 401½ pennyweights. The reason for making a block of this weight is that when it is rolled out to the proper thickness it makes a sheet which can be conveniently handled. This alloyed gold is 14 carat, which is the standard for fountain pen points.

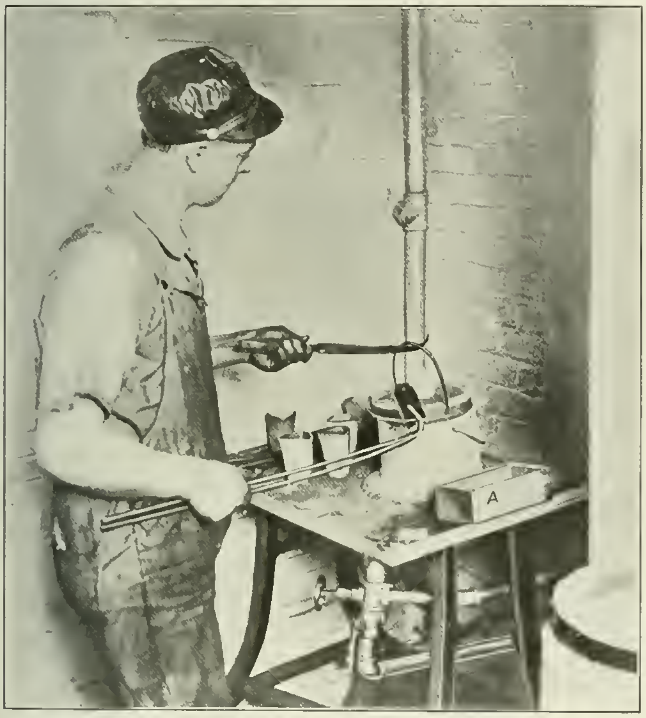

Fig. 1. Melting the Gold for the Pen Points

Following the production of the block which is cast in the iron box A, Fig. 1, the block of gold is conveyed to the rolling department, where it is passed through steel rolls from fifteen to twenty times until it is rolled out into a sheet of the required thickness. Rolling hardens the gold somewhat, and if carried too far without annealing is likely to produce cracks; it is therefore necessary to wind up the rolled sheet, and put it in an annealing furnace, where it is heated to a dull red, after which it is taken out and allowed to cool off gradually. The sheet is annealed twice before it is rolled out to the required thickness—about 1/64 inch. The blanks for the pen points are again rolled out to the exact thickness, after the iridium has been fused onto them.

Cutting the Blanks for Pen Points

After rolling the gold to the correct width and thickness, the strips are taken to the foot-presses, one of which is shown in Fig. 2. The blank is cut out by means of a blanking punch and die to approximately the required shape. After blanking, the pen point is taken to a miniature milling machine, where a narrow ledge is milled across the point, the object of which is to form a seat for the iridium to be fused on.

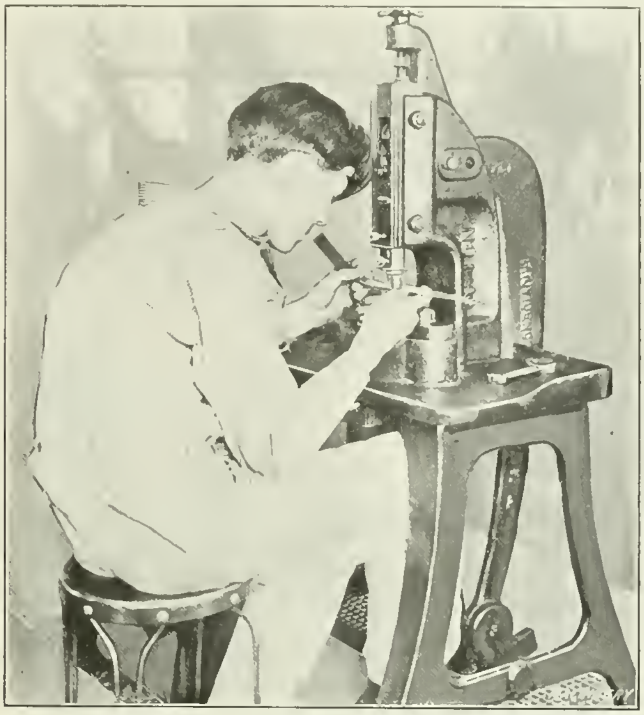

Fig. 2. Blanking the Gold Pen Points in a Foot Press

The Discovery and Characteristics of Iridium

In 1803 Smithson Tennant found that the metallic residue which remains when platinum ores are dissolved contains two elements, to one of which he gave the name "iridium" on account of the varying color of its salts, and to the other "osmium," from the Greek, a smell, because of the peculiar odor which its volatile oxide possesses. Iridium is found in platinum ores in considerable quantities in the form of the alloys, platiniridium and osmiridium. The first of these occurs in grains and frequently in small cubes with rounded edges. Iridium is one of the hardest known metals and costs $1500 a pound. It is secured in the Ural Mountains on the border of Asiatic Russia.

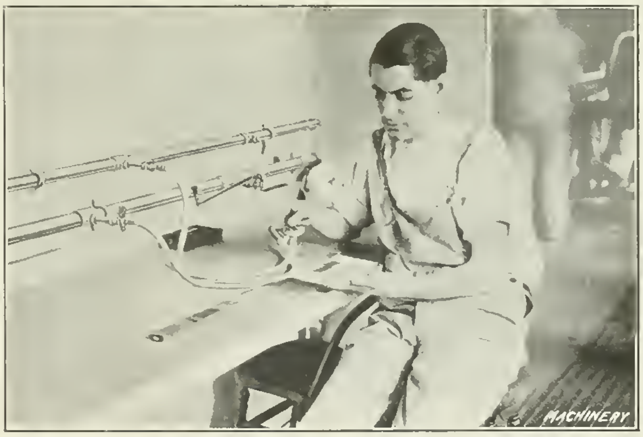

Fig. 3. Fusing the Iridium on the Gold Pen Points

The atomic weight of iridium, taking hydrogen as 1.008, is 191.5. The specific gravity is 22.4 and the point of fusion is between 1950 degrees C. (3542 degrees F.) and

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[*] For a description of the methods used by L. E. Waterman Co., in the manufacture of the rubber pen parts, see the December number of MACHINERY.

[†] Associate Editor of MACHINERY.

[‡] The word carat as applied to gold means the twenty-fourth part and is used to designate the proportion of pure gold. The gold used for commercial purposes is not pure, but generally contains a certain proportion of silver or copper. Pure or fine gold is called 24 carat, but when it contains ten parts of silver, copper or other metal, it is called "14 carat gold," because only fourteen parts of the whole is pure gold The alloy used for Waterman's fountain pen points consists of 14 parts pure gold, 5.5 parts silver and 4.5 parts copper. This alloy is called 14 carat gold.

2200 degrees C. (3960 degrees F.). Iridium is very brittle when cold, but at white heat is somewhat malleable. The specific gravity of the fused metal is 22.15. The extraction of iridium is carried on in a manner somewhat similar to that used for other precious metals. The processes used in the extraction of the platinum alloys can be found in the majority of up-to-date books on chemistry. Iridium can be fused and volatilized in an electric furnace.

Gold pens have been found to resist the friction and wear incident to writing, as they glide over the paper better than pens made from any other metal. Gold is also used chiefly because of its non-corrosive and non-oxidizable qualities. Gold alone, however, is soft and will not last long. Before the adoption of iridium, the gold pen point was tipped with diamonds or rubies, which, of course, made the pen very costly. It was found, however, that iridium could be fused with the gold and a much stronger and more durable pen point produced.

Tipping the Gold Pen Point and Re-Blanking

A granule of iridium, about 1/16 inch square or smaller, depending on the width of the point, is fused onto the gold pen. For stub pen points two granules are used, one on each nib. To accomplish this the operator dips a camel's hair brush in the fluxing fluid and applies this to the nibs. Then he takes a granule of iridium, holds it on the pen with a pair of tweezers and locates it by means of a magnifying glass in the correct position. The pen points with the iridium granules on them are then placed on a charcoal block. The operator now, as shown in Fig. 3, fuses the gold around the iridium by means of a gas- and air-torch, thus retaining it in position. The reason for forming a seat on the pen for the iridium is that the pen can be ground down flush on its under surface and still have a layer of iridium to protect it and to increase its wearing qualities.

Fig. 4. General View of the Gold Pen Point Grinding Department

The blank up to this operation is considerably thicker than is necessary for the finished pen point, and to reduce the blank to about 0.008 inch thick, it is passed through a small pair of steel rolls. A horizontal slit is cut in the upper roll in which the granule of iridium fits, so that it will not be broken during the rolling operation. It is necessary to roll out the blank to give it sufficient resiliency, because the fusing on of the iridium granule anneals it. The shape of the pen point after rolling is distorted, it thus being necessary to blank it out again. This is done in the foot-press shown in Fig. 2.

After trimming, the heart-shaped hole *A*, Fig. 7, from which the slit forming the nibs extends, is cut in the pen point. Then the number and trademark are stamped in the pen point, in the screw press shown in Fig. 5, after which it is formed to the shape shown in Fig. 7 by a forming punch and die held in a screw press.

Slitting the Pen Point

The next operation consists in slitting the pen point to form the nibs. This is accomplished in the manner shown in Fig. 6. The pen point is held in a pair of tweezers *A*, which are supplied with a rubber handle. The operator grips these tweezers in his right hand, allowing them to rest on the support *B*. The pen point *C* is then brought into contact with the rapidly revolving copper disk *D*, which is 3 inches in diameter by 0.0055 inch thick, and rotates at 4000 revolutions per minute. The disk is punched out from a copper sheet of the required thickness, and projects about 3/8 inch above the supporting washers *E*, which steady it while slitting the pen point. Of course this disk rotates at a high speed and it requires considerable pressure to deflect it. The pen point is held on the disk by the operator, so that the slit will come directly in the center of the heart-shaped hole.

The copper disk *D* is coated with superfine emery, mixed with oil which is applied to it by means of a piece of felt fastened to a stick. It is impossible to slit a gold pen point tipped with iridium in the same manner as a steel pen is slit, because the iridium, on account of its extreme brittleness, would fly into fragments, if a slitting punch and die were used. The emery-coated copper disk, however, works very effectively and cuts through the iridium so easily that it seems to require no special effort at all on the part of the operator.

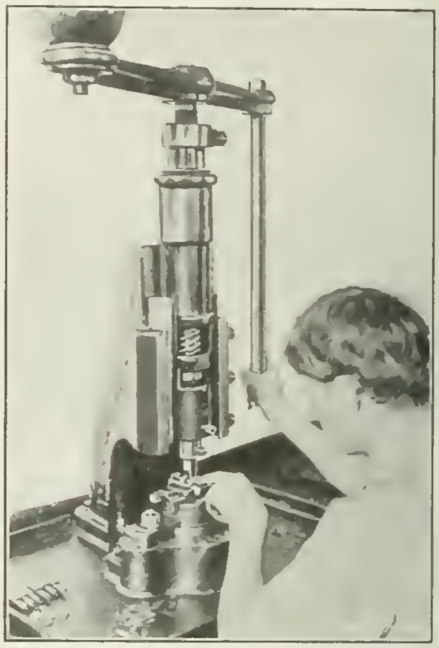

Fig. 5. Stamping the Name on the Gold Pen Point in a Screw Press

The slitting of the pen point, however, requires considerable skill, as the slot between the nibs must be perfectly straight; that is, if the slot is on a slant, the nibs will interlock as shown at *B* in Fig. 7. This causes one nib alone to bear on the paper and prevents sufficient ink from reaching the point; in fact, the pen will hardly write at all. However, this can be rectified when grinding, as will be explained later.

Grinding the Pen Point to the Desired Shape

The operations previous to grinding require considerable skill on the part of the operator, but the grinding of the pen point is really the most important one of all. In this operation the pen point is given its final shape. The operator holds the pen point *A* in a pair of tweezers, as shown in Fig. 8, and applies it to an emery-coated copper wheel *B*, which is provided with four different diameters, so that each part of the pen point can be ground to the required shape. This operation is so important and requires such skill that the shaping of the pen point cannot be watched by the naked

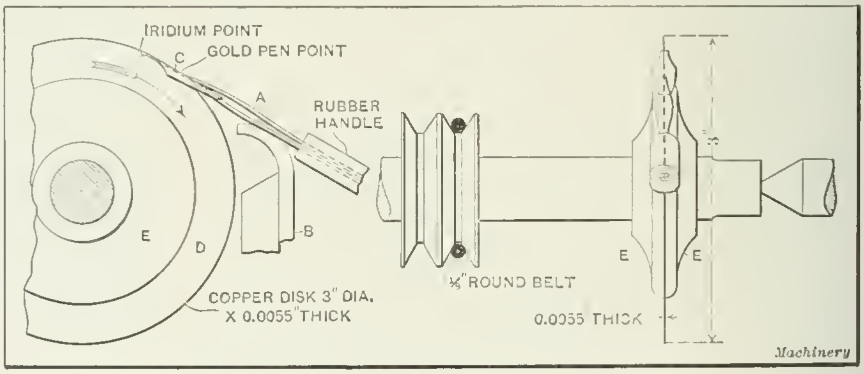

Fig. 6. Slitting the Gold Pen Point on an Emery-coated Copper Disk

eye, but requires the aid of a powerful magnifying glass. The operator grinds a little, removes the dirt from the pen, and then looks at it with the magnifying glass shown at *C*.

The slit is also squared up in this operation, so that the nibs will pass by each other freely without interlocking. The disk shown on the left end of the spindle, which is 3 inches in diameter by 0.007 inch thick, is used to square up the slit. This disk is made from taggers iron* and is coated with superfine emery applied with a piece of felt. The shape of the slit is clearly shown at *C* in Fig. 7. As will be noticed, it gradually increases in width from the point until it reaches the heart-shaped hole *A*.

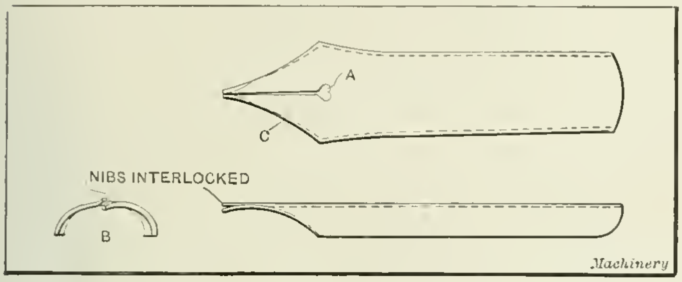

Fig. 7. View showing the Action of Improperly Slitted Nibs

A general view of the gold pen grinding department, in which the grinders are seen at work, is shown in Fig. 4. In this illustration can also be seen the washing troughs and the cans used in collecting the gold dust which adheres to the hair and hands of the grinders.

Setting the Pen Point

Each shape or grade of pen point requires a different "set," so that it will feed the ink freely and evenly. A stub point —another name for a wide-pointed pen point—must have less resiliency than a fine point, so that the former will feed the ink much more freely than the latter. This "set" to the pen point is accomplished by hand. The setter grips the pen point between the first finger and thumb of both hands and moves the nibs back and forth past each other. Bending the nibs back and forth in this manner stiffens them and gives them greater resiliency.

The desired set is a matter of "feel" only. The setter, after moving the nibs back and forth, holds the nibs under a jeweler's magnifying glass, and slightly depresses the frame of the magnifying glass on the nibs, spreading them apart. The amount of pressure required to separate the nibs is all that the operator goes by in setting the pen point. It can therefore be seen that setting the pen point is a matter of experience only, and the setter must thoroughly understand the action of the nibs for the different grades of pen points. Besides setting the pen point, the setter also smooths it up on superfine emery cloth so that it will write freely without scratching, all sharp corners being removed. The setting and final touching up of the pen point is the last operation.

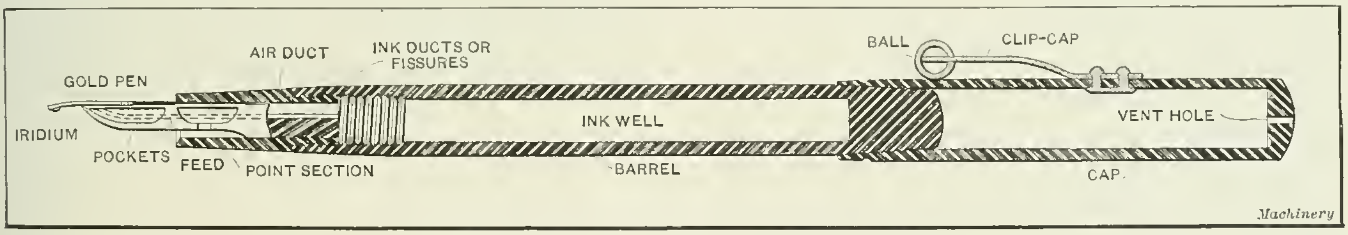

Fig. 9. Sectional View of L. E. Waterman's Ideal Fountain Pen

Assembling the Pen Point—Feed and Point Section

To assemble the pen point and feed in the point section, the operator places the feed on the pen point, so that by looking down on the top of the latter the feed can just be seen projecting slightly in advance of the curved section of the pen point. The pen point and feed are then placed in the point section, and the latter is screwed into the barrel. The assembled pen is now held over a Bunsen burner to soften the rubber feed slightly. The feed is then pressed down on the pen point so that there will be no space at all between them. To see that the feed fits properly, the operator inspects it by means of a magnifying glass. If there should be a space between the under side of the pen point and the feed, the pen would overflow, which, no doubt, has been the experience of many a novice who has attempted to place a pen point in the point section.

The sectional view of the assembled pen, Fig. 9, shows the feed and pen point placed in their proper positions relative to the point section. This illustration also shows the twin rivet used in holding the clip-cap to the rubber cap. The ball is swaged onto the clip-cap instead of being soldered, as was the practice formerly followed.

Collecting the Gold Dust

The gold dust which results from grinding and working 14-carat pen points is worth about $12 an ounce, and as over 1,500,000 pens are turned out per year, it is evident that the waste is considerable. The sweepings from the grinding-room floor alone are sold for $4500 a month, while over $500 worth of gold is reclaimed each month from the water in which the grinders wash their hands and faces. Every grinder is supplied with a new pair of overalls each "clean-up," and the old ones, which are burned, return as much as $5 in gold dust—a case where use increases the value.

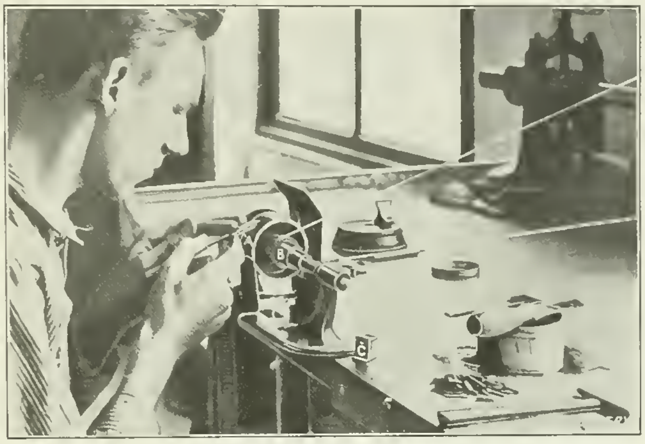

Fig. 8. Grinding the Gold Pen Point to the Desired Shape on Emery-coated Copper Wheels of Various Diameters

Fountain Pen Ink

As the L. E. Waterman Co. makes its own fountain-pen ink, it may be of interest to give a short description of the materials used and the methods of manufacture employed. The ordinary writing fluid is, as a rule, not clean enough to give good results in a fountain pen as it clogs the feed, causing the ink to flow unevenly. Fountain-pen ink consists mainly of tannic acid, gallic acid and water. The tannic and gallic acids are obtained from a peculiarly shaped nut, called "nutgalls," which is deposited by an insect on the leaves of trees in Asia Minor. These nuts, when received at the factory, are crushed and put in a piculator, where water is poured on them. The fluid from the piculator is boiled to extract the acids, after which an aniline coloring matter and other chemicals are mixed in with the acids to produce the record inks, as well as the various colored inks.

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It is stated that a high-speed steel containing about 0.25 per cent of vanadium has a cutting capacity which is almost double that of steel containing no vanadium.

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* Taggers iron is the name given a class of very thin sheet iron, about 0.007 inch thick, which is used largely for metal tags, and no doubt derives its name from its use. This grade of sheet iron has a slightly mottled appearance due to the oxide adhering to the surface. It is a special grade of Russian sheet iron produced by hammering a pile of heated sheets having slight projections or indentations on its surface.

NORTON COMPANY'S MEDICAL PLANT*

In May, 1911, the Norton Co., of Worcester, Mass., established a medical department in its works. This department was the outcome of two ideas: first, that a medical department would increase the efficiency of the employes and, second, that it would also increase the already well-marked good feeling between the men and the company. To obtain maximum production, the human material must be of the best quality, and the best quality in factory employes means perfect physical health. The problem of health, therefore, must be taken into consideration, if increased efficiency is desired, and we might say that if every man employed were physically well, all departments would run with the utmost smoothness.

The medical department adopted the following procedure to investigate the condition of the employes: 1, a complete physical examination of all employes; 2, immediate attention to all defects found on examination and an effort to rectify them; 3, re-examination of employes having physical defects to see that they are in the best possible condition; 4, immediate attention to all employes incapacitated by injury or illness and an effort to get them into normal condition in the shortest time. The fulfilling of these conditions in a systematic manner would mean that all those unfit for work would be immediately eliminated, the capacity of those partially unfit would be increased, sickness would be prevented, wounds and injuries would be properly treated, poisoning would be avoided, and tuberculosis and other contagious and dangerous diseases would be eliminated.

A hospital consisting of a room of moderate size, well-lighted and ventilated, is equipped with the necessary outfit, such as a glass-topped table for dressing, sterilizer for instruments, dressings, examining table, bowls, instruments, etc. A doctor is regularly in charge, giving about three hours a day at the factory, about one and one-half hour in the morning and the same length of time in the afternoon. In the morning he examines all sick employes applying for treatment, either prescribing for them, or, if they are sick enough to stop work, advising them to call in a physician. Those having minor ailments are treated in the hospital in the works.

The complete elimination of accidents in a large factory is practically impossible and in the majority of cases, if these accidents receive proper and careful attention, they prove merely an inconvenience to the employe, perhaps preventing him from working for forty-eight hours, but seldom longer. Even the smallest wound or scratch, if it becomes infected, may lead to a long and sometimes serious illness, so that proper attention and thorough cleansing of all wounds is of prime importance. It is also important that an employe receive immediate attention by someone in the department in which he is working in order not to break up the work of the other employes. To carry out this scheme the Norton Co. arranged to have all the foremen of the various departments take special instruction from the doctor once a week for ten weeks. They were given thirty-minute talks upon the various accidents most frequently met with and their immediate treatment. Each lecture was made as simple as possible and was illustrated by blackboard drawings and actual demonstrations, such as putting on bandages, splints, etc. At the end of this course of lectures, an examination was held and since then there have been examinations and conferences about once a month. The foremen have shown considerable interest in this part of their work and have ably demonstrated their ability to apply the principles they have learned. Each foreman is supplied with a "first-aid jar," containing bandages, sterilized gauze pads, finger splints, etc.

Upon entering the employ of this company, each employe receives a complete physical examination and any defects, such as abnormal conditions of the back or abdomen, are charted on a diagram. After examining a man, the doctor discusses his physical defects with him and strongly urges him to attend to any physical weaknesses which he may have. Those men having ruptures are advised to wear trusses, those with poor teeth are advised to go to a dentist, and all are instructed in the care of minor diseases. If the employe examined is too sick to work he is sent at once to his family physician. When an employe is found to have a weak heart and is doing work not suitable to his condition, his work is modified in accordance. Men having organic diseases are required to report at varying intervals of time for examination and advice.

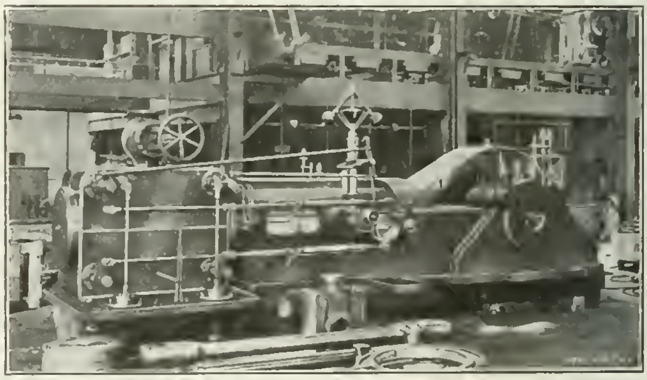
In connection with the dispensary the foremen are provided with "Sick Slips" which they fill out in all cases of injury or sickness, giving the date of absence from the factory and the number of days or hours of time lost. These are filed by the doctor in the order of the department numbers, and the length of absence and cause are noted on the original examination card. When a man has left the factory without seeing the doctor, he is sent for on his return and the cause of his absence ascertained. All physical examinations are filed by name and two lists are kept, one of normal men and the other of those having defects. By this system the exact condition of each employe is known, as well as any accident or sickness he may have had and the length of time he has lost by it.

This work has been going on for six months and the development has naturally been slow. It will be several years before statistics can be obtained to show whether or not efficiency has been promoted. However, judging from the data now on hand, there is good reason to believe that ultimately a high degree of efficiency will be achieved.

* * *

A 32- BY 48-INCH CORLISS ENGINE BUILT IN SIXTEEN DAYS

When the Mesta Machine Co., Pittsburg, Pa., established the record, a short time ago, of building a heavy Corliss mill engine and mill for the Sellers Mfg. Co., of Chicago, in exactly twenty-six days, it was thought that the limit of speed had been reached on this class of heavy machinery building. However, this record has again been broken by the Mesta Machine Co. in building a 32- by 48-inch Corliss engine (shown in the accompanying engraving) for the American Sheet & Tin Plate Co.'s plant at Martin's Ferry, Ohio, to replace an old engine that had broken down beyond all repair. The order was placed with the Mesta Machine Co. on account of its reputation for record-breaking engine building, and shipment was promised in three weeks' time. Sixteen days after the order was received, the complete shipment was made, and fourteen days later the engine was put into operation, making a total of thirty days from the date the engine was ordered until the new engine was driving the mill.



Thirty-two by Forty-eight-inch Corliss Engine Completed in Sixteen Days

All the parts of the engine had to be made from the raw material, including the forgings which were forged in the company's own forge department on a large steam hydraulic forging press, recently installed. Before the Mesta plant was equipped with steam hydraulic forging presses it required all of sixteen days to have a set of forgings delivered to the shop, and only a few years ago it required more than that time to make a casting of a Corliss cylinder of this size—this work alone taking more time than it now does to make the complete engine.

To make a delivery in such a short time requires a foundry equipped with molding machines and the most modern appliances for doing the work, as well as a completely equipped brass foundry, steel foundry and forge shop, and a machine shop equipped with all the tools and appliances necessary for modern engine building.

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* Abstract from *Grits and Grinds*, November, 1911.

APPLICATION OF AUTOMATIC FEEDS TO POWER PRESSES*

The demand for power presses for producing articles made from sheet metal has caused many devices for automatically feeding the strips or blanks to be attached to the various styles of presses. The types of automatic feeds most generally known are the single and double roll, grip, gravity, push, dial and reciprocating feeds. There are numerous ways of applying these types of feeds to power presses in order to adapt them to the specific requirements. Frequently feeds of two types, as illustrated in Fig. 5, are combined to facilitate production. The feeding devices illustrated in the following article are applied to the power punching presses built by the E. W. Bliss Co., Brooklyn, N. Y.

In addition to the economy of a more rapid production, the application of automatic feeds to power presses assists in protecting the hands of the operator, because the blank or stock is automatically fed to the dies, giving the operator no occasion to put his hands near the dies. Various kinds of feeds are applied to presses of every type, the kind of feed used depending upon the material to be handled. To entirely cover this subject would require an exhaustive article, so we will confine ourselves to a brief description of a few of the standard types of feeds.

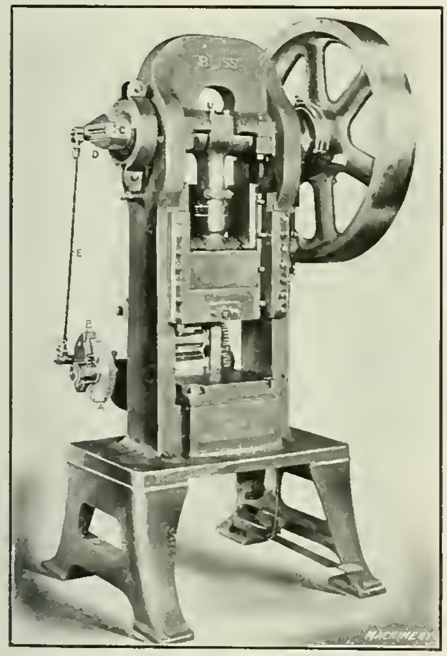
Fig. 1. Straight-sided Bliss Press equipped with a Single-roll Ratchet Feed

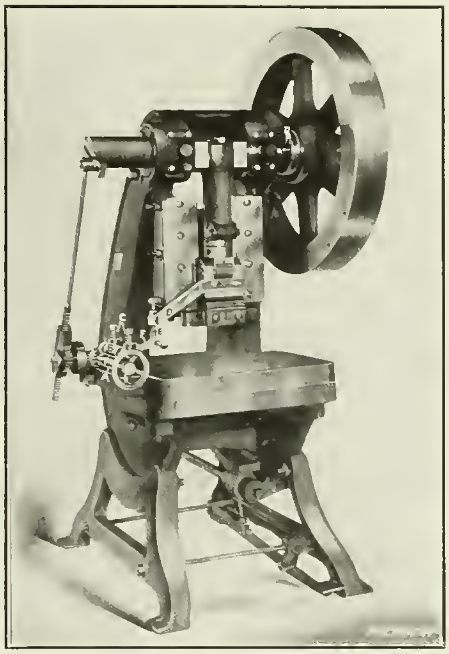
Fig. 2. Bliss Inclined Press furnished with a Rack-operated Roll Feed

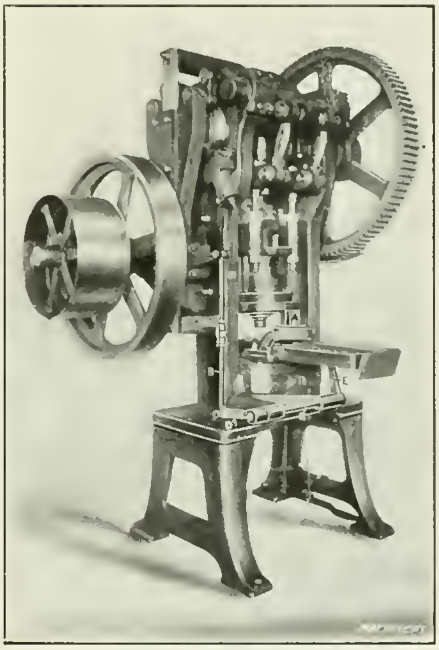
Fig. 3. Toggle Drawing Press having a Push Feed and Magazine

Single-roll Feed

In Fig. 1 is illustrated a single-roll feed, fitted, in this case, to a straight-sided press. This type of feed is used for feeding strip stock, but the particular feeding device illustrated is not built in the regular manner, as the work for which it is used requires a very accurate feed—more accurate than could be obtained with the regular size of standard single-pawl feed. The difference in construction from the regular feed is in the ratchet *A*, which is operated by three pawls held to a segment disk *B*. This feature reduces the inaccuracy in feeding to a minimum without the use of a ratchet three times the circumference of the single pawl ratchet, which would be necessary to accomplish the same result with the old type of feed.

The type of ratchet feed illustrated in Fig. 1 can be adjusted for a wide range of length of feeds, the adjustment being made by means of an adjusting screw in the block *C*, held in the eccentric arm on the end of the crankshaft. Power is transmitted from the eccentric arm *D* to the roll shafts through the ratchet *A* and pawls, the connecting-rod *E* being fitted with universal joints. The roll shafts are connected by gears, as shown, and to avoid over-feeding, due to the momentum of the feeding parts, the lower roller shaft is fitted with a brake. The feeding device in this case is situated at the rear of the press, but it can also be arranged either in front or to the right- or left-hand sides, as desired.

Another type of single-roll feed, fitted to an inclinable press, is shown in Fig. 2. This feed differs from the one shown in Fig. 1 in the method of driving, the rack type of drive being used instead of the ratchet type. The rack type of drive is largely used for long feeding, as it gives a wider range of feed, with the same size rolls, than can be obtained with the ratchet feed. It is not advisable to feed over 90 degrees, or one-quarter turn of the rolls, with a ratchet feed, but with the rack feed several revolutions of the feed rolls can be made for one stroke of the press. This permits the use of small feed rolls, making a smaller and more compact attachment. The feed rolls shown in Figs. 1 and 2 are provided with an automatic release, this being more clearly shown in Fig. 2. This automatic release of the rolls is necessary when pilots are used in the punches. The operation of the automatic roll release is as follows:

Referring to Fig. 2, the feed rolls *A* and *B* are held in contact by means of springs *C*. The lower bearing in which the roll *A* is held, is stationary, while the upper bearing carrying roll *B* is movable. The releasing device consists mainly of a bar *D*, attached to the ram of the press, in one end of which is a set-screw *E*. The point of this set-screw bears on an arm *F* which is cast integral with the top roll bracket. As the ram of the press descends, the screw *E* comes in contact with the arm *F*, releasing the stock when the pilots in the punches enter the die. It will be noticed that the roll release arm *F* is provided with a handle so that the upper roll can be released by hand when starting a new strip.

Push Feed

The toggle drawing press shown in Fig. 3 is provided with a push feed, the operation of which is simple. The flat blanks (which have previously been cut out) are placed in the magazine *A* from which they are removed one at a time to the dies, the feeding being accomplished by a traversing slide receiving its motion through rods *B* and *C*, and levers *D* and *E*.

Friction Dial and Push Feeds

In Fig. 4 is shown an inclinable power press to which is fitted an automatic friction dial and also a push feed. This press is used for reducing and stamping shells which have been previously cut out and drawn in another press. In operation, the shells are placed on the table *A* from which they are removed to the revolving dial *B*, the top of which is flush with the table. The dial *B* carries the blanks to an automatic stop from which they are released one at a time by the cam and spring-actuated feed arm *C*, carrying them to the dies. The arm *C*, which is pivoted to the bracket *D*, is actuated by a cam *E* on the vertical shaft *F*. This shaft derives its power through the bevel gears shown, one of which is attached to the end of the crankshaft. From the vertical shaft *F*, power is also obtained to drive the revolving dial *B* through pulleys *G* and *H*, by a round belt running over suitably placed idlers.

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* For additional information on automatic feeds for power presses and kindred subjects, see MACHINERY, October, 1911, "Automatic Feeds for Power Punching Presses," and other articles there referred to.

Another feature of this press which might well be mentioned, but which in a measure could not be considered a feed, is the method used in removing the finished blanks. This is accomplished by means of a continuous operating endless belt fitted between the sides of the press and driven by a belt running over the hub of the flywheel. After the first blank has been fed to the dies and operated upon, the blank following it is carried to the die by means of the feed arm which pushes the first blank off the die onto the conveyor, the latter depositing the blank in a suitable receptacle.

Friction Dial and Reciprocating Feed

A combination automatic friction dial and reciprocating feed fitted to an inclined press is shown in Fig. 5. Three operations are performed by this press simultaneously. Presses fitted with this combination of feeds are particularly adapted for the production of pieces on which there is a series of operations. The shell to be operated upon in this press is previously cut out and drawn in another press fitted with a feed similar to that illustrated in Fig. 4. After the shells have been blanked and drawn they are placed on the continuously revolving dial *A* which carries them up to an automatic stop from which they are released one at a time. Here they are gripped by the traveling jaws of the reciprocating feed which automatically carry them to each of the three dies *B*, *C* and *D* in consecutive order, finally discharging the finished product at the other end of the press.

The revolving dial *A* is driven by a round belt from a grooved pulley on the flywheel shaft. This belt is changed from a vertical to a horizontal position to drive the pulley attached to the dial shaft by means of idlers. The reciprocating motion of the traveling jaws *E* is accomplished by lever *F*, which is actuated by the "race cam" *G* on the end of the crankshaft.* The automatic opening and closing of the jaws *E* is accomplished by motion transmitted from cam *H* through bellcrank *I*, link *J*, rod *K*, link *L* and levers *M* and *N*. By means of the handle *O*, the traveling jaws *E* may be independently opened at any position. After the first three revolutions of the crankshaft, the press performs three operations at every stroke.

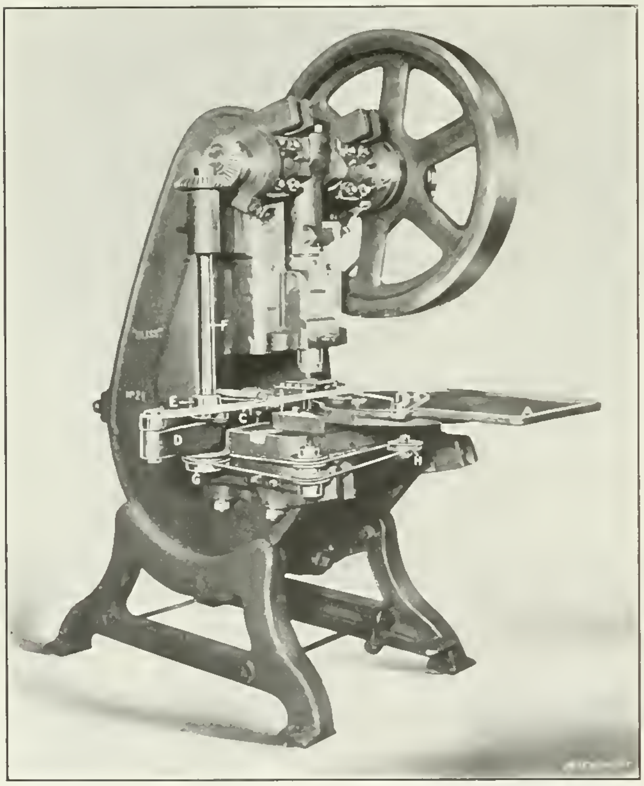

Fig. 4. Bliss Inclined Press equipped with a Combination Friction-dial and Push Feed

Another type of feed which is so well known that it needs no description is the ratchet dial feed. It might be well to mention, however, that presses equipped with this feed are generally provided with a safety device. This device is so connected with the clutch used in stopping and starting the machine as to stop the ram on its downward stroke before it can do any harm, if it should so happen that the dial is prevented from assuming its correct relative position. It will be seen from the foregoing that the various ways in which feeds may be employed are practically unlimited, each and every condition requiring its own solution, whether a combination or single feed is used. The illustrations given, however, show means of eliminating danger to the operator and increasing the production.

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BROWNING STEEL GUN BARRELS

The following is the standard formula used by the United States Government for browning gun barrels and similar steel articles: Alcohol 1½ ounce, tincture of iron 1½ ounce, corrosive sublimate 1½ ounce, sweet spirits of niter 1½ ounce, blue vitriol 1 ounce, nitric acid ¾ ounce, and warm water 1 quart. Dissolve the above ingredients in the water and keep in a glass bottle.

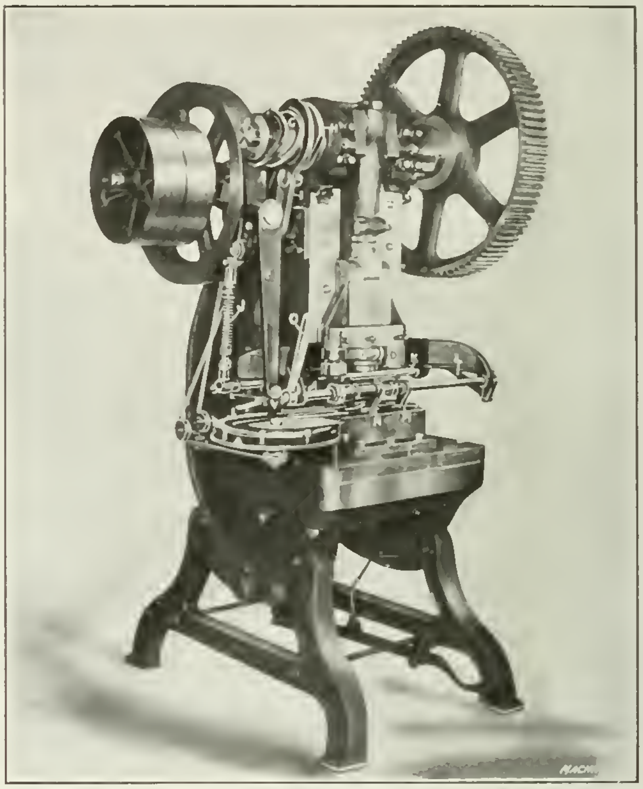


Fig. 5. Inclined Press equipped with a Combination Friction-dial and Reciprocating Feed

The gun barrel to be treated is cleaned with potash of soda to remove the grease, and all stains are then removed with fine emery cloth, so that an even bright surface is produced. The bore and vent of the barrel are closed by plugs of wood. The solution is then applied to the surface of the steel with a sponge and allowed to dry in the air for 24 hours, after which the loose rust is rubbed off with a steel scratch brush. Another coating of the solution is now applied, and allowed to dry in the same manner, after which the scale is again rubbed off with a scratch brush. Finally the barrel is washed in boiling water, dried rapidly and wiped with boiled linseed oil or given a coat of shellac.

* * *

At the last meeting of the German Machine Tool Builders' Association, it was stated that the volume of trade in machine tools during the last year had been satisfactory, on the whole, throughout Germany, but prices had not been so satisfactory, There has been an upward tendency in the cost of raw materials, and an increase in wages. German manufacturers are advised by the association to specialize along certain lines of machine tools. It is reported that the present outlook is satisfactory, and it is anticipated that the trade will be good for a considerable time.

REMARKS BY THE ONLOOKER

Just at this time of the year Machinery's article in the December number on toy-making is happy and interesting. In everyday affairs many things come before our notice to which we give little thought as regards their means of production. It is the cheapness of mechanical toys that attracts the attention of the engineer and designer, and it is interesting to find out some of the reasons for their cheapness. Of course large quantities make for a low cost, but when you inspect a toy carefully you see at once that one of the fundamentals in commercial machinery is entirely neglected, that is, lasting quality. The article gives some surprising figures on the amount of money paid for toys; certainly it is a sum that most of us would hardly think possible. It is evident that very great ingenuity is shown in toy design and no small amount of real engineering skill in production.

The article on collapsible tubes brings to my mind the fact that they are produced in Germany, imported to America, paying a 35 per cent duty, and yet sold 10 per cent lower than American prices. I have this information from one of the largest tube users in America. As far as my informant knew, the quality of the American tubes is no better than that of the imported German tubes. One who has never seen the operation of making these tubes could hardly believe that the methods described so clearly, especially that of "punching" as it may be termed, could be satisfactorily carried on. The business of making tubes in New London is growing rapidly, and a great many of the special machines have been designed and built by Mr. Sheffield, which goes to prove that he belongs to a "mechanical tribe." After all, the soil of New England seems very much better adapted to the growing of collapsible tubes, sewing machines, scissors, machine tools, etc., than agricultural products.

The question of large quantities referred to is a great factor in mechanical production, as is clearly shown in the pages of Machinery by many articles which we call small tools in the shops. Take, for instance, the exhibit of drop-forged wrenches. A drop-forged wrench, beautifully finished, right up to size, and admirably proportioned, can be bought for, say, one-tenth the cost of producing the same wrench in a machine shop with ordinary appliances. This business of manufacturing drop-forged wrenches has been so highly developed that no one thinks now of attempting to make wrenches for himself, but simply orders one as he would a loaf of bread.

One of the interesting exhibits of drop-forging is that of the Billings & Spencer Co.'s multi-point diamond lathe tool. This tool strikes me as being one of the most ingenious labor-saving devices I have seen, but I don't quite see how all the points can be used unless the blank in the middle is made considerably longer than it appears to be in the illustration.

The introduction of high-speed tool steel has brought tool-holders into great prominence. It has always worried me in the past to see eighty cents on a dollar's worth of tool steel "loafing," while a few cents worth at the end of the shop was doing all the work. These tool-holders again show the ingenuity of the American mechanic, and I sometimes wonder whether anybody can get up a new form possessing any material advantages over those now in use. I hardly think that more are needed.

In looking at the advertisement of a hacksaw made in New Haven, Conn., my thoughts went back to the time when a Stubbs' hacksaw was the only one on the market so far as I knew. I have actually seen a man filing the teeth of one of these hacksaws, an operation which I think has not been performed in the United States for many years. The cheapness of modern hacksaws is a source of wonder; they may be regarded as another case of Yankee ingenuity.

When I saw the first "Lo-swing" lathe, it seemed to me that accurate production could not be expected from it, but upon buying one and using it, I found the principal difficulty was to clear away the chips. Having a certain number of shafts to finish to three diameters, I used the "Lo-swing" lathe on stock 2¼ inches in diameter. The first day I had to send out and buy a wheelbarrow of exceptionally large size to wheel away the chips, and I believe I lost my reputation as a man of veracity when I showed a visitor the piled-up chips of a few days' work. I know he said afterwards that I must have a large interest in the company building the lathe if I was ready to fake up what it could do, as I did. Of course the capacity of this machine is confined to moderate diameters—about 4 inches—but its design is in line with that of coming machine tools, having a limited range of capacity and capable of an enormous output.

Referring to the editorial "Efficiency in Men and Machines," I wish to say that while I agree thoroughly with the idea that a good tool should be operated by a good man, I think, Mr. Editor, that you overlooked the fact that a first-class machinist will not run a special tool for any great length of time. The work becomes monotonous to him and he thinks it is beneath his dignity. A man of low mental ability can be trained to run repetition machines, and run them satisfactorily. Such men produce a large output which enables the manufacturer to pay good wages, and it is to his advantage to do so.

I drew the attention of an acquaintance to the article by Mr. Lucas, "Making Dies for Hammering Machines," which gave him the first idea of the wonderful productive capacity of this type of machine for certain classes of work. Within twenty-four hours, he told me that he thought a business in which he was interested and which was paying almost no profit could be made profitable by employing hammering machines to form certain parts. So much for the value of a good technical article! The first machine for work of this character that I recollect was Mr. Goodyear's swaging machine—another Yankee invention.

The German decision concerning trade secrets is interesting, and it seems to me that the higher courts were right in deciding that the knowledge which a man acquires in the course of his work can be used freely by him even if it be in competition. It could hardly be expected that a beautiful melody once heard by a musician could be forgotten by him, and how can a man forget experience which he has gained in years of work? How can we deny to him his right to use his knowledge afterwards?

In reading the description of the manufacture of fountain pens I was astonished to learn that there was so much hand work required. I naturally thought that the enormous number produced would have resulted in the development of more automatic machinery.

Referring to the articles on "The Manufacture of the Ross Rifle," we are all talking now of peace, and most of us believe in peace when we have gotten too old to do any more fighting. But how much the mechanical world owes to military demands! Hall began the production of interchangeable parts of guns in Maine years and years ago, and I think it is fair to say that had this system not been called into existence by military demands, cheap cutlery, sewing machines and a thousand and one other articles now within the reach of all, would not have materialized nearly as soon as they did. In passing remarks on the gun manufacture, the ingenuity in making the fermetures of guns is remarkable. It seems a very simple problem to close a hole and open it again, but I estimate that at least 1500 patents have been issued on breech closing devices, and the end is not yet. The problem becomes more and more complicated with the increase of breech pressures that has to be provided for. Simplicity is absolutely necessary too.

The concrete information given in Machinery concerning gear cutting has lifted a great load from the shoulders of designers. The article by Mr. Burley giving data for the depth and width of land of end-mills having various numbers of teeth is an example. But we are all specialists today, and it is a great deal easier to write to a milling cutter manufacturer, telling him what we want, and let him run the risk connected with making and hardening a cutter than it is for us to try to do such work in the ordinary shop.

In the article on "Methods in Automobile Manufacture," by Mr. Hays, Fig. 6 shows connecting-rods being milled. It seems rather strange when considering this operation that three rods are practically standing idle awaiting their turn to be milled while one is going through the operation of being finished. Is not time lost here? Would it not be much better and cheaper to use a simple single operating machine and mill the rods in multiples? Such a machine could be designed and built at a small cost, and one man could attend to the work and be doing something all the time instead of standing by, looking on and watching the parts take their turn being machined. This is a crank notion of mine, but I find that it is "taking hold," as the boys say. I am now designing a machine that will cost less than $200, and will replace machines that cost over $4000, and my machine will have the great advantage of not being able to do anything wrong. It will have the disadvantage, however, that it can be used for only one operation, thus making it so special that in case the work is given up the machine's value is only what it will bring for junk.

In speaking of small tools which can be obtained today, twist drills seem to give the largest return for the money of anything that goes into the machine shop. They last a long time if properly used, but judgment is required of the user. In a large shop, not very far from New York, I saw a barrel full of drills over 2 inches diameter, every one of which was split on the end. I had never had this happen in my own experience, and upon investigation found that the trouble came from running the drills too slow with too heavy a feed. My way of using drills above 2 inches diameter, or even 1½ inch diameter, is always to drill a pilot hole, say ¼ inch diameter. I think most mechanical men will agree with me that the pilot hole saves time and drills.

Almost every machinist is likely to believe, if he is of the old-time sort, that he ought to harden his own tools, and in fact a good many think that unless they grind their own tools they won't get good results, but it has always seemed absurd to me that a man who only occasionally hardens a tool and draws its temper could expect to even approach the quality of work turned out by the man who is doing it constantly. We have a concern in South Boston that can harden almost any tool or caseharden and anneal almost anything. I have seen some of the work produced by the New England Annealing Co., and it simply makes the hardening and tempering work done in the ordinary shop look foolish.

I want to say one thing more about twist drills, and that is, it would be a great convenience to users if the size were stamped in more than one place. The size is often obliterated by misuse, of course, and time is lost in calipering drills. I know one shop that has a good method which helps out considerably. All drills in the sixty-fourth sizes have a nick ground in the taper shank. This nick enables a man to take a sixty-fourth-inch size even in the dark, and has often prevented the making of serious mistakes. W. D. F.

* * *

A boat operated by wireless transmission of electricity was recently exhibited on the Danube at Vienna. The boat carries a storage battery which furnishes the motive power. The new invention consists in controlling this motive power, the steering gear and other mechanisms, by electric waves from the shore. At the exhibition the boat moved forward and backward, turned to the right and left, described various curves, was guided to definite points, rung bells, exhibited flags and lights, etc., giving proof of effective control. The mechanism, however, was far from perfect in that the response to the operator's will was hesitating and inexact, and the range limited to some few hundred feet. The exhibition, however, notes the beginning of a development which possibly will have some importance.

* * *

According to a report made by the House Committee on Expenditures in the Post Office Department, the 10,000 publishers in this country reported an output of more than 6,500,000,000 copies, weighing 1,750,000,000 pounds during the past fiscal year. Of this the postal service handled 951,001,669 pounds, for which it received 1 cent per pound, excluding 500,000 pounds which were carried free within counties; 840,466,574 pounds were delivered by the publishers, newsboys, news companies, etc., 202,729,510 pounds were delivered by express and 121,491,748 pounds by other rail shipments. The rate by express and rail varied from ¼ to 1 cent per pound. The bulk of the shipments, however, was sent at the rate of ¼ to ½ cent per pound.

ON THE CHOICE OF A PROFESSION

The following correspondence regarding the question that every ambitious young man must decide for himself is submitted without comment except that the answer to us seems particularly apt and expressive.—EDITOR.

April 2nd, 1910.

The Cutler-Hammer Mfg. Co.
Milwaukee, Wis.

Gentlemen: I write for a little information. I am going to study either electrical or civil engineering in an university next fall, but I have not decided which to study. Could you tell me what kind of work is to be done along these lines, and what salaries are paid? Or could you tell me where to get some reliable information on the subject?

Yours respectfully,

Dear Sir:—We are in receipt of your letter of April 2nd stating that you intend to take up next fall the study of either electrical engineering or civil engineering, but are undecided as to which of the two professions it would be better to adopt. We would gladly comply with your request for advice if this were a matter in which the advice of one person would be helpful to another, but the question is one of those that every man must determine for himself. If instead of entering a university you contemplated marriage and had written us, "I intend to get married next fall; which shall I marry, a blonde or a brunette?" you can realize that the question would have been a difficult one for us to answer, but no more so than the question you have propounded in your letter. If you are in love with electrical engineering, be an electrical engineer. If you are in love with civil engineering, be a civil engineer. And, if you are not in love with either of them but merely think that it would be nice to be an engineer of some kind follow the advice of *Punch* to people about to marry—"DON'T."

It really makes no difference what profession you adopt or what business career you decide to follow so long as you do well the thing that you undertake to do. Carlyle said "No man is born into this world whose work is not born with him," and sooner or later all of us find the work we are best fitted to do.

As to the question: "What salaries are paid," we are equally unable to reply to this, and we do not believe that anyone who thinks first of his salary and then of his work is ever likely to accomplish much in any profession or industry. The things that are really worth while doing are done by the men who work for work's sake, for the love of doing, and for the satisfaction that comes to every man when he has done a thing well. The salary follows the work, as trade is said to follow the flag, and you may be sure that, whatever work you do (if it is work that is worth doing and is done well) you will nearly always receive in dollars and cents the value of your labor. Not quite the full value, perhaps, for the man you work for is entitled to a profit on you as on everything else in which risk of capital is involved.

For information regarding courses in electrical and civil engineering, we suggest that you write to the Ohio State University, Columbus, Ohio, and with best wishes for your success in whatever career you may elect to follow, we are,

Very truly yours,
THE CUTLER-HAMMER MFG. CO.
Chas. L. Benjamin,
Advertising Manager.

* * *

A typical form of railway water tank is that having the tank mounted on a framework of steel or wood. A new form has been adopted on the Cotton Belt Ry. at East Waco, Texas, where a tank 24 feet in diameter and 35 feet high has been erected. This tank is mounted on a low concrete foundation and is provided with the usual gage and delivery spout. The space below the discharge pipe acts as a settling chamber and affords a reserve capacity that can be drawn on in emergencies, when the normal water supply fails. Another point in favor of this construction is less cost and greater durability than the common form. The water and lower shell courses act as the support for the tank proper, that is the portion above the discharge pipe. This form of water tank is symmetrical, easy to keep painted, and simple to erect.

LETTERS ON PRACTICAL SUBJECTS

We pay only for articles published exclusively in MACHINERY.

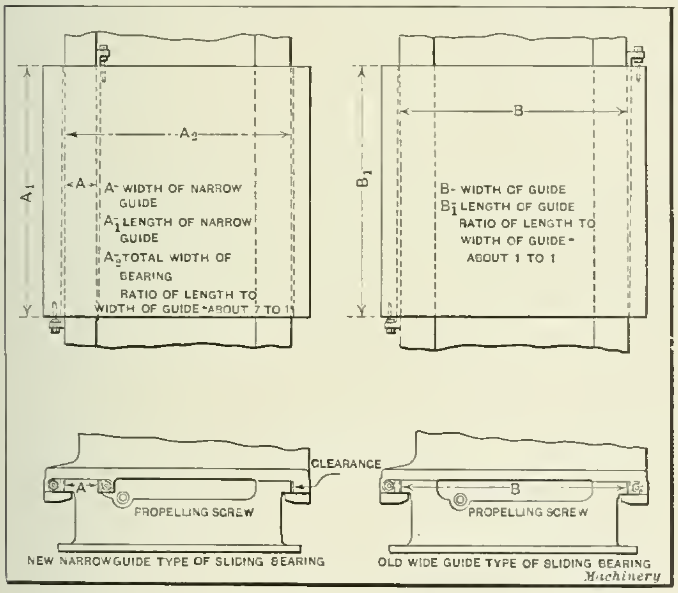
THE INTRODUCTION OF THE NARROW GUIDE ON MACHINE TOOLS

In compliance with your request for a statement from me as to the reason for introducing the narrow guide on our tools, the following will give you our experience:

About the year 1897, we required a horizontal drilling and boring machine, and not finding one on the market to suit our purposes, we concluded to build one that would fill our requirements. This we did on the general lines then in practice by other builders.

In testing the machine out, we soon discovered that the alignment of the spindle in being moved to different locations, transversely by the movement of the column on its runway, and vertically by the movement of the saddle on the column, was inaccurate, which we discovered was caused by the necessary looseness of the sliding fits of the column on the runway, and of the saddle on the column. The wide surfaces then in use by the builders of these tools, whose designs we followed, were provided with guides at the outer edges of these surfaces only.

The looseness necessary to permit the slides to move freely was always sufficient to change the alignment of the spindle when the location of the saddle or column was changed, and was sufficient to make the cutting head (when used for milling) drag at its back edge into the milled surface. Seeing this difficulty, we realized at once that we could reduce this inaccuracy of the alignment of the spindle to a minimum, by making the guideways as narrow as practicable, and as much greater in length than the width as the character of the machine would allow. This we have done since on all of our tools with marked success, except our planers, on which the necessity for this narrow guide does not exist to the extent that it does on horizontal boring machines and tools of that character.


A₂
A₁
A
A- WIDTH OF NARROW GUIDE
A₁- LENGTH OF NARROW GUIDE
A₂- TOTAL WIDTH OF BEARING
RATIO OF LENGTH TO WIDTH OF GUIDE - ABOUT 7 TO 1
Y
B
B₁
B- WIDTH OF GUIDE
B₁- LENGTH OF GUIDE
RATIO OF LENGTH TO WIDTH OF GUIDE - ABOUT 1 TO 1
Y
CLEARANCE
A
PROPELLING SCREW
B
PROPELLING SCREW
NEW NARROW GUIDE TYPE OF SLIDING BEARING
OLD WIDE GUIDE TYPE OF SLIDING BEARING
Machinery

The Narrow Guide Type of Sliding Bearing, and the Wide Type

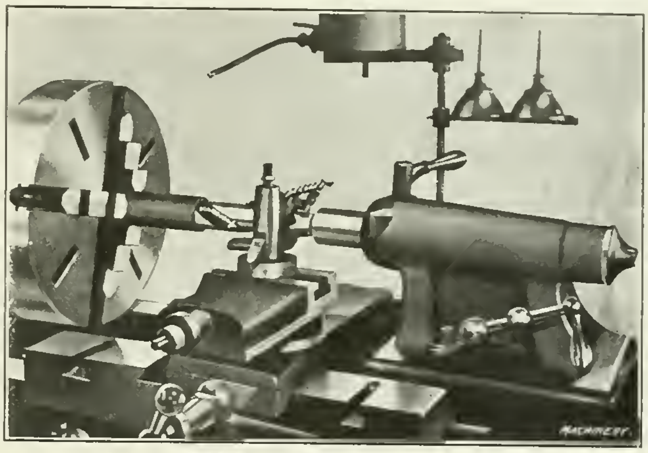
When the attention of Professor Sweet of the Straight Line Engine Co., was called to this feature in our tool he recognized at once this improvement and gave us an order for a tool embodying it. The late Mr. E. P. Bullard, of the Bullard Machine Tool Co., happened in our shop soon after we had adopted this narrow guide, to see how the vertical mills were going that we had purchased from him a short time before, and he thought so well of it, that he proceeded to use it on the cross-rails of his vertical mills, and we notice that other builders of tools have adopted it also. At this time, we also showed Mr. Bullard a device we had applied to his vertical mills, for stopping the table, and later on, he supplied a device on his mills for this purpose. There is no question as to the narrow guide being an improved method of guiding the tool-carrying head of any machine, and I predict its more extended use in the future.

J. S. DETRICK

Baltimore, Md. Pres. Detrick & Harvey Machine Co.

DRILLING BY POWER FEED

When drilling a large hole in a solid piece, such as an iron casting, a bar of steel, etc., it is a tedious job to feed the drill in by hand, especially when the hole is very deep. Having had considerable drilling of this kind to do, the writer struck on the following plan: The drill, which has a tapered shank, is forced into the sleeve of the tailstock, and the tailstock head is clamped to the lathe bed. A dog is then fastened to the drill as illustrated, the tail resting on the toolpost base. The tool is clamped in the toolpost, as shown, bearing against the rear of the dog, and the nut and handle are removed from the screw in the back of the tailstock spindle, thus allowing the spindle to move freely out of the tailstock. The attachment is then ready for operation when the feed-nut is engaged with the lead-screw, thus traversing the carriage; and as the dog is backed up with the tool in the toolpost, the drill is fed into the work.

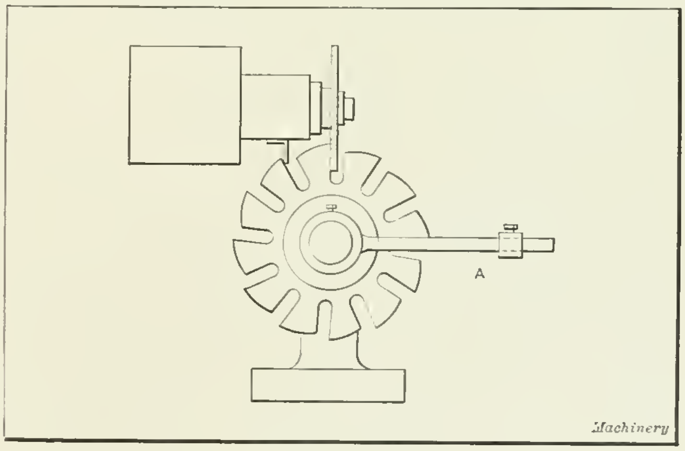


Drilling a Large Hole by Power Feed

C. E. POND

SHARPENING A HOB IN A SHAPER

In the October number of MACHINERY, Mr. E. J. Carlson describes a method of sharpening a hob in a shaper. Apparently the hob in question had straight flutes, otherwise the method indicated would not have been satisfactory. If the flutes are spiral (or, more strictly, helical) it will be necessary to turn the hob arbor through an angle in the horizontal plane equal to the pitch or spiral angle of the flutes, and to attach a guide-finger to the head carrying the grinding wheel instead of mounting an indexing bracket on the table of the machine. The guide should be placed on the grinding head so that its point is immediately beneath the axis of the



Method of Sharpening Hobs having Spiral Flutes, in a Shaper grinding wheel arbor and a tooth ahead of the wheel, as shown in the accompanying illustration.

As the guide-finger moves with the wheel in a straight line, it causes the hob to turn slightly about on its axis; the combination of these two movements results in the formation of the spiral or helical cutting edges of the hob. To keep the teeth against the guide-finger (which should be wider than the spaces between the threads on the hob, so as to provide continuous action between the finger and the hob), either a slight pressure of the hand has to be applied or a small suspended weight has to be attached to the end of a cord or string wrapped once or twice around the hob arbor.

Another way of doing this is to fasten an adjustably weighted arm on the hob arbor, as indicated at *A*. This method, it should be noted, can only be applied to hobs having equally spaced flutes; where the flutes are unevenly spaced, the guide-finger would have to be placed so that its point falls immediately beneath the grinding wheel, and touches the bottom of the flutes in the hob. This condition is much more difficult to effect than the previous one, because the guide-finger has to be made much smaller and consequently weaker, thereby increasing the risk of something going wrong.

Sheffield, England. GEORGE W. BURLEY

SPEED-REDUCING MECHANISMS

In the October number of MACHINERY an article appeared on speed-reducing mechanisms, written by Mr. S. Hurley. A statement is made which, although correct in substance, in this instance is wrong in principle, *viz*: "Since the diameter *A* is a little more than that of *B*, *C* is revolved slowly in the same direction as *L*."

The diameter of the gears has absolutely nothing to do with the direction of motion of *C*. Gear *A* could be a little more or a great deal more in diameter than gear *B*, or gear *B* could be a trifle or a great deal larger in diameter than gear *A*, and still gear *C* could revolve in either the same or in the opposite direction to handle *L*. It is the numbers of teeth in the gears and not the diameters which control the final movement.

The following is a method for analysis of epicyclic gearing which the writer arrived at many years ago. The method is applied in the following to the arrangement shown by Mr. Hurley (see Fig. 1 of the following article). Handle *L* is turned around in, say a right-hand direction, bringing with it eccentric *E*. Gears *A* and *B* are carried around with the eccentric. Gear *D* is fixed to the frame of the machine, and gear *A* moves around the eccentric inside of *B*. Gear *B* makes the same number of revolutions as *A*. Apparently, if gear *C* had the same number of teeth as gear *D*, it would have no movement whatever, because for one revolution of crank *L*, gear *A* will engage with 61 teeth in gear *D*, and gear *B* will engage with the same number of teeth in gear *C*. Gear *C*, however, has 63 teeth, therefore, 2 teeth have been pushed forward out of the way so that these 2 teeth represent the movement of gear *C* in one turn of handle *L*, and as gear *C* has 63 teeth, the movement $= \frac{2}{63} = \frac{1}{31.5}$ of a revolution, or, in other words, handle *L* must make 31.5 revolutions for one revolution of gear *C*. In this particular case, no calculations are necessary as the result can be seen at a glance. It is only when all four gears have a different number of teeth that any calculations are required.

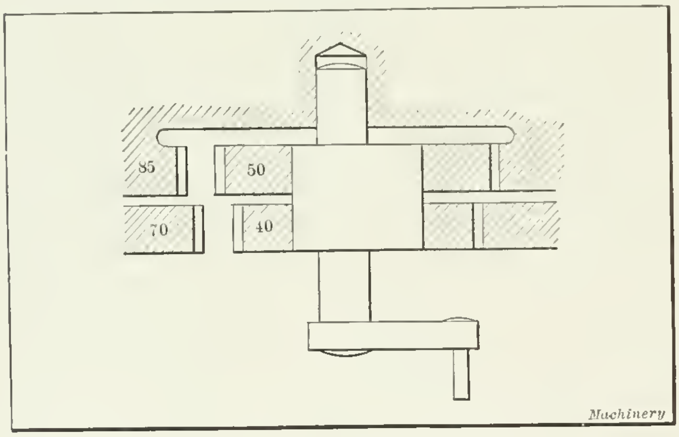


Fig. 1. Type of Speed-reducing Gear Mechanisms

As an example, assume that gear *A* has 40 teeth, *B* 50 teeth, *C* 85 teeth, and *D* 70 teeth, as indicated in Fig. 1. Here *D* has $1\frac{3}{4}$ times the number of teeth of *A*. If the motion of the crank should produce no motion of the gear *C*, it would be necessary that the latter should have $1\frac{3}{4}$ times the number of teeth of gear *B*, or $1\frac{3}{4} \times 50 = 87\frac{1}{2}$. Gear *C*, however, has only 85 teeth, hence, $2\frac{1}{2}$ teeth are pushed back for each revolution, and the movement of gear *C* in a reversed direction to handle $L = \frac{2\frac{1}{2}}{85} = \frac{1}{34}$ of a revolution. Hence, 34 revolutions of handle *L* are required to one revolution of gear *C*.

As a final example, we will take the arrangement shown in Fig. 2. This arrangement is the well-known two-speed feed-gear, which is found very often on automatic screw machines. When the feed belt is on pulley *A*, shaft *B* is driven at full speed, but when the belt is on pulley *C*, there is a reduction of speed due to the planetary gearing. In order to find the speed reduction and the direction of revolution according to the method given, we first note that gears *D* and *E* are equal. Therefore, we know that if gear *G* had the same number of teeth as gear *H*, no movement would take place. It actually has, however, four teeth more; therefore, four teeth are pushed forward out of the way for each revolution of *C*. As gear *G* has twenty-six teeth, the forward movement for each revolution of *C* is $\frac{4}{26} = \frac{1}{6\frac{1}{2}}$ of a revolution, or in other words, pulley *C* makes $6\frac{1}{2}$ revolutions to one revolution of shaft *B*, the motion being in the same direction.

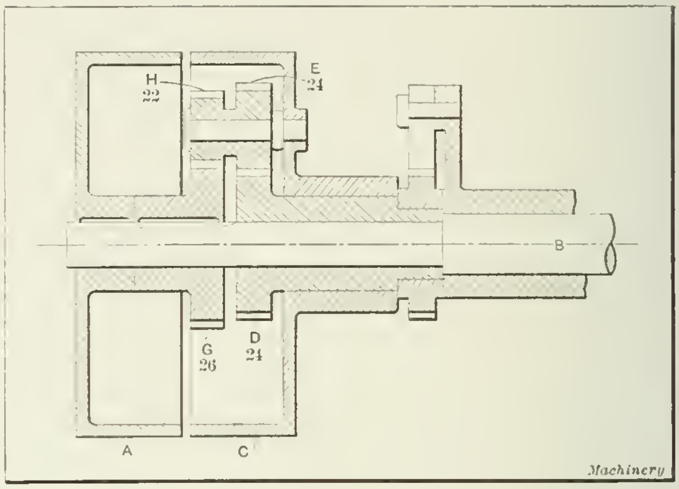


Fig. 2. Another Epicyclic Gear Arrangement

It is not claimed that the above method will apply to every case, but it will apply to the majority of planetary gearing arrangements, and it has the advantage of being simple and easily applied. RICHARD W. DICKINSON

Pawtucket, R. I.

[The method given by our correspondent is the simplest and so to say, most natural method that can be applied to planetary gearing. Its only disadvantage is that it is liable to cause confusion and mistakes in complicated cases of planetary gearing. In such cases, the safest method, and one which is always applicable, is that given by Mr. Hurley in the October number. —EDITOR.]

ANALYSIS OF SPEED-REDUCING MECHANISM

The mechanism shown in Fig. 1, reproduced from the article by Mr. S. Hurley in the October number of MACHINERY, is generally known, and is applied to several mechanisms, among others to the well-known Moore's differential pulley block. The analysis is very simple and may be reasoned out as follows: As will be remembered, gear *A*, in Fig. 1, has 45 teeth, 16 pitch; gear *B*, 45 teeth, 18 pitch; gear *C*, 63 teeth, 18 pitch; and *D*, 61 teeth, 16 pitch. The gears *A* and *B* are locked together, and as they have the same number of teeth it is evident that for every revolution of crank *L* the number of teeth displaced in the internal gears *C* and *D* will be the same. Since gear *D* is fixed, it is evident that the movement of *C* must be the difference of the number of teeth in gears *C* and *D* divided by the number of teeth in *C*; hence, the movement of $C = \frac{63 - 61}{63} = \frac{2}{63}$ revolution for every revolution of the crank.

Further, as gear *C* has a greater number of teeth than gear *D*, it will move in the same direction as *L*. This may perhaps be better understood by referring to Fig. 2, which represents the same kinematic conditions as in Fig. 1. As the gear *D* is fixed, if we give one revolution to the arm *L*, then *C* will make one revolution forward, due to this movement. Due to the train of gearing the movement will be $\frac{D \times B}{A \times C}$ revolutions, and as shown by the arrows in the diagram in Fig. 2, this movement will be opposite to that of *L*. Hence, the movement of *C* for every revolution of the crank *L* will be equal to,

$$1 - \frac{61 \times 45}{45 \times 63} = 1 - \frac{61}{63} = \frac{2}{63} \text{ revolutions.}$$

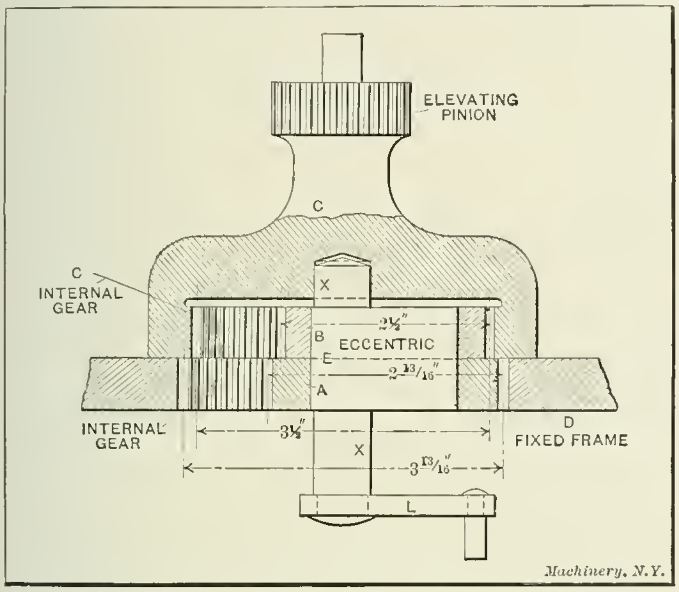


Fig. 1. Epicyclic Gear Train used in Speed-reducing Mechanism

G. H. LONGWORTH

Belfast, Ireland.

[The simple analysis above is possible in this case only because gears *A* and *B* happened to have the same number of teeth. If these gears had been different, the analysis could not have been so easily made, and the simplest method to employ would then have been the method given in the October number. That method is general, covering all cases of epicyclic gearing, and was therefore given for this special case also.—EDITOR.]

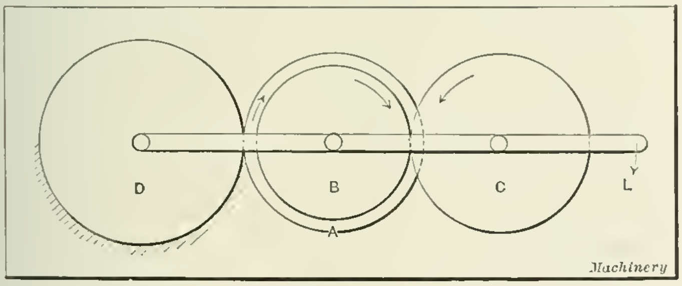


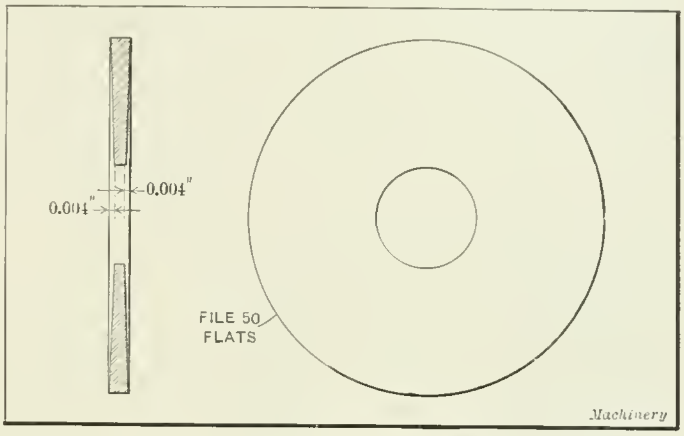
Fig. 2. Diagram for Analysis of Epicyclic Gearing in Fig. 1

SLOTTING LOCK TUMBLERS

Having had considerable trouble with the teeth stripping and the saws breaking when slotting lock tumblers, we experimented with different kinds of saws, operating them at various speeds. This, however, did not rectify the matter, so we made a disk 3½ inches in diameter, wide enough to cut the slot in the tumbler. This disk was hardened glass-hard and drawn, the outer edge being left a light straw color. It was then ground tapering on the sides, as shown in the accompanying illustration, to 0.004 inch, to provide for clearance, and placed on an arbor between shaper centers which, in turn, were placed on a magnetic chuck on the grinder. Fifty flats were ground on the edge of the disk, each flat meeting the one next to it.

The tumblers to be slotted were made from brass and cold-rolled steel, and varied from 0.020 to 0.050 inch in thickness. The pulleys on the overhead works for the sawing machine were changed, so that the disk was rotated at 1600 R. P. M. This disk cut the tumblers like cheese and did not leave any burrs; it could also be used for weeks without grinding.

W. C. BETZ



Friction Disk for Slotting Lock Tumblers

DIES FOR DRAWING A DEEP STEEL SHELL

Little information has appeared in the technical press on the subject of drawing dies, and the writer considers that this line of work is only in its infancy. A large majority of work which was previously made from castings can now be made from sheet steel by drawing up bosses and reinforcing ribs to strengthen the work. In our shop we recently completed a set of drawing dies for producing a steel can 4 inches in diameter and 8⅝ inches long, with a 3/32-inch shoulder formed at an angle of 15 degrees with the sides. Fig. 1 shows the blank *A* and the successive drawing operations. The blank is made from sheet steel, 1/16 inch thick, and is 12 3/4 inches in diameter.

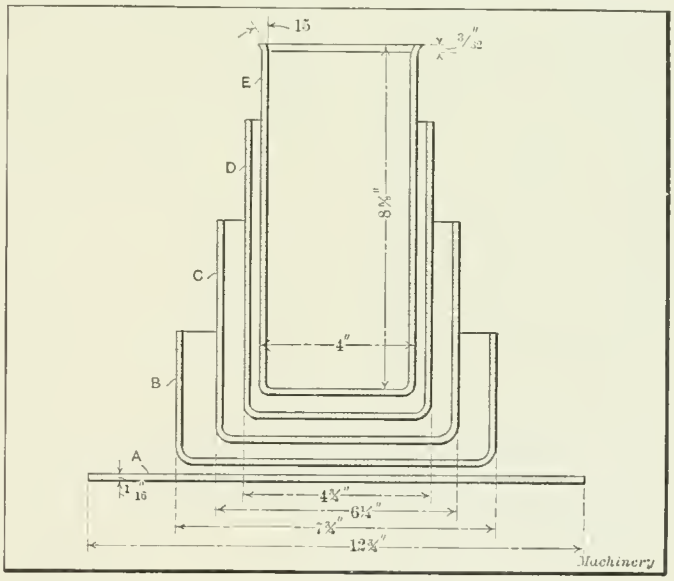


Fig. 1. The Blank and the Successive Drawing Operations

The first drawing or cupping die is shown in Fig. 2, and the cup produced in this die is shown at *B* in Fig. 1. The die bed *A*, Fig. 2, is made from cast iron, while the drawing die *B* is made from machine steel, pack-hardened. The punch *C* is also made from machine steel, and pack-hardened, and the blank-holder *D* is made from cast iron, faced with a hardened machine-steel ring *E*. The cup is stripped from the punch by means of the finger *F*, acted upon by the spiral spring shown.

The construction of the second drawing die, shown in Fig. 3, is substantially the same as that shown in Fig. 2, except that it is provided with a gage-plate *G* for holding the cup. The length of the shell produced by the die shown in Fig. 3 is indicated at *C* in Fig. 1. After these two drawing operations the shell is annealed, and then put through the die shown in Fig. 4. The construction of this die is similar to that shown in Fig. 3, and therefore needs no description.

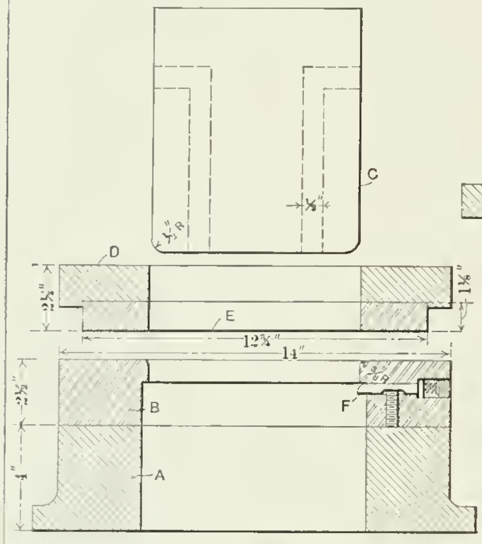


Fig. 2. Punch and Die for Forming the Cup

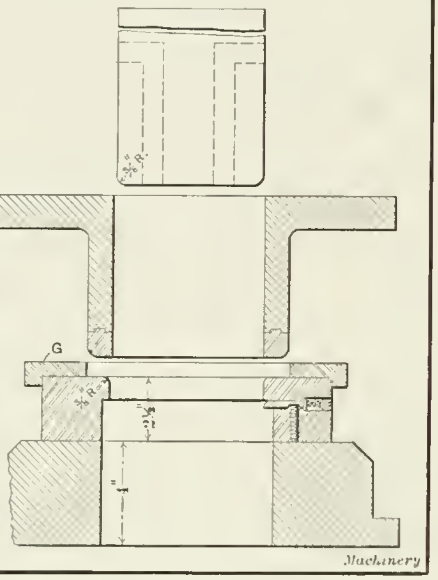


Fig. 3. Punch and Die for Second Operation

The cup *D*, after the third drawing operation, was too long to be inserted in the press for the fourth drawing operation, and had to be trimmed down to 7½ inches. The shell is kept in an upright position in the die, Fig. 5, by a ring gage or guide *A*, which fits in the top of the shell when it is located in the die, and holds it while the punch forces it through. The distance between the bed and the ram of the press was not sufficient to allow the use of this guide without trimming the shell, which operation could have been dispensed with if a suitable press had been available.

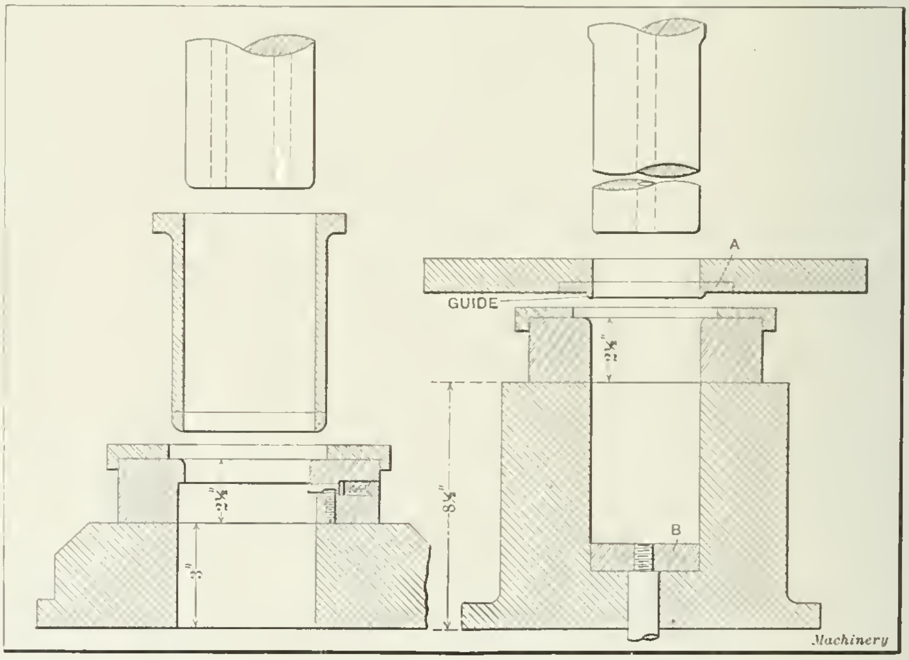
The shell was annealed after the third drawing operation, and then put through the finish-drawing die shown in Fig. 5, after which it was trimmed to the required length. The last drawing die, Fig. 5, is provided with a knockout *B*, which was necessary, as it was impossible to force the shell through the die in this operation, on account of the punch forming a flange on it, as shown at *E* in Fig. 1. All the drawing punches were provided with air passages, and the drawing faces of the blank-holders were made from tool steel and hardened. THOMAS ALMA

THE VALUE OF THE SCLEROSCOPE

No doubt most readers of mechanical magazines have heard about the scleroscope, and probably have used it with satisfactory results. My experience with this instrument is very favorable and I could write much about it, but will only give those instances which best serve to show its advantages. It seems rather queer to me that steel houses do not equip their warehouses and salesmen with the scleroscope. It undoubtedly would settle all disputes in delivering steel, etc. On the other hand, some salesmen wish that it had never been invented, for the reason that it is somewhat of a "judge," and steel is often returned because it is found by the scleroscope not to be as represented. This is where the instrument gets in its good work.

My experience has demonstrated that the scleroscope when used on annealed steel will give almost the exact working results of the steel when in the hardened and tempered state. There is a great saving of time in testing annealed steel, as it does away with the work of cutting off samples, hardening, drawing, breaking, and crystallizing to find the carbon contents, etc. Of course, the latter method is all right, but the use of the scleroscope is much simpler. We have used it a great deal on hardened stock, but only in tempering, because when the quality of the steel in its annealed state is known, the temper to which it should be drawn is easily obtained. Sometimes steel that is sold for high-carbon steel is found to be low in carbon.

A few years ago we could judge approximately the carbon contents of steel, but now we can tell it exactly. Drop dies for lock keys must be made from high-carbon steel in order to harden as much as possible in the center of a 2- by 3-inch bar. Carbon steel striking 33 to 35 (by the scleroscope) in the annealed state is the best, and 2- by 3-inch stock will increase about 10 points in the center after hardening, which is just sufficient to keep the die-block from sinking. This grade of steel can be drawn to a purple color and will give good service, but a piece of 2- by 3-inch stock striking from 28 to 30 will not harden in the center at all, leaving a crust that settles down into the soft center with the blow of the drop hammer, and after a few blows cracks. Some salesmen will say, "We have a steel that will suit your purpose." They send us a sample piece of ½-inch by 2-inch by 3-inch stock, and it strikes about 37. Here is a good point to remember: Do not trust to their annealing; anneal it yourself and you can get the actual quality of the steel. After annealing, this same piece would probably strike 33, but more often 28 or 29, which indicates that it is low in carbon. A piece of steel should strike at least 30 to make any ordinary tool that will give good results.



Figs. 4 and 5. Punches and Dies for the Third and Fourth Drawing Operations

It seems difficult now to get high-carbon steel for special work. Perhaps the reason is that there is so much alloy steel on the market (which is all right in its place) that the steel warehouses do not carry a large amount of high-carbon steel.

For making key dies, straight carbon is the best. We have tried a great many different grades of steel for this particular work, but have come to the conclusion that the regular high-carbon steel is the best if properly tempered. If manufacturers and warehouses would sort their steel with a scleroscope it would place the selling of steel on a sound basis.

This brings to my mind an article which I read some time ago in one of the technical magazines about a Mr. Jackson having considerable trouble in hardening steel uniformly, although he had all the best and most modern equipment, pyrometers, etc. Mr. Jackson took a trip to see how the steel was made at the mills with the hope of finding the cause of his trouble. He watched the "headlooker" peer into the furnaces and wondered how he was gaging the different heats, so he asked what pyrometers they used; but that was a new one on them as they had never even heard of such an instrument, and were sure that there were none about the place. He then began to wonder why he should use such a good equipment when at the steel mills the steel was made by the eye alone, which seemed more like guesswork than the methods he was using. It may be inferred from this that the makers and warehouses do not generally use the scleroscope; if they did it would be better all around.

New Britain, Conn. J. W. Dickinson

DRAFTSMEN'S DIFFICULTIES IN FOLLOWING HEALTH RULES

The article "Physical Health and Drafting" in the November number of Machinery contains a great deal of truth, and if the rules could be followed absolutely, much good would result. However, it seems to the writer that some of the statements as to the proper posture that a draftsman can maintain are slightly erroneous. The author says that many draftsmen begin their day's work by tying a small apron about their waist to protect the clothing from being rubbed, but points out that the draftsman's work does not really call for the use of the abdominal portion of the body to correctly fulfill his duties; yet, it is practically impossible to follow this occupation without submitting that portion of the body to considerable pressure. The theory of proper posture is very good and it is obvious that serious results may follow if it is entirely neglected, but the draftsman, however willing he may be to aid nature in preserving his health, finds it incumbent upon him to produce the work, and to this end he must assume positions which at the best are extremely uncomfortable. This is especially true on large drawings; for although, as suggested in the article referred to, the draftsman may rest his knees on his stool, any draftsman who has tried this, especially on a revolving stool, knows how incompatible this position is with rapid work and comfort. The advice to assume a sitting position on the board is practically impossible to follow on all adjustable tables.

The average height of the front edge of the majority of drafting tables is perhaps about 3 feet 6 inches, with the back edge 4 or 5 inches higher. A man of ordinary height, standing or sitting at a non-adjustable table of this height will be able to assume a proper posture and work over any small drawings, but when any part of the work exceeds a distance of 15 inches from the edge of the table, he cannot do the work and keep clear of the edge. When drawing horizontal lines on accurate work by means of the T-square, he must lean over until the eye is vertically above the line to be drawn. Hence, with a table 38 or 40 inches in width, this means that when a draftsman is working on a drawing that is nearly the full width of the table, he must lean over the edge at least 20 inches, even if the work is accessible from all sides, which unfortunately is not often the case. The advice which is given in the article referred to is often given in class-rooms by drawing instructors. This can be followed on the small drawings with boards to suit which are here used, but the argument loses a great deal of its force when applied to practical work. Many drafting-rooms, even in large plants, have tables which cannot be moved or adjusted in any manner, and the stools are often of a fixed height—consequently the draftsman must make the best of the situation.

The writer has found that the arrangement shown in Fig. 1 of the previous article, with the drawing tables placed with the left end towards the window and the table a little back of the direct line of the window, is not as satisfactory as when the table is put a little ahead of the direct line of the window. When in this position there is no glare of light shining in the face of the draftsman, and the light falls on the board at an equally good angle. The ribbed glass windows that are installed in some places give a most excellent distribution of light and rest the eye from the tiresome glare.

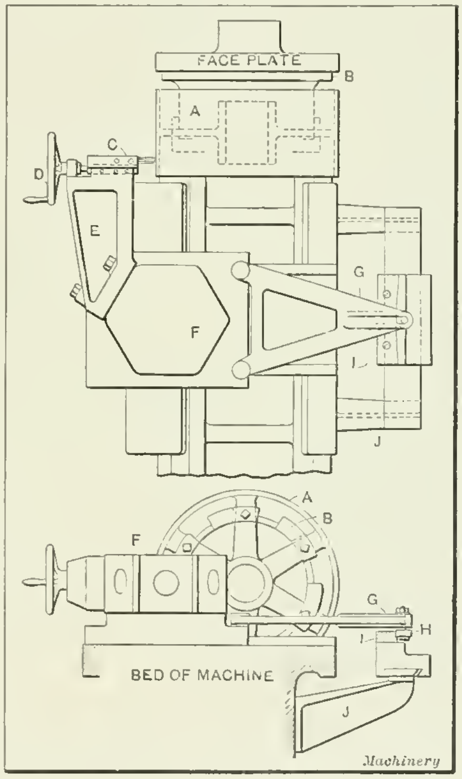
In articles referring to the health of draftsmen, a point rarely mentioned that affects many men, is the habit which some draftsmen have of going out into the shop without putting on any additional clothing. In many places the draftsman frequently goes out into the shop without putting on a coat and head covering, although he passes directly from a warm room to what is in many cases a cold shop. The writer has known of two cases of bad colds, followed by pneumonia, that were laid to this cause.

Hamilton, Ohio. J. B. Haskell

PULLEY-CROWNING ATTACHMENT

In articles referring to the health of draftsmen, a point the writer is connected made an attachment adapted to a Bullard lathe, consisting of a radius bar pivoted at its outer end; this connection, attached to the cross-slide, caused the turret to swing through an arc of the desired radius, as the carriage advanced, crowning the pulley. This proved quite satisfactory for pulleys of small size, but when it was attempted to crown large pulleys, it was found that a sufficiently large radius could not be obtained.

The accompanying engraving shows the manner in which the difficulty was solved; the attachment is designed to accommodate pulleys of all sizes within the capacity of the lathe. Pulley *A*, to be crowned, is attached to the faceplate by a jig *B* which clamps over the pulley arms, the pulley being slipped on and then swung through a part of a turn under the clamps and there secured. A tool is mounted on a carriage *C*, this carriage being fed forward by handwheel *D* on ways in a bracket *E*, which is bolted to one of the faces of the turret head *F*.



Pulley-crowning Attachment for Bullard Turret Lathe

Secured to the cross-slide of the lathe at the side of the turret head is a bracket *G*, carrying on its outer end a roller *H*. The outward pressure between the work and the tool keeps this roller *H* in contact with a form or crowning shape *I*, supported at the rear of the lathe by brackets *J*. The form *I* is detachable and may therefore be replaced at will by the desired shape to give the correct crown. The form is of the exact shape and size of the crown to be produced. To keep the roller on the form, in taking a light cut, a guide should be placed on the other side of the roller.

The bracket *G* is slotted so that the turret can be brought nearer to the center line of the lathe when it is necessary to crown small pulleys; this is accomplished by loosening the bolt and nut which hold *G* and *I* together.

Ashburnham, Mass. K. P. Albridge

SYSTEMS OF DIMENSIONING DRAWINGS

After reading Mr. I. E. Hall's article on "Systems of Dimensioning Drawings," in the November number of MACHINERY, the writer finds himself moved to make a few comments on this subject. Mr. Hall points out that there are four different systems in use for dimensioning, and recommends using a system made up of both common and decimal fractions, because in so doing it is possible to indicate to the mechanic whether a piece of work must be made very accurately or only approximately to size.

The limitations of this system are that the method of dimensioning does not in any way indicate the actual limit of accuracy that is required. More attention should be given to this point. It is just as important to show some limit of accuracy, as it is to show whether a piece has to be made accurately or not. Is the mechanic to work to a limit of 0.0005 or 0.001 inch every time the dimension is given in decimals? Some method should apparently be devised so that the limits of accuracy could be indicated more directly.

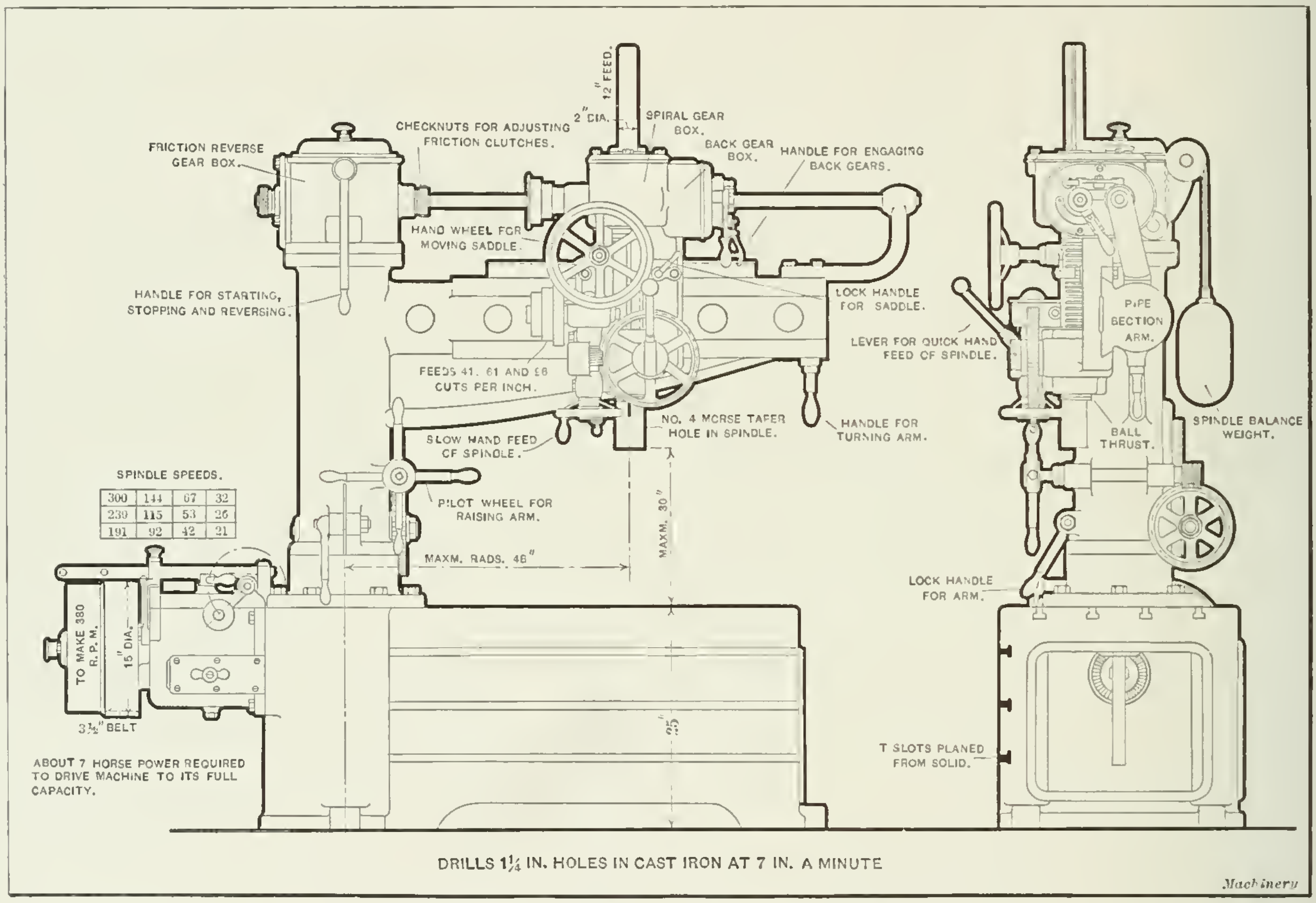
A satisfactory system using nothing but decimals can be adopted which will give the limits to which a piece of work should be finished, the limits being indicated by the number of decimal places used. For example, assume that a certain pin is to be ⅞ inch long, and that the exact length is required; the dimension then would be written 0.8750 inch. Now say that a limit of 0.001 inch over or under the exact size is permissible; this would be shown by writing the dimension 0.875 inch. Again, if a limit of 0.005 inch is allowable, then we would write the dimension 0.87. By the use of certain limits corresponding to the number of decimal places shown on the drawing, it will be possible to see at a glance what is required. The limits adopted to correspond to a certain number of decimal places are, of course, arbitrary, and can be adopted to suit the particular work handled in each shop. For example, four decimal places may indicate a limit of 0.0005 inch above or below; three decimal places, 0.001 inch above or below; and two decimal places, 0.005 inch above or below. It is good practice to place a table of limits right on the drawing on some space provided for that purpose.

In some cases it is necessary that certain work must not be over a certain size, but it can be somewhat smaller. In that case all we would need to do would be to write the dimension 0.875—; this would at once show that the piece must not be longer than 0.875 inch. If the piece could not be shorter than 0.875, but might be somewhat longer, the dimension should be written 0.875+. Of course, the system outlined applies only to shops where a line of accurate work is to be done, but in such shops the system will be found better than any other. It tends to eliminate errors and greatly facilitates the work.

Kingston, Pa. H. J. SCHMIDT

METHOD OF MAKING TENDER-DRAWINGS

When buying a machine, a drawing is of great assistance in helping one to arrive at the merits of the various devices and mechanisms of which the machine is composed. Similarly, if one is trying to sell machines, a drawing is the best medium by which to convey the good points of the machine to the prospective customer. It is safe to say that of two machines, other things being equal, the one which is illustrated by the neatest drawing will stand the better chance of securing the order. There are many styles of drawings used for tendering purposes, ranging from the common or garden variety, in which all the lines are of equal thickness, to the elaborately shaded productions which necessarily take a tremendous amount of time to make.


12" FEED.
2" DIA.
SPIRAL GEAR BOX.
CHECKNUTS FOR ADJUSTING FRICTION CLUTCHES.
FRICTION REVERSE GEAR BOX.
BACK GEAR BOX.
HANDLE FOR ENGAGING BACK GEARS.
HAND WHEEL FOR MOVING SADDLE.
HANDLE FOR STARTING, STOPPING AND REVERSING.
LOCK HANDLE FOR SADDLE.
LEVER FOR QUICK HAND FEED OF SPINDLE.
PIPE SECTION ARM.
FEEDS 41. 61 AND 86 CUTS PER INCH.
NO. 4 MORSE TAPER HOLE IN SPINDLE.
HANDLE FOR TURNING ARM.
SLOW HAND FEED OF SPINDLE.
BALL THRUST.
SPINDLE BALANCE WEIGHT.
SPINDLE SPEEDS.
300 144 67 32
239 115 53 26
191 92 42 21
PILOT WHEEL FOR RAISING ARM.
MAXM. 30"
MAXM. RADS. 46"
LOCK HANDLE FOR ARM.
TO MAKE 380 R.P.M.
15" DIA.
3½" BELT
25"
ABOUT 7 HORSE POWER REQUIRED TO DRIVE MACHINE TO ITS FULL CAPACITY.
T SLOTS PLANED FROM SOLID.
DRILLS 1¼ IN. HOLES IN CAST IRON AT 7 IN. A MINUTE
Machinery

Tender-Drawing of a "New Model" 28-inch Radial Drilling Machine

The method we have adopted seems to be about as good as anything I have seen, and it has the advantage of not taking a fraction of the time that would be required to make a shaded drawing, with which, for effectiveness, it compares very favorably. As shown in the accompanying engraving, reproduced from the tracing, the outlines of the machine are heavy lines (about 1/16 inch in this particular instance). The effect of these heavy outlines is to give the drawing a more substantial appearance; the machine stands out more and gives the observer a better idea of its general appearance. Of course, liberal notes explaining the various "points" of the machine are necessary if the drawing is to be thoroughly effective.

Keighley, England. ALBERT CLEGG

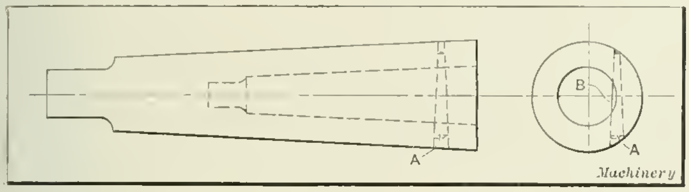
SHOP KINKS

PRACTICAL IDEAS FOR THE SHOP AND DRAFTING-ROOM

Contributions of kinks, devices and methods of doing work are solicited for this department. Write on one side of the paper only and draw sketches on separate sheets.

A DRILL SOCKET FOR HOLDING DRILLS WITH BROKEN TANGS

In the October number of MACHINERY I noticed a drill socket for holding broken tangs. I have tried one similar to it, but the drill socket shown in the accompanying illustration is, I think, much better.

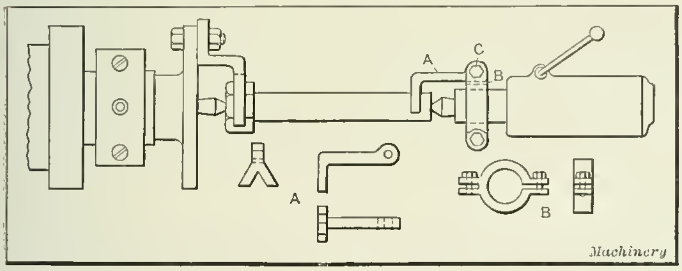


The tapered pin *A*, filed flat on the inside at *B*, is driven into the socket as shown; then a corresponding flat is filed on the shank of the drill until it fits in the socket. This pin holds the drill very effectively.

Wadsworth, Ohio. EDWARD ALLAN

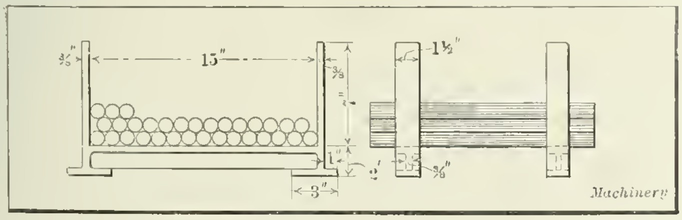
DEVICE FOR LOCATING WORK ON THE LATHE CENTERS

In shops where large quantities of work similar in character are to be turned out, the piece-worker, in order to make good, must devise means to expedite the work. Devices which would be impracticable in a jobbing shop, would, in many cases be applicable to a shop in which piece-work is done. The accompanying illustration shows a simple device for locating work on the lathe centers, applied to a hexagon-head bolt. A U-clamp is fastened to the faceplate, as shown, acting as a driver, and a swinging V-guide *A* is held in a split ring *B*, which is clamped to the tailstock spindle. This device prevents the workman from forcing the tail-center into the end of the work instead of in the center prepared for it, and it also enables him to locate the work more quickly on the centers. The V-guide can be quickly adjusted or drawn out of the way by releasing the clamp screw *C* so that one V-guide will cover a large range of diameters. M. B. H.



A SHAFT RACK

In piling up shafts on a work bench I have often noticed that nails are used to support the shafts and keep them in position. Very frequently the weight of the shafts upon one another causes them to spread, and the shafts roll down on the floor. To overcome this difficulty the shaft rack shown in the accompanying illustration was made. It consists of two cast-iron brackets, which can be placed the required distance apart. By using these brackets more shafts can be piled in less space than is usually required. The rack shown is made to hold 100 one-inch shafts, requiring a space 15 inches long by 7 inches high.



Hartford, Conn. J. E. COOLEY

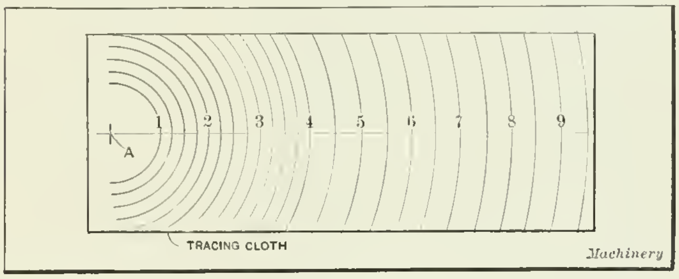
PREVENTING A FILE FROM SCRATCHING

When using a new file, especially in the lathe, it is sometimes found to scratch and produce an undesirable finish. This can be obviated by taking an oilstone and rubbing it over those parts of the file which are doing the scratching. This kink is not very well known, and may be of value to those having much filing to do in the lathe.

Norristown, Pa. GEORGE OELSCHLAGER

MEASURING IRREGULAR CURVES

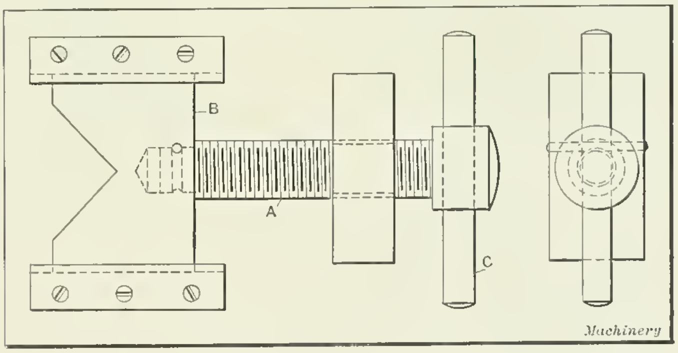
It is common practice in most drafting-rooms to dimension all curved portions of machine webs, legs, etc., in order to assist the patternmaker in laying out the curves accurately. I used to find this a tedious task, chiefly when the curves were very irregular, but hit upon an idea which entirely eliminated the difficulty. This idea consists mainly in taking a piece of tracing cloth, describing a series of arcs upon it, and drawing a center line as shown in the accompanying illustration. The size of this chart, of course, depends entirely upon the character of the work.



The method of applying this chart is as follows: Place it on the drawing in such a position that one of the arcs will coincide with the one to be measured. Now to find the center of the arc prick through the center *A* of the chart. This gives the center of the arc which can then be read direct. J. L.

CUTTING A GROOVE IN A SWIVEL SCREW WITH A DRILL

The accompanying illustration shows a simple means of cutting a groove in a swivel screw which is placed in a sliding V-block. The groove, of course, could have been cut in the lathe, but as there was no lathe handy at the time, the writer struck on the following method: The screw *A* was placed in the hole in the sliding block *B*, up against the shoulder, and a hole was drilled clear through the block and screw, half in each. The drill was then raised until the point was on a level with the center of the screw, when the latter was turned to the left by means of handle *C*. The point of the drill then acted as a mill, cutting a groove in the turned portion of the screw.



Springfield, Mass. R. A. CLAPP

In soldering it is often desirable that the surfaces should tin only to certain boundaries. If it is possible to put a fine copper wire or thin copper strip at such points, the solder will not flow beyond. GEORGE W. ARMSTRONG

SHOP RECEIPTS AND FORMULAS

A DEPARTMENT FOR USEFUL MIXTURES

This page is intended to be used only for the publication of such shop receipts as the contributors know from experience to be practicable. Receipts are solicited on the condition that the contributors personally know that they are reliable. The fact that a receipt is old and supposedly well-known does not bar it, provided it has not already appeared here.

COMPOUND FOR PIPE CONNECTIONS

I have found shellac to be a very satisfactory substitute for lead in sealing air and gas pipe connections. It is applied with a brush to the joints and hardens very rapidly, and being brittle, the pipes can be readily disconnected. S. C. S.

HARDENING SOLUTION FOR TOOL STEEL

The following hardening solution will be found satisfactory for hardening crucible tool steel which has a carbon content of about 0.90 per cent or 90 points. This solution has been found especially valuable for hardening such tools as punches, stamps, heading bunters, etc., and, in fact, any tool which has to resist wear and compression. In hardening, the tool is heated to a cherry red, about 1652 degrees F., then dipped in the following solution, which consists of: sal ammoniac, 4 ounces; alum, 4 ounces; common salt, 3 pounds; water, 6 gallons. The solution should be kept in an earthen-ware jar and covered to prevent dust or other foreign matter from collecting in it; it should also be well mixed before using. M. G.

A HARDENING SOLUTION

The following hardening solution will be found suitable for hardening small tools, such as taps, dies, etc. Pieces hardened in this solution are made extremely tough and will withstand considerable pressure. The solution is as follows: To 15 gallons of water add 1 pound of cyanide of potassium, 6 pounds of saltpeter, 2 pounds of common lime, 3/4 ounce of permanganate of potash. Distilled water if it can be obtained should be used, but rain water if pure and clean will also answer the purpose, although distilled water is better. Before dipping the tools they should be heated to a cherry red, and when dipped in the bath they should be kept moving, so that they will harden uniformly. It is not necessary to draw the temper after hardening.

Plainfield, N. J. JOS. R. WEANER

LUBRICATING WORMS AND WORM-WHEELS

Worms and worm-wheels under heavy duty often wear out quickly when run dry, or when lubricated with common machine oil. Cases have been known where worm-wheels gave out in three weeks' time when lubricated with ordinary oil, and when supplied with a special lubricant, ran continually with no perceptible wear. The following is a compound which has been used with satisfactory results for this purpose:

To one gallon of prime lard oil, add 1½ gallon of steam cylinder oil, one 1-pound package of Dixon's graphite, and 2 quarts of flowers of sulphur. Mix this compound thoroughly and keep the worm almost entirely submerged all the time.

M. W. W.

SOLDERING ALUMINUM

Although there have been various methods given for soldering aluminum, I offer no apology for adding another to the list. The constituents of this solder and the method of using it have the advantage of several years' test.

To prepare the solder, melt half a pound of phosphor tin in a ladle, and add to this half a pound of zinc. With the aid of a wooden stick, stir in a half a pound of beeswax, after which put in half a pound of block tin. Mix the molten metal well, and cast into strips. If mixed according to these directions, there should be no difficulty in soldering aluminum, either to another piece of aluminum or to a different kind of metal.

When using, clean the articles to be soldered, and tin them with the above solder in the usual way, but do not use a flux. If it is required to fill up a blow-hole, this can be done after tinning, by using any ordinary solder. When joining aluminum to another metal, it is only necessary to use the special solder on aluminum, as ordinary solder and methods can be used on the other metal. A. E. D.

OIL AND WATERPROOFING BLUEPRINTS

A cheap and effective agency that will resist water and oil, is made by dissolving paraffine in gasoline. Take a large mouthed bottle and shave into it some paraffine—the large, yellowish and greasy coach candles furnish the best—to the depth of about one-fourth of the bottle; then fill the bottle with gasoline, and shake occasionally until the paraffine is dissolved.

Now, lay the prints on a flat surface, pour on a small quantity of the solution, spreading it with a paint brush until the paper has absorbed all that it will hold. At first the paper will be transparent, but as soon as the gasoline dries, the paper will resume its natural tone. When about half the gasoline has evaporated, the surplus solution should be wiped off with a clean, soft cloth or else there will be a white coating of paraffine left on the paper, which would be objectionable, the body of the paper having absorbed enough to render it impervious to water and grease. Below a temperature of 60 degrees F., the solution coagulates, when it must be warmed to again reduce it to a liquid. In making and using, the solution must be kept away from fires. H. W. WEISGERBER

Salem, Ohio.

REMOVING SPOILED NICKELING

While in many cases nickel-plated articles are so cheap that it would not pay to remove the nickeling in case this did not turn out well, there are cases where this would sometimes be found desirable. The best process for doing this, says the *Allgemeine Schlosser Zeitung*, is to abrade the coating with emery powder and then proceed as usual to replate. For iron and steel articles this is the best method which can be employed. For articles made of brass, copper, German silver or Britannia metal, an acid bath may be used to remove the plating. The requisite bath consists of 27 parts, by measure, of oil of vitriol (fuming sulphuric acid) and 18 parts of nitric acid. The articles to be cleansed must first be freed from fat by dipping them in lye, the same as for newly plating. This assures regular action of the acid bath. The article is moved about in the latter until all the nickel is dissolved; it is then rinsed first in hot and afterwards in cold water. The acid attacks the base, also, but polishing will restore its original appearance.

Dresden, Germany. ROBERT GRIMSHAW

MIXTURE FOR HARDENING TOOL STEEL AND CASEHARDENING MACHINE STEEL

The following mixture will be found suitable for hardening gages or similar tools made from either tool- or machine-steel. Tools hardened in this mixture do not warp or change shape to any perceptible extent, and thus it should be appreciated in the tool-hardening department. The compound consists of: five parts of potassium prussiate $[KFe(CN)_6]$ and eight parts of potassium carbonate (K_2CO_3). To prepare, the potassium prussiate should first be thoroughly melted in an iron pot, after which the potassium carbonate should be added. These two constituents should be well mixed. When the mixture is not in use, it should be covered to exclude dirt or other foreign substances.

In using, put the pot in the forge and pack it up well with coal, so that it will be heated evenly. Before the mixture is heated, drop the pieces to be hardened into it, and cover them up. When heated sufficiently, remove the pieces and dip them in either water or oil. Water is used where the tool is not of a delicate nature, but where the work is slender, oil is preferable; a good grade of lard oil gives the best results. Extra precautions should be taken when using this compound not to get any water near it, or an explosion will result.

This same mixture can be used for casehardening machine steel, with very good results. Some manufacturers have found it advisable to make gages of machine steel and harden them in this way. When a tool is hardened in this mixture, it is given a nice mottled appearance.

G. MURRAY

NEW MACHINERY AND TOOLS

THE COMPLETE MONTHLY RECORD OF NEW DESIGNS AND IMPROVEMENTS
IN AMERICAN METAL-WORKING MACHINERY AND TOOLS

J. N. LAPOINTE BROACHING MACHINE

The J. N. Lapointe Co., Marlboro, Mass., is manufacturing an improved design of broaching machine which is capable of handling work ranging in size from the smallest to the heaviest parts that it is practicable to broach. This machine is illustrated in Fig. 1. The pulling mechanism consists of a sliding head operated by a 2¾-inch screw passing through the hub of the main gear in which a special composition nut is inserted in such a way that it can be quickly removed for replacement when necessary. In order to overcome the friction and increase the power of this machine when the load is applied, a large ball thrust bearing is placed to receive the longitudinal pressure.

The machine has a positive geared drive and return and is arranged with two speeds in order to suit the various classes of work. The speed is changed by a sliding gear connected direct to the driving gear. The driving mechanism is of simple construction throughout. No pins or positive clutches are used in the drive, and the machine can be run at any speed desired without injury. The screw which operates the sliding head telescopes into a tube attached to the rear end of the machine, in order to protect it from dust accumulated by the belts. Under the front end of the machine there are two lugs to which a special supporting table or other holding fixtures can be fastened by means of screws, in case such fixtures are necessary. These special appliances are connected under the table instead of to the face of the machine, to avoid interference when connecting the broaching tools. This machine has been successfully used for broaching 1½-inch holes in steel castings 15 inches long, which illustrates its pulling power. It is equipped with an automatic oil pump for lubricating the work and a countershaft.

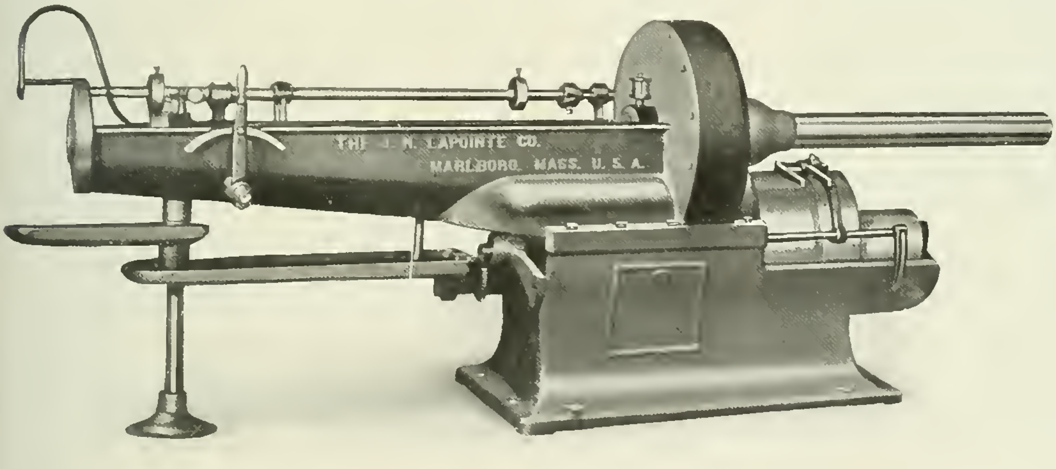


Fig. 1 Lapointe No. 3 Broaching Machine

Fig. 2 shows a number of broached parts, and the following data relating to this work will doubtless be of general interest. Part *A* has a ⅞-inch square hole 1½ inch long which is finished in one operation by the use of one broach at the rate of thirty-five to forty-five per hour. Four ¼-inch rivet grooves are cut in part *B* in one operation at the rate of about one hundred pieces per hour. The blank is ¾ inch thick and three pieces are broached simultaneously. Part *C* has a 1¾-inch square hole 1¾-inch deep, with "round corners," and it is done in two operations by the use of two broaches at the rate of about twenty per hour. Ten ¼-inch keyways 1¾ inch long are broached in part *D* in one operation at the rate of about thirty-five per hour. Part *E* is an internal gear 3 inches in diameter and ⅞ inch thick, and it is broached in one operation. Two gears are finished at a time, and the rate is sixty per hour. Part *F* has a 1½-inch square hole 4 inches long, which is broached by two roughers and one short finishing broach at the rate of about ten to twelve pieces per hour. The nickel steel blank *G* is broached by three roughing and one short finishing broach at the rate of about six per hour. The data for part *H* is similar to that given for part *C*. The toolpost *I* has a slot ⅝ inch by 2½ inches, which is finished by a roughing and finishing broach at the rate of about twelve to fifteen pieces per hour, the hole being first jig drilled to admit the broach. Part *J* has four ⅜-inch keyways cut in a 1-inch hole 1¾ inch long, in one operation at the rate of thirty to thirty-five per hour. A 2-inch square hole 2½ inches long, with "flat corners," is broached in part *K* in two operations at the rate of twelve to fifteen per hour. Part *L* has four ⅜-inch keyways cut in a 1⅜-inch hole 2 inches long, in one operation at the rate of about thirty per hour. Wrench *M* has a 1¼-inch hexagonal hole which is finished with one short broach at the rate of thirty-five to forty pieces per hour. Part *N* is a nickel-steel universal-joint blank 5 inches in diameter and 1¼ inch thick, having four rectangular holes broached so as to be equi-distant from a bored central hole within a limit of 0.0015 inch. These holes are forged with ⅛-inch stock left for broaching, and they are finished to a width of ¾ inch and a length of 1¾ inch. This work can be done either by the use of twin broaches, that is by operating two broaches at a time, or by using a single broach mounted in a work bushing or fixture so as to hold it in the proper position. The production depends upon the method employed, but, generally speaking, these blanks can be broached accurately at the rate of about four or five per hour. The wrench *O* is done in practically the same manner and at the same rate of production as listed for wrench *M*.

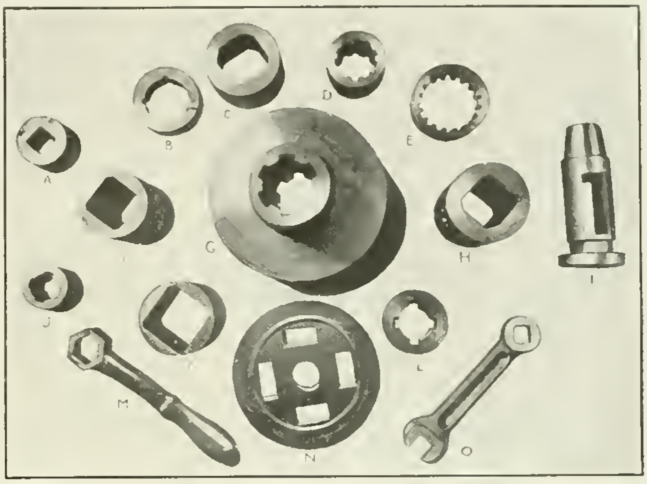
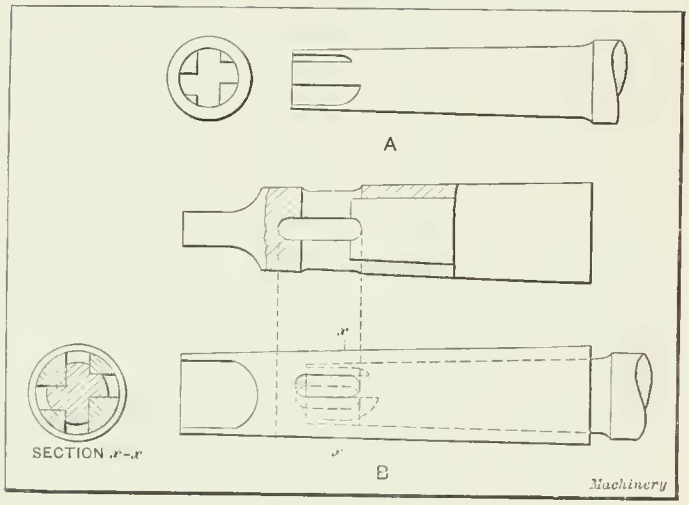


Fig. 2. Examples of Broached Work

GROSS DRIVING TANG

The Morse taper shank which is shown at *A* in the accompanying line engraving has a new form of tang drive, brought out by Elmer S. Gross, Harrisburg, Pa. By referring to the end view, it will be noted that the tang differs from the common form in that there are additional side tangs which are offset from the center. The form of sleeve or socket used with this style of tang is illustrated at *B*. This sleeve has the usual cross-slot with clearance above the tang for a drift-key and, in addition, shorter cross-slots offset to correspond with the side tangs. The relation between the tang and socket is clearly shown in the sectional view *x—x* to the left. A taper shank drill or other tool having a common flat tang, can be inserted in this socket. It is claimed that by offsetting the side tangs, a more rigid construction is obtained, and this feature also has the advantage of presenting a larger portion of the socket, on the driving side of the extra slots, when using tools having ordinary tangs.



New Form of Drive for Tang-driven Tools

CONOIDAL MULTI-BLADE FAN

A fan has been developed by the Buffalo Forge Co., Buffalo, N. Y., the blade construction of which gives the wheel the shape of the frustrum of a cone. The inlet is on the side corresponding to the base of the cone, as shown in Fig. 1 of the accompanying illustrations. The prevalence of conical shapes in the design is responsible for the name "Conoidal," which has been given to this fan. It is claimed that this new design, as compared with a centrifugal fan, has higher efficiency and requires less space for a given capacity. The efficiency curve is said to remain practically constant for a total range of nearly 60 per cent, thus permitting a load of approximately 30 per cent above or below the regular capacity with little loss of efficiency. The blades of this fan, instead of having parallel edges, are slanting so that the inlet side of each blade is much narrower than at the rear, thus giving an inlet of large diameter.

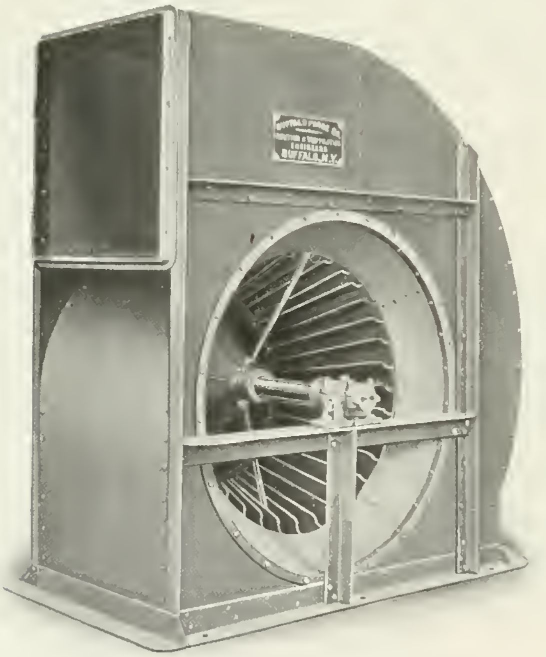
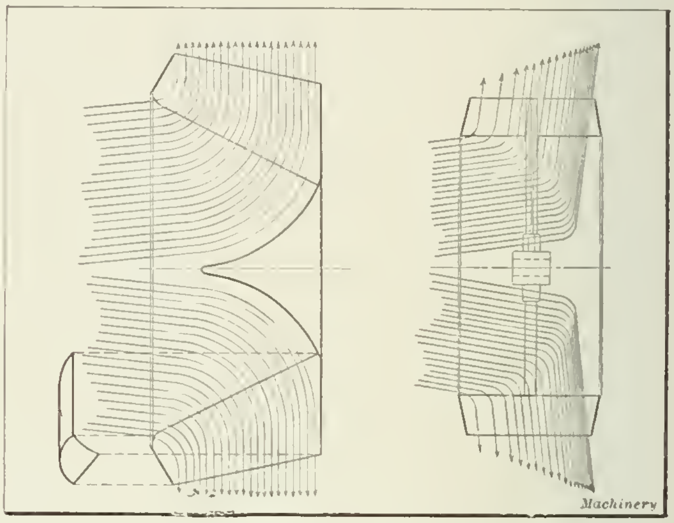


Fig. 1. Multi-blade Fan built by Buffalo Forge Co.

The action of the air when passing through this fan is illustrated by the diagram, Fig. 2. As the air is drawn in through the inlet it is gradually deflected by a central conical hub towards the blades, which are so arranged in regard to curvature, inclination to the axis of the wheel and increasing width towards the driving side, that the air is delivered by the entire width of the wheel at an even volume and pressure. It is claimed that when a multi-blade fan of the type shown in Fig. 3 is in operation, the air rushes in almost at right angles against the opposite or "drive" side of the fan and its course is then abruptly changed nearly 90 degrees (as indicated by the arrows), which results in a loss of power and velocity. It is this loss that the conoidal fan was designed to overcome by increasing the width of the blade from front to back. The increased width of the blade at the drive side handles the excess amount of air, which is gradually deflected by the hub so that it describes an easy curve towards the periphery, as indicated in Fig. 2. The blades are also curved, the radius of the curve increasing toward the rear, thus forming a conical surface. This curve is so proportioned that the air is scooped up with the least impact, and the radius of the curve is in exact proportion to the diameter of the inlet.



Figs. 2 and 3. Diagram showing Approximate Movement of Air when passing through Conoidal and Parallel Blade Fans

The increased width of the blades at the rear gives exceptional strength to the wheel, so that high speeds and loads can be maintained without difficulty. These blades are securely riveted in front to a conical flange and at the back to an extra heavy plate. The fan wheel has long babbitted bearings equipped with oil chains in the center and it is balanced by a special method to eliminate all vibration. The housing is involute in shape and built of rolled steel plate, well riveted and strongly reinforced by vertical and horizontal angle irons.

WHITNEY SILENT CHAIN

The Whitney Mfg. Co., Hartford, Conn., is making a chain of the silent type which is so constructed that the sprocket wheels used in connection with it need not be flanged nor grooved, thus gaining the entire width for wear. This is accomplished by means of guide plates, which form an integral part of the chain, as shown in Figs. 1 and 2 in the accompanying engravings. The guide plates *A*, Fig. 2, are connected by outside plates *B*, which give additional tensile strength to the chain. The links are so assembled that each joint has four wearing surfaces, making a very durable construction. Hardened steel bushings *C* are forced tightly into the guide plates, so that they are held fast and cannot turn. The steel links turn about the outside of the hardened steel

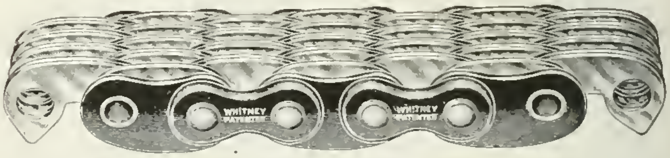


Fig 1. Whitney Silent Chain

bushings, and the hardened steel rivets, which are also forced into the outside steel plates, turn within the bushings. These chains are made in various sizes, having ⅜-, ½-, ⅝-, ¾- and 1-inch pitch and also in various widths to suit requirements.

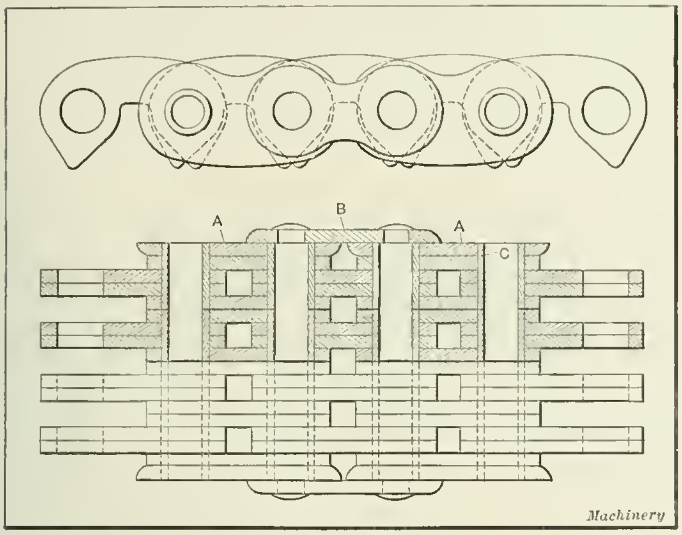


Fig. 2. Views showing Construction of Whitney Silent Chain

They are used for driving magnetos and cam-shafts on gasoline engines, machine tools, line shafting, pumps, and also in connection with automobile transmissions, motor drives, etc.

AMERICAN TOOL WORKS 24-INCH HIGH-DUTY LATHE

The lathe illustrated in Fig. 1 is a 24-inch size of the "high-duty" type built by the American Tool Works Co., Cincinnati, O. The most prominent features claimed for this design are the great driving power and the high grade of workmanship. The arrangement of the geared head is shown by the diagram, Fig. 2. This head gives eight spindle speeds through a medium of twelve gears, two frictions and one jaw clutch. The speeds vary in geometrical progression and range from 7.3 to 270 revolutions per minute. The gears are of wide face and the pitch of the teeth is as coarse as practicable. These gears are mounted on short shafts which are rigidly supported to eliminate all vibration. The frictions have a large area of frictional contact which, in combination with their location on the initial driving shaft having a constant but high rate of speed, insures an ample transmission of power without slippage.

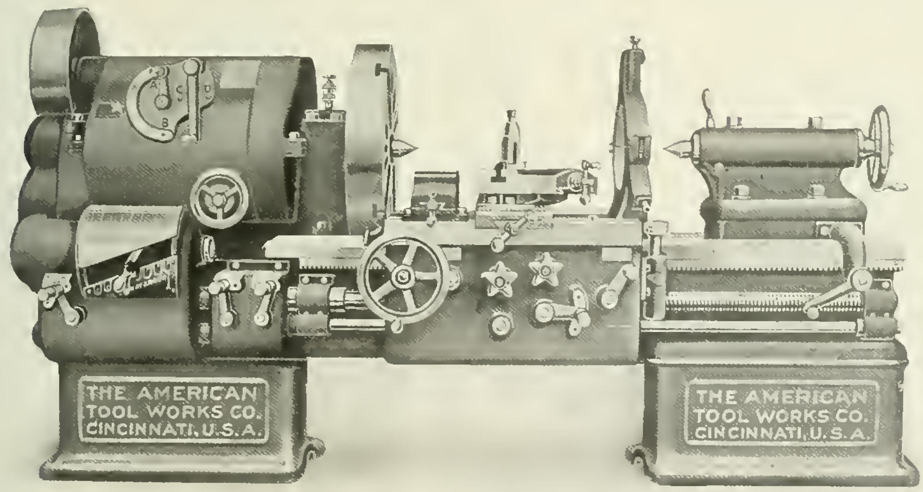

THE AMERICAN TOOL WORKS CO. CINCINNATI, U.S.A.
THE AMERICAN TOOL WORKS CO. CINCINNATI, U.S.A.

Fig. 1. American 24-inch Lathe with Geared Head

The spindle bearings have sight feed oilers and the other bearings are bronzed bushed, the bushings having recesses for retaining the oil. The oil is supplied through pipes from the outside of the head, and it is fed to the bearings by means of felt strips inserted in slots cut in the bushings. These felt strips filter the oil and distribute it uniformly over the bearings. They also prevent the lubricant from running out of the bearings and being wasted. The driving pulley runs on a bronze-bushed steel sleeve which relieves the initial driving shaft of all belt strain.

The thread-cutting and feeding mechanism is of the cone-and-tumbler type, and by means of seventeen gears and three control levers, gives forty-eight changes for threading or feeding. The cone-and-tumbler gears are cut with Brown & Sharpe 20-degree involute cutters, thus producing teeth which are pointed at the top and therefore easily engaged. The power can be transmitted direct through the cone for cutting coarse threads, thus eliminating the necessity of speeding up this mechanism by compound gearing. A quadrant construction at the end of the bed gives the lathe an almost unlimited range for feeding and screw-cutting. Any thread or feed not listed on the index plate can be obtained by placing gears of the proper size on the quadrant. The index plate, showing the different combinations for obtaining the various threads and feeds, is located directly over the tumbler lever and is direct-reading.

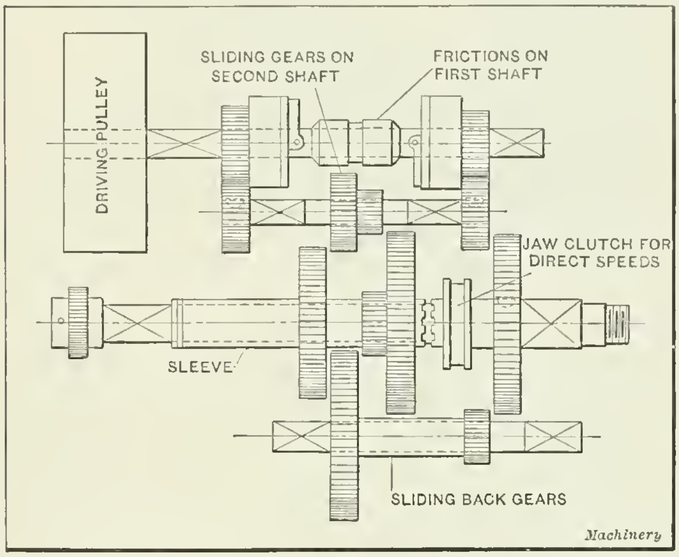


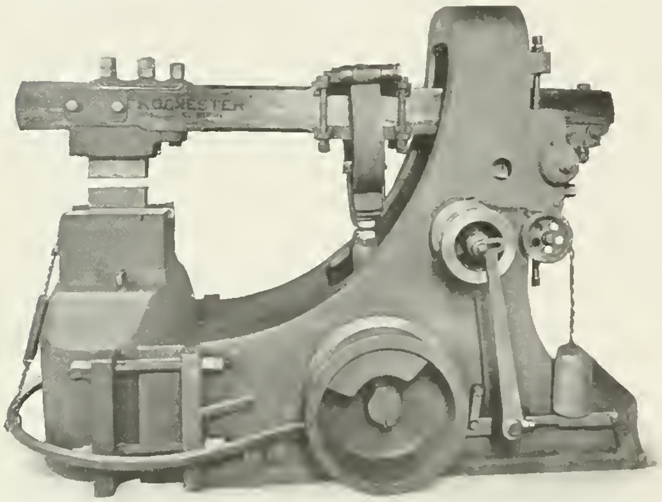
Fig. 2. Diagram showing Arrangement of Geared Head

The apron is of the double-plate type. All gears in the apron are of steel and the studs are hardened and ground. A non-interfering plate prevents the lead-screw and feed-rod from being engaged simultaneously. Oil for the apron is introduced from the outside through pipes which lead to reservoirs formed in the back plate. The oil is then fed to the different bearings by means of oil ducts and it is filtered and the flow regulated by strips of felt placed over the duct openings. The tailstock is the four-bolt type, the back bolts extending to the top of the barrel, which arrangement is very convenient for clamping. The tailstock is further supported by a pawl which engages a rack in the center of the bed. The barrel of the tailstock is solid and is equipped with an improved form of plug binder for clamping the spindle.

The power of this 24-inch geared head machine is indicated by the following data obtained from a recent test: A cut ¼ inch deep was taken across a bar of 6-inch machinery steel with a cutting speed of 150 feet per minute and a feed of ⅛ inch per revolution. This work was done with a single tool which removed 55.8 cubic inches of metal per minute, or 837 pounds per hour. This machine is also built with the cone pulley type of headstock or it can be furnished with a motor drive. The regular equipment includes a steadyrest, follow- and full-swing rests, thread dial, countershaft, wrenches, etc.

ROCHESTER HELVE HAMMER

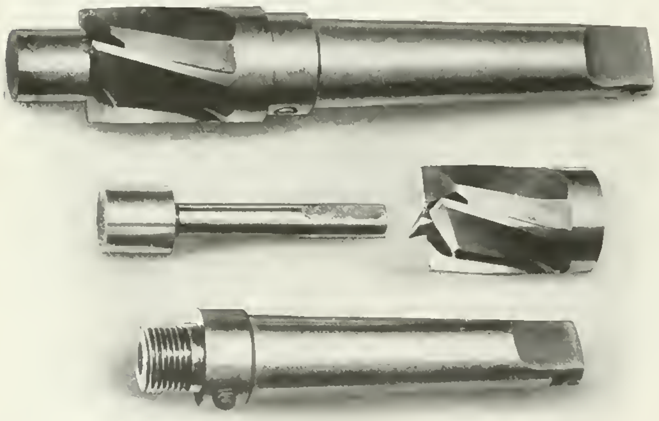
The "manufacturers' type" of helve hammer shown herewith is built in 60-, 80- and 100-pound sizes. The hammer illustrated is a 100-pound size and weighs 4000 pounds. The frame is a solid casting having solid babbitted shaft-boxes of large dimensions. The anvil is separated from the frame by wood segments which absorb the shocks from the blows and prevent them from being transmitted to the frame. The anvil is made in two parts which are keyed together, thus allowing for adjustment or the removal of the top part if necessary. The weight of the anvil is sufficient to give the proper resistance to the blow, which is an important feature. The boxes which support the helve-pivot at the rear end of the helve, have an adjustment of 5 inches, which is effected by the screws shown. This adjustment, in connection with the adjustment of the connecting-rod, adapts the hammer to a wide range of work. The helve is made of first-grade hickory, and the U-shaped spring and connecting toggles are of such design that a fine cushion is obtained by a slight action of the spring, thus minimizing the tendency to crystallization. This hammer is built by the West Tire Setter Co., Rochester, N. Y.



Rochester 100-pound Helve Hammer

NATIONAL TOOL CO.'S COUNTERBORE

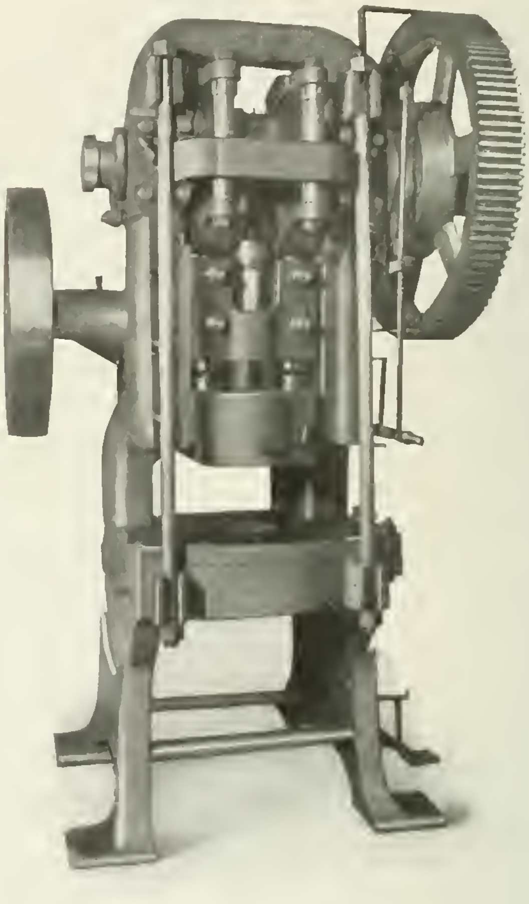
The National Tool Co., Cleveland, O., has recently put on the market a patented counterbore which consists of three parts, namely, the shank, cutter and pilot. The accompanying illustration shows the assembled counterbore and also its component parts. The shank is made of machinery steel and the lower end is threaded for receiving the cutter. The cutters are made of high-speed steel. The hole for the pilot in both the cutter and shank is ground to insure a good fit for the pilot shank. The pilot is held by a set-screw which is inserted in the enlarged part of the shank as shown. The cutters have spiral flutes which give a shearing cut, and these flutes extend back so that the cutter can be used until two-thirds of its length has been ground away. This feature gives a long life to the cutter. Both cutters and pilots are interchangeable and are furnished with either taper, straight or double-groove shanks. All parts are made of the best material and are hardened and ground. The cutters and pilots carried in stock range in size from $\frac{3}{4}$ inch to 4 inches, advancing by sixteenths.



National Counterbore and its Component Parts

STANDARD DOUBLE-ACTING CAM PRESS

The double-acting cam press shown herewith was designed for the deep drawing, at a single stroke, of light and medium gage metals, and also for producing the maximum draw, at one stroke, that stock of this nature will stand. It is particularly intended for drawing and forming stock having a maximum flow and a maximum ductility (such as mild aluminum, brass and copper) without broaching or breaking. This machine is built by the Standard Machinery Co., Providence, R. I. It is equipped with an extra-heavy drop-forged crankshaft, having tool-steel cams forced over the wings of the shaft, which are on each side of the upper connection of the inner or drawing ram. The diameter of the wrist pin on the drawing ram is $3\frac{1}{2}$ inches and the bore of the cams, $7\frac{1}{8}$ inches. The over-all length of the cams is $4\frac{3}{8}$ inches, and they have a bearing surface of 3 inches. The throw of the blanking ram is 3 inches, which is unusually large for a cam press, but is provided to allow the production, at a single stroke, of a piece over three inches high without a raising die.



Standard Double-acting Cam Press

The drawing stroke or the stroke of the inner plunger is 7 inches, and the machine is so arranged that the blanking and drawing rams leave on the up-stroke at the same time, the movement being controlled by the setting of the cams on the crankshaft. The machine is fitted with capped boxes making it unnecessary to remove the shaft endwise. The yokes are of steel and the two lower ones extend through bronze-bushed holes in the blanking ram. The adjustment of this ram is controlled by the spanner nuts shown. The holes in the supporting strips at the back and front of the press, through which the yoke pins pass, are babbitted to secure good bearing surfaces. The inner plunger is of forged steel and runs up and down in the blanking plunger through a bronze sleeve.

The construction of both the blanking and drawing plungers, as well as the yokes and cams, is such as to give simple and easy adjustments and good wearing qualities. There is a single train of cut driving gears, and the company's regular instantaneous roller friction clutch is used. The machine is furnished either with a balance wheel or tight-and-loose pulley drive and can be used inclined. Either a hand or foot trip can be provided, and the machine can be equipped with a roll or dial feed for the production of special work.

NEWTON COLD-SAW CUTTING-OFF MACHINE

The cold-saw cutting-off machine shown in Figs. 1 and 2 has a 40-inch blade and a capacity for round stock up to and including 12 inches in diameter, and for square material of the same dimensions. This machine is built by the Newton Machine Tool Works, Inc., Philadelphia, Pa., and it is designed for high duty. The spindle is of large diameter and its length is equal to the diameter of the blade. It revolves in bronze-bushed cap bearings located at both ends, and the driving spur gear is placed between the bearings to eliminate chatter and to prevent interference from chips or lubricant. The driving pinion meshing with this spindle gear is cut from the solid worm-wheel shaft. The worm-wheel is a solid bronze casting and the driving worm is of hardened steel and fitted with roller thrust bearings. The saw blade is driven by three round keys or pins and it is held in place by a large washer to prevent buckling.

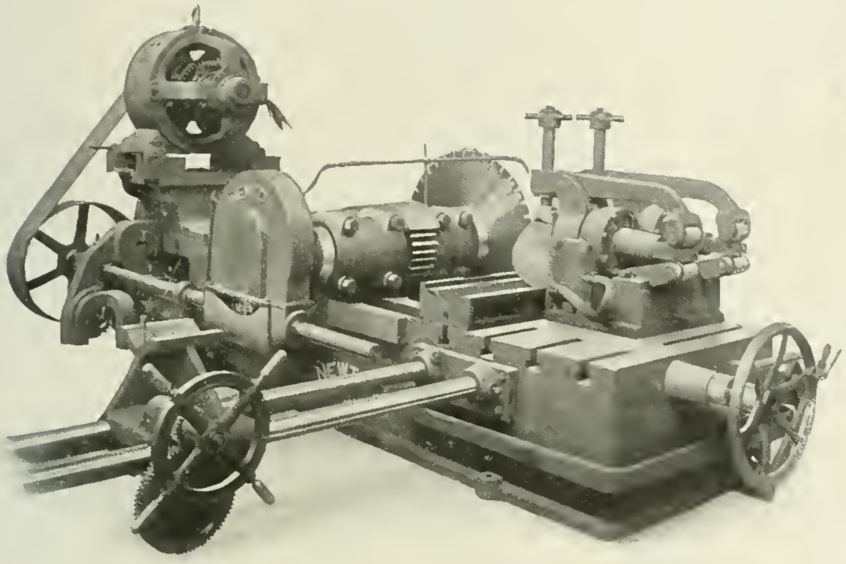


Fig. 1. Newton Cold-saw Cutting-off Machine with Pneumatic Clamps

The saddle has square bearings on the base and underlocking gibs. The bearing extends the full length and width of the shears. There are six changes of geared feed, a reversing fast power traverse and a hand adjustment. The feed-screw has a bearing at each end to always maintain a tension and it is located centrally between the saddle guides. The feed-nut is placed in advance of the spindle to draw the blade to the cut, thus preventing backlash and a rocking of the saddle on the base.

This machine is driven by a Westinghouse 30-horsepower motor which is mounted rather high to obtain a long belt drive.

The locations of the various operating levers are shown in Fig. 2. Handwheel *A* is for the hand feed, and levers *B* at each end of the machine engage and disengage the feed and fast power traverse. This machine is equipped with pneumatic clamps controlled by lever *C*, and there is a stock feed trolley which is clearly shown to the left in Fig. 1. The operator, after adjusting the stock trolley, turns the handscrews *E* until the serrated V-blocks on their lower end touch the stock, after which the clamping is effected by simply turning air valve *C*.

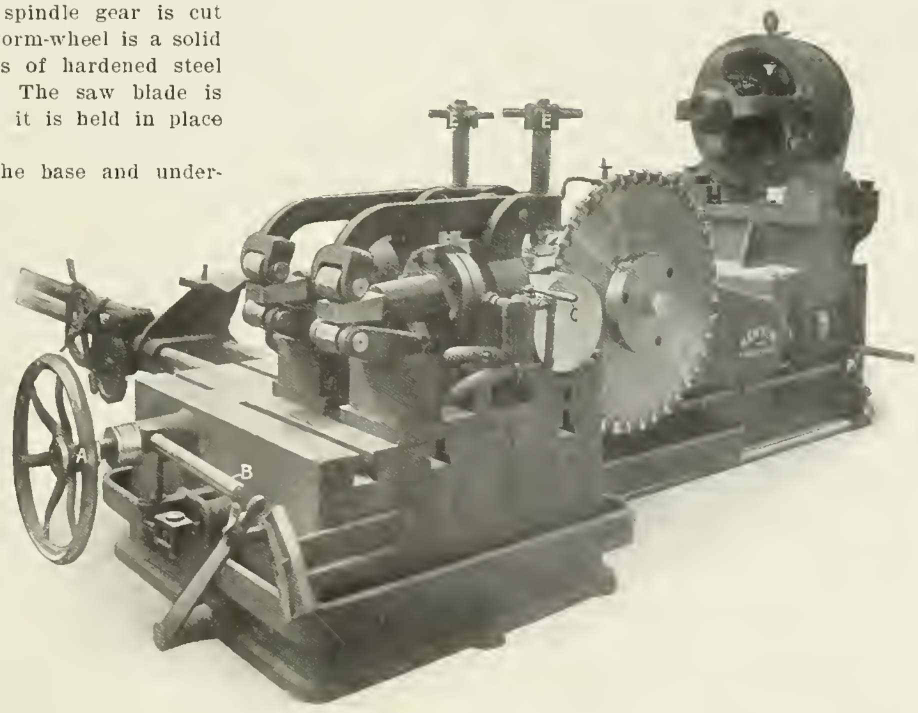
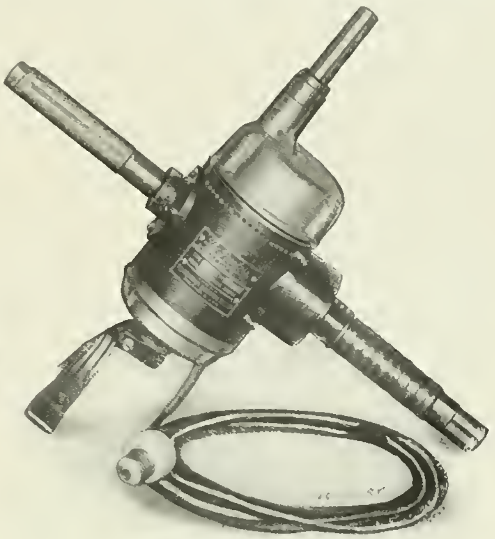


Fig. 2. Another View of the Newton Machine

It is claimed that as a result of the rapid clamping facilities and the convenient control, the blade is actually cutting about 90 per cent of the time. This machine is said to cut 10-inch round stock having a 35 to 40 point carbon content in about 4½ minutes, while during tests much greater speeds and feeds are possible. The average production of this machine since its installation has been twenty-three pieces of 7¼-inch round stock in one hour and fifty-six minutes, which includes the time for setting and removing the work.

CINCINNATI PORTABLE REAMING AND DRILLING MACHINE

The electrically driven portable reaming and drilling machine shown herewith is an improved design made by the Cincinnati Electrical Tool Co., 650 Evans St., Cincinnati, O. This tool weighs only 27 pounds, but has a capacity for reaming holes as large as ½ inch in diameter and for drilling in steel up to ¾ inch in diameter. The motor is series wound and its armature is mounted on ball bearings. The gears, which are fully enclosed, are hardened and run in grease. The controlling switch is operated by a sliding sleeve on the



Cincinnati Reaming and Drilling Machine

handle. The spindle can be fitted with a chuck or be bored to receive a No. 1 Morse taper socket, the latter being recommended. Ten feet of insulated wire and an attachment plug are included in the equipment.

HENRY & WRIGHT MULTIPLE SPINDLE DRILLING MACHINES

A recent addition to the line of drilling machines built by the Henry & Wright Mfg. Co., Hartford, Conn., is illustrated in Fig. 1. This machine, which is known as the "class B", has incorporated in its design a number of interesting improvements.

The tension of the driving belts is controlled from the front by means of handwheels located near the spindle driving pulleys. The spindle pulleys are supported at the top and bottom, instead of at the bottom only, and the spindles are driven by a new balanced drive, which consists of two hardened steel rollers set in a diametrically opposite, vertical position. These rollers are loosely fitted half-way into grooves in the spindle, so that they bear at the nearest possible point at the outside of the spindle and not only furnish an almost frictionless drive, but also a very powerful drive. This drive is located underneath the spindle pulley instead of on top, as formerly, which allows the use of a much shorter spindle and reduces the tendency of vibration when the spindle is raised to its highest point. The spindle is also much stiffer for a given length of traverse.

The spindle arms are of a new design and they are equipped with a new clamping device which is very simple and strong in its construction. The clamping levers for the arms are located on the left side instead of the right, as formerly, so that the workman can use both hands to the best advantage when raising and lowering the arm. The height of the drilling heads has been increased considerably and the base lowered an amount corresponding to this increase, in order to produce a stiffer and more convenient design. This machine is made either with a handwheel for raising and lowering the table or, when specially ordered, with a crank as shown in the illustration. The rear shaft pulley is fitted with a spring-locking device which enables it to be adjusted, when changing speeds, without the use of a wrench, from the front of the machine. There is an entirely new belt-shifting device which allows the belt shifter proper to be set at any angle. The base of the machine has an oil groove, and either a plain table or one having an oil groove can be supplied. The stop on this machine is applied to the rack instead of at the top of the spindle, as formerly.

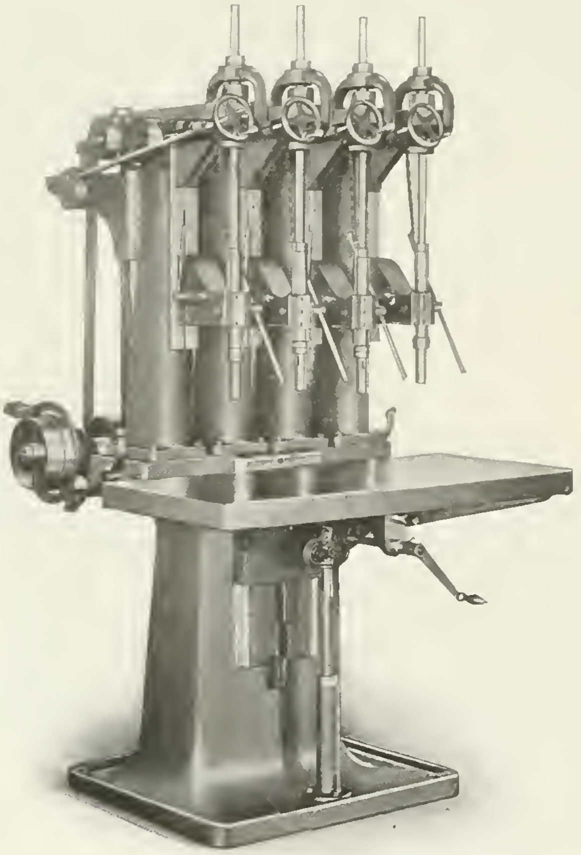


Fig. 1. Henry & Wright Drilling Machine

The machine shown in Fig. 2 is similar to the "class B" design with the exception of the base and table. As the illustration shows, the base is of the cabinet type. This machine is designed to be used where extreme stiffness and accuracy are desired. The table is attached to the base by four screws so that it can easily be removed for re-planing, if necessary.

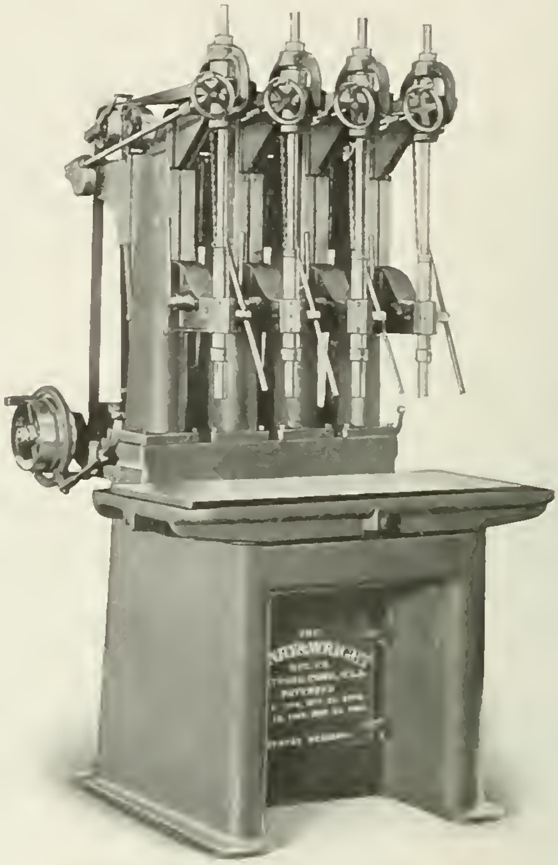


Fig. 2. Henry & Wright Drilling Machine with Cabinet Base

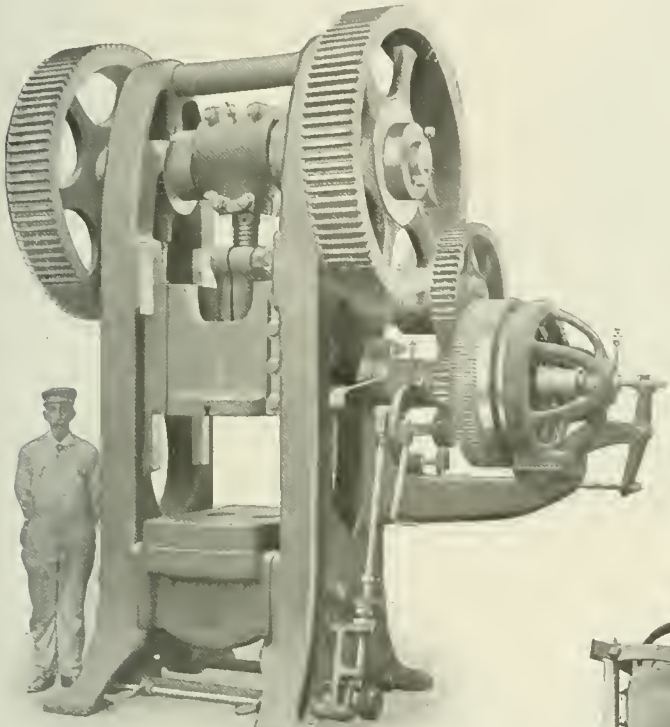
Both of these machines are furnished with lubricating equipment, when so ordered, and in case of the cabinet base design, the oil tank is located inside the base and is connected with the table by four oil ducts leading from the centers of the four sides of the table.

FERRACUTE PRESS WITH IMPROVED FRICTION CLUTCH

The Ferracute Machine Co., of Bridgeton, N. J., has recently built a press designed for pressures up to 200 tons and fitted with a new form of friction clutch. The clutch mechanism is mounted on a bracket attached to the side of the press (as shown in the accompanying illustration) instead of using an independent outboard bearing. With this construction the position of the press can be changed at any time, without re-setting and re-aligning the clutch. As this clutch and its bracket form a complete unit, it can be attached to various machines without altering the design, by simply bolting it in place.

The brake spider has been made a part of the clutch supporting bracket, which is new feature. This brake spider is a separate piece, but the face or seat to which it is bolted is cylindrical and the axis of this cylindrical surface coincides with the axis of the clutch shaft, so that perfect alignment is secured. Another improvement is the motion which relieves the clutch and does the braking direct without introducing additional mechanism. This effect is produced by the clutch disk which is a horizontally moving, double cone located between the brake spider and the flywheel. Attached to the front and back rims of the clutch disk are wooden sectors or blocks the outer faces of which bear against corresponding surfaces on the inside rim of the flywheel and clutch spider. These blocks are adjustable radially by means of screws which are secured by lock-nuts. The blocks are attached to the clutch disk by carriage-bolts. The movement of the clutch disk in one direction or the other produces the clutch or braking action as desired, the clutch disk having both the clutch and brake frictional surfaces.

The clutch shaft is journalled in two boxes. Gear teeth are cut in an enlarged portion of the shaft, producing a pinion which engages with the intermediate gear, as shown. The flywheel revolves freely on the clutch shaft and the outer end of the latter is bored axially. A cylindrical rod or plunger moves horizontally in this bored hole and the inner end of this rod is connected by toggles to the clutch disk, which is given the small amount of motion and heavy pressure required. The clutch may be engaged by a foot-treadle or by the hand-lever shown at the side of the press. The action can also be automatic if desired. Accessibility to the parts requiring adjustment has received careful attention.



Two-hundred Ton Ferracute Press

Some of the principal dimensions of this press are as follows: Stroke of the ram, 10 inches; adjustment of the ram, 6 inches; distance from the bed to the ram with the latter at the top of its stroke and adjustment, 30 inches; distance between the columns, 32 inches; thickness of bolster, 5 inches; extreme height, 127 inches, and total weight, 38,000 pounds.

RADIAL DRILLING AND REAMING MACHINE

The wall type of radial drilling and reaming machine shown herewith is one of a number furnished to the McClintic-Marshall Construction Co. (contractors for the steel work on the Panama Canal Locks), by the William E. Gang Co., Cincinnati, O. These machines are used principally for drilling and reaming, and when in use they are attached in gangs to the columns or legs of a movable steel structure similar to a gantry crane.

The drill spindle and its driving motor is mounted on a double-hinged arm consisting of two 4-foot sections. The maximum distance from the center of the spindle travel to the face of the wall-plate, is 8 feet 7 inches, and the arm has a vertical travel on the wall-plate of 3 feet 5 inches. Fig. 2 shows the elevating mechanism in detail. A 2½-inch elevating screw *E* is supported on a roller thrust bearing *B* in a bracket that can be set on either side of the wall-plate. The elevating screw is connected by miter gears and a sliding clutch *C* with the power shaft *A*. In this case, the elevating mechanism for a group of machines is driven by one motor, connection being made at *D*. The lever shown hanging from the elevating gear bracket (see Fig. 1) controls the vertical movement of the arm, and the slotted bar shown is an adjustable stop for limiting the travel. The elevating lever can be locked in a neutral position.

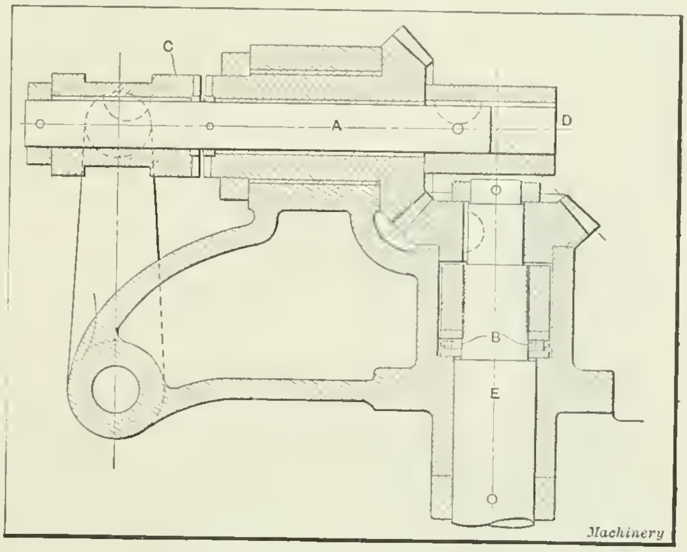


Fig. 2. Elevating Mechanism of Radial Drilling Machine

A pull of less than ten pounds is sufficient to move the arm to any position, due to its being provided at the hinges or trunnions with roller bearings and ball thrust bearings. The rollers run between inner and outer steel sleeves, and in case looseness should develop through wear, these sleeves can be easily replaced without affecting the steel trunnions. The trunnion journals are capped to facilitate taking them apart, and to insure accurate alignment they are tongued and grooved and taper dowel pinned. Provision is made for excluding the dust and dirt from the ball and roller bearings.

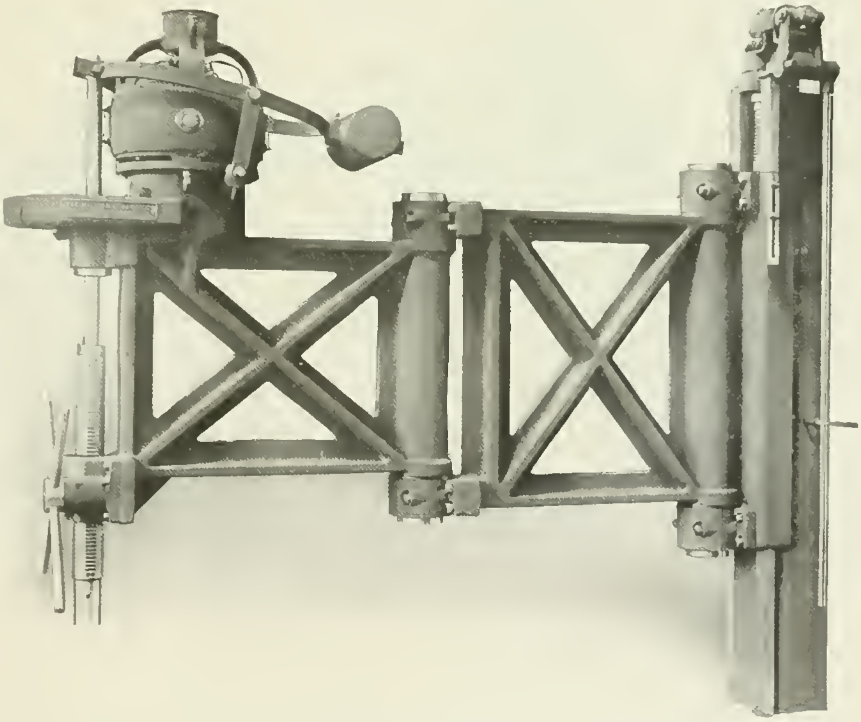


Fig. 1. Special Radial Drilling and Reaming Machine built by the William E. Gang Co.

The driving motor for the spindle, which is mounted near the outer end of the forward gate or arm, is geared directly to the spindle by steel gearing. It is a Crocker-Wheeler, variable speed type of 3¼ horsepower capacity. The spindle is made of high-carbon crucible steel, and it runs in a bronze-bushed steel quill or sleeve. The vertical traverse of the spindle is 26 inches, and it is moved up or down by a steel rack and pinion and the pilot wheel shown. The pilot wheel levers are screwed into a steel pinion head and they are pinned in position to prevent their working loose. The method of counterbalancing the spindle is clearly shown by the illustration. This machine is massive and of high-grade construction. Its net weight, including the motor, is 7000 pounds.

CINCINNATI GEAR TURNING LATHE

The Cincinnati Pulley Machinery Co., Cincinnati, O., is now manufacturing a 32-inch gear turning lathe. This machine, front and rear views of which are shown in Figs. 1 and 2, is specially designed for finishing steel gear blanks. It is, of course, also adapted to cast-iron work at increased speeds and feeds.

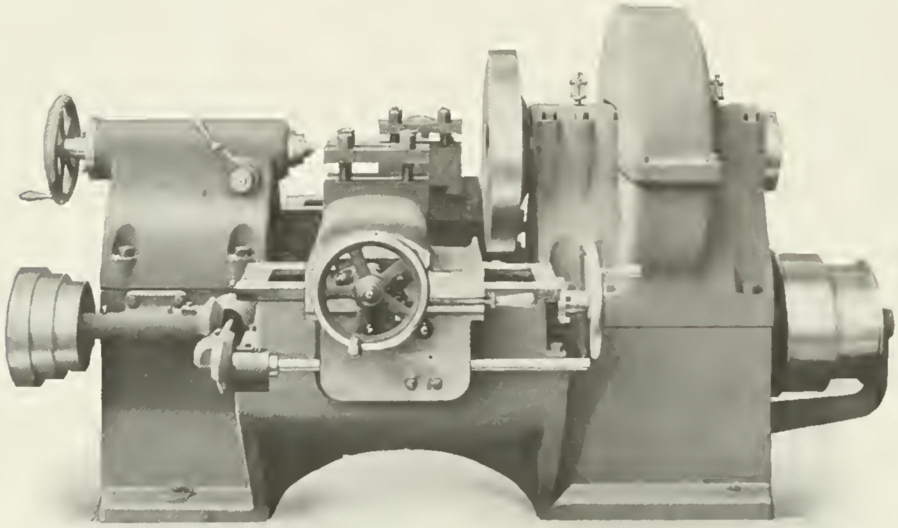


Fig. 1. Special Gear Turning Lathe built by Cincinnati Pulley Machinery Co.

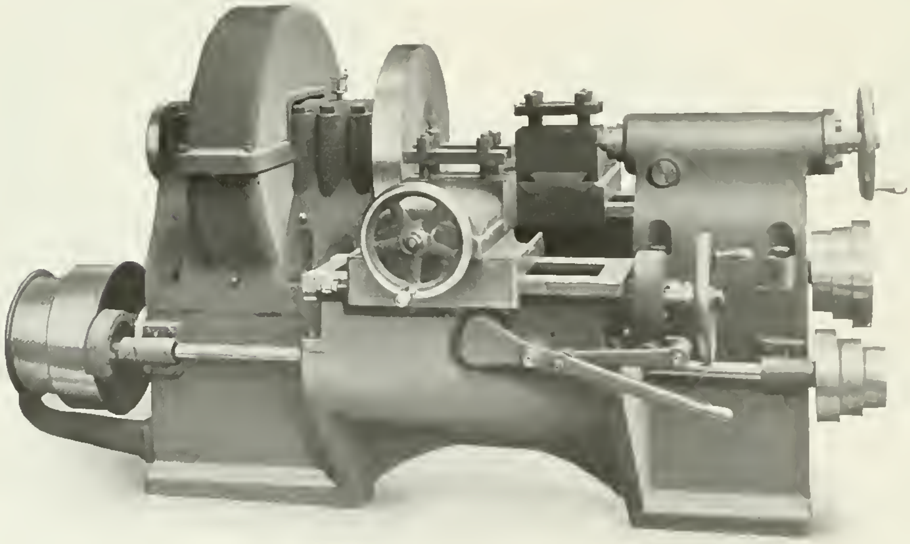


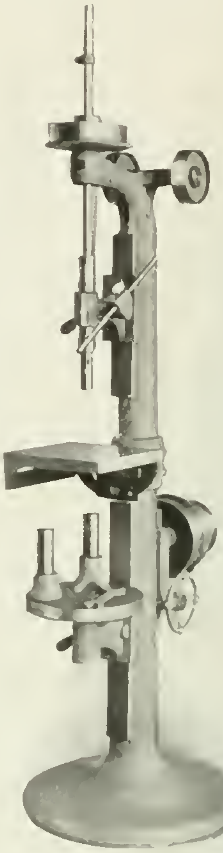
Fig. 2. Another View of Gear Turning Lathe

There are two tool slides, one being at the front and the other at the rear. These slides are mounted on rails which are bolted to extensions on each side of the bed, and they have independent movements. One slide is provided with a power longitudinal feed and the other has a power cross-feed. In addition, both slides have cross and longitudinal hand adjustments.

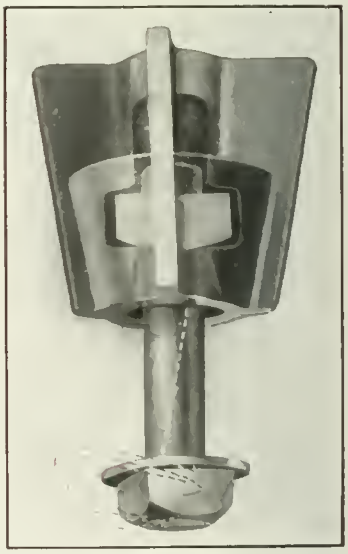
The machine is driven by a belt operating on the two-step cone pulley seen to the right in Fig. 1. This pulley connects with the spindle through large spur gearing, having a ratio of 26 to 1. The spindle has four speeds ranging from 9 to 16.5 revolutions per minute, which are obtained by a two-speed countershaft and the two-step cone pulley. The main spindle gear, which is of steel, has a 4-inch face and is 4 pitch. The spindle, which is 7 inches in diameter, is made of hardened crucible steel and is bored its entire length.

The feeding movement is derived from the cone pulley shaft through spur gearing, which drives the feed-shaft as shown in Fig. 2. This feed-shaft actuates the longitudinal slide above it and the feed is engaged or disengaged by the clutch lever and clutch shown to the right. Connection to the opposite side of the machine is made by a belt operating on the three-step cone pulleys shown. Fig. 1 clearly indicates the feed transmission for the slide having the power cross-feed.

This machine is heavily built and of very rigid construction, as the illustrations show, and it is adapted to the heaviest cuts which high-speed steel tools are capable of taking. All pinions and feed gears are of steel and are entirely encased. The machine has a 32-inch swing and a capacity for widths up to 18 inches. There are three longitudinal feed changes, varying from 1/32 to 1/16 inch and a similar number of cross-feed changes, varying from 0.018 to 0.036 inch. The weight of the machine is 6500 pounds.



Washburn 15-inch Drilling Machine



Bolt Anchor for Concrete Construction

WASHBURN DRILLING MACHINE

The Washburn Shops of the Worcester Polytechnic Institute, Worcester, Mass., are now manufacturing a 15-inch drilling machine, the general construction of which is shown by the accompanying illustration. This machine has ball bearings throughout and it is designed to take high-speed drills up to and including ¾ inch in diameter. The drive is from the back cone to the spindle pulley by a quarter-turn belt running over idler pulleys in the usual manner. The construction of the spindle pulley is such that the belt tension is carried by an independent bearing, thereby relieving the spindle so that it runs absolutely free. This bearing is surrounded by a concentric ring which retains the oil and prevents it from spattering. The belt tension is controlled by an automatically locked belt tightener. The arrangement of this device is such that the cone is locked in any position in which it may be left, and the belt tension can be changed by simply turning the handwheel shown. The machine is equipped with both square and round tables. The square table may be tilted and it is mounted on a bracket which revolves about the column, thus permitting it to be swung out of the way when the round table is used. The size of the square table is 12 inches and the apron at the side is 4 inches wide. The round table is 12 inches in diameter and it is adjustable on the column. It may also be removed and either a cup or crotch center substituted. Both of these centers are included in the equipment. The net weight of the machine, with countershaft, is 625 pounds. The countershaft is fitted with ring oiling bearings and the loose pulley runs on a loose bronze bushing.

HILL BOLT ANCHOR FOR CONCRETE WORK

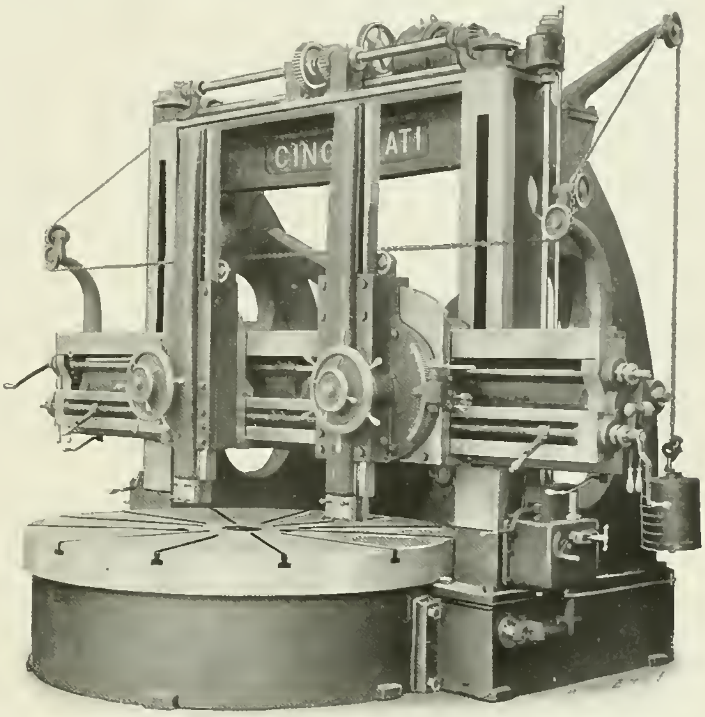
A bolt anchor for use in connection with concrete construction is illustrated herewith. This anchor was primarily designed for supporting shaft hangers, but it is adapted to various other classes of concrete work. The anchor body is conical and it has wedge-shaped longitudial wings or ribs. This form of anchor is strong but light, and it has great holding power. The conical wedge shape resists tensional strains and the wings prevent the anchor from turning. The nut is inserted within the casting as shown. It has a chamfered face resting on a seat and is free to oscillate, but is prevented from turning by abutments. With this arrangement, the bolt can readily be entered in the nut even though inserted at an angle, thus allowing for considerable irregularity in setting the anchor. These anchors are made for bolts of the following sizes: 1½ inch by 3 inches, ⅝ inch by 4 inches, ¾ inch by 4½ inches, ⅞ inch by 5 inches, and 1 inch by 6 inches. They are the product of the Hill Clutch Co., Cleveland, O.

CINCINNATI BORING MILL

The boring mill illustrated in the accompanying view is an 8-foot size built by the Cincinnati Planer Co., Cincinnati, O. This machine is similar in its construction to the 10-foot size Illustrated in the department of New Machinery and Tools for February, 1911.

The entire mechanism of the mill is supported on the bed, so that only one foundation is required and alignment of all parts is assured. The table is supported on a broad flat annular bearing of large diameter, which is automatically lubricated by rollers. The oil pockets are filled and drained from the outside. The table diameter equals the full capacity of the mill. The center spindle revolves in a bushed adjustable bearing and there is a step bearing at the lower end which can be adjusted to take more or less load, as desired. The table can also be raised sufficiently for high speeds. The main internal driving gear is cut from the solid, and the pinion is made from a solid steel forging.

The housings have, in addition to the usual brace, an X-brace at the rear to take any side or twisting strains due to heavy cuts when the cross-rail is elevated considerably above the table. The cross-rail has a deep arch at the rear to eliminate deflection, and it is secured to the uprights by clamps engaging both the inner and outer sides of the housings. The heads have a narrow guide bearing at the bottom of the rail to prevent tilting or binding, thus relieving the feed mechanism and insuring permanent alignment. Both heads have a rapid power traverse in addition to the hand adjustment. The handles have a safety lock so that they cannot revolve when the rapid traverse is used. Ratchets are provided on the rail screw for making fine adjustments. These can be moved to suit the convenience of the operator. The cast-steel tool bars also have the rapid power traverse in both directions. Eight feed variations are provided, ranging from 1/32 to 1 inch. These changes are effected by levers on the feed-box at the side of the housing. A separate feed-box is attached to each housing, so that the heads have independent feeding movements.



Cincinnati Eight-foot Boring Mill

Either a belt or motor drive is supplied. For a belted drive, a four-step cone pulley is mounted on top of the speed box giving sixteen variations, and the drive for raising and lowering the rail is taken direct from the countershaft. For a motor drive, a 2 to 1 variable-speed motor is used in connection with a speed-box giving four mechanical changes. This motor can be belted to the speed-box or connected direct by gearing. A small additional motor is required for raising and lowering the cross-rail.

NEW MACHINERY AND TOOLS NOTES

Tap Wrench: Alert Tool Co., 4731 N. Mascher St., Philadelphia, Pa. Ratchet tap wrench which can be made either right- or left-hand at the will of the operator. These wrenches are made in sizes varying from ⅛ to ¾ inch.

Screw-driver: H. D. Smith & Co., Plantsville, Conn. Screw-driver with handle divided longitudinally through the center and so arranged that one or both halves can be set at right angles to obtain a leverage, when inserting a large screw.

Electric Grinder: Hamilton-Beach Mfg. Co., Racine, Wis. Aluminum mounted electric grinder, which weighs only five pounds and is adapted for either external or internal work. A one-tenth horsepower motor is used which operates on direct or alternating current.

Compound Rest: Stark Tool Co., Waltham, Mass. Improved compound slide rest for bench lathes. The tool-post will hold either round or square turning and boring tools. The boring tools are held in an eccentric quill giving an adjustment for setting the tool central.

Cylinder Boring Machine: Moline Tool Co., Moline, Ill. Single spindle cylinder boring machine for single or twin cylinders. It has a compound table so that two or more cylinders may be bored at one setting. The feed is by double steel rack and pinions. The table is counterbalanced and has an automatic stop and quick return by a pilot-wheel.

Toolholder: B. Morgan, Newport, R. I. Toolholder consisting of two hardened steel parts between which the tools are clamped. The upper and lower members are kept in line by a connecting link which has an elongated slot that allows the respective positions of the parts to be reversed. One side of each member has a V-groove, and either round, square, hexagon or other shaped tools can be held.

Cold Saw: Higley Machine Co., Croton Falls, N. Y. Cold sawing machine with capacity for I-beams or other material up to 20 inches wide and 7 inches high. The saw cuts from above so that it is easy to adjust the work by marks made on the upper surface. The table has a lateral movement of 3 inches, so that the work can be set approximately in line with the saw and then be accurately adjusted.

Press Guard: H. & A. Lock Co., 156 Fifty-third St., Brooklyn, N. Y. Automatic punch-press guard operated entirely by the regular pedal trip. The arrangement is such that the clutch is not engaged until the guard is raised. As the foot pedal is pressed, the guard swings upward until it is nearly vertical when the clutch acts and the press is tripped. It is impossible to trip the press when the guard is down.

Drill Chuck: Emrick Drill Co., 139 Stockholm St., Brooklyn, N. Y. Chuck in which the drill is gripped by three equally spaced cam-shaped jaws, which are geared together and controlled by a knurled outer sleeve. As the twisting strains on the drill increase, the grip automatically tightens. The drill can be instantly released while the machine is in motion by holding the knurled sleeve. The chuck is simple in construction and has few parts to get out of order.

Patternmakers' Disk Grinder: Gardner Machine Co., Beloit, Wis. Motor-driven patternmakers' disk grinder of the single end type carrying a 30-inch disk wheel. This wheel is driven from the motor shaft through spur gears, the pinion of which is of rawhide. The controller is attached to the front of the machine and the operator can start or stop the machine from the working position. A five-horsepower motor is used. This same style of drive is adapted to other kinds of disk grinders built by this company.

Special Facing and Boring Machine: Rochester Boring Machine Co., Rochester, N. Y. These machines are built for combined facing and boring or for facing only. There are two facing arms which can be operated simultaneously on surfaces in different planes. The arms are of different lengths and the longer one will face up to 50 inches in diameter. The feed for facing is of the well-known star wheel type. The starting, stopping and changing of speeds are controlled by a single conveniently located lever.

Shaper Attachment: L. E. Rhodes, Hartford, Conn. Horizontal shaper with attachment for vertical planing. The vertical attachment is applied by mounting it on the column after the regular ram is removed. It consists of a housing carrying the ram and a bellcrank driving mechanism which connects with the regular rocker arm of the shaper. The ram can be tilted from the vertical for machining angular work, and its stroke is changed in the usual way. The stroke may be varied from 0 to 3½ inches, and the maximum distance under the ram is 8½ inches.

Hacksaw Machine: L. H. Olmstead's Son, Hasbrouck Heights, N. J. Hacksaw machine of compact design, constructed to give a true vertical cut. The hacksaw frame is reciprocated by a revolving crank and connecting-rod, and the movement of the frame is the same irrespective of its height above the table. The work can be set to an angle, and its position is indicated by a pointer and graduations. The machine is started and stopped by a clutch attached to it. Three sizes are built having capacities for stock varying from 2 to 4½ inches square.

Machinists' Tools: Brown & Sharpe Mfg. Co., Providence, R. I. Improved machinists' tools consisting of pocket slide caliper rule adapted to internal and external measurements; a thread tool vernier for measuring thread tools when grinding for different pitches; an inside micrometer caliper with a capacity from ½ to 1½ inch; a micrometer head designed to be readily attached in any position for making fine adjustments; an improved universal bevel protractor with vernier reading to five minutes; and accurately made hardened and ground V-clamps made in pairs and designed for use when laying out work.

Grinding Machine: Norton Grinding Co., Worcester, Mass. Grinding machine especially designed for car axles. The machine is equipped with a hoist and a pneumatic arrangement to facilitate handling the work. The total weight is about 23,000 pounds and the weight of the grinding wheel head with its revolving parts is about 5000 pounds. The machine is motor-driven, one motor supplying power for all the parts. It is equipped with a pump which delivers about fifty gallons of water or lubricant per minute. The headstock and footstock are made heavy to absorb vibration and the headstock has a gear-box to provide the necessary speed changes. The work is started and stopped by a lever conveniently located near the center of the machine.

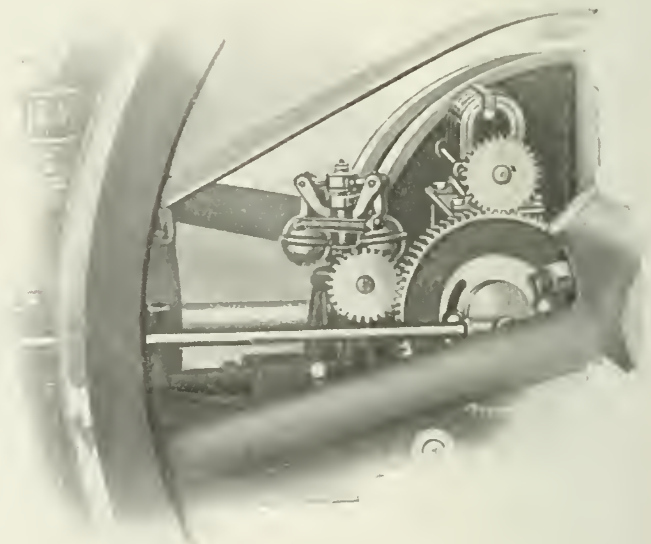
Vacuum Cleaner: B. F. Sturtevant Co., Hyde Park, Mass. Vacuum cleaner adapted to factory use and for general work. This is an electrically driven fan-type machine and maintains a strong steady suction free from pulsations. The suction is produced by a two-stage fan, directly connected to the motor. The fan is enclosed in a cast aluminum casing mounted on rubber-tired wheels so that the machine can easily be moved about, and it is equipped with ball bearings and is perfectly balanced to eliminate vibration. Oiling is not necessary as the bearings are packed in grease, which seldom needs replacing. The machine can be emptied and the dust bag replaced in less than a minute. All tools are aluminum, with the exception of the extension handles which are nickel-plated brass tubing.

Vertical Shaper: Pratt & Whitney Co., Hartford, Conn. Vertical shaper resembling in appearance a slotter and designed for the usual run of small slotter work and also for the class of work ordinarily done on the horizontal shaper. It is equipped with a rotary table and has cross and longitudinal movements similar to a slotter. The ram slide containing the ram can be set to an angle for taper planing and its position is shown by graduations. The ram is driven by a link mechanism similar to that used in the Pratt & Whitney horizontal shaper. The ram head and toolpost can be swiveled to any angle in a horizontal plane, so that the tool can be set in the best position. This shaper has a maximum stroke of 6½ inches and a maximum distance from the top of the table to the end of the ram of 13½ inches. The rotary table is 20 inches in diameter, the longitudinal travel 25 inches, and the cross movement 14 inches.

* * *

GAS ENGINE WITH BUILT-IN MAGNETO

The Foos Gas Engine Co., Springfield, O., has abolished batteries on all its standard-type engines, and magnetos will be used hereafter. The magneto is a "built-in" design which forms an integral part of the engine. The method of driving it directly from the crankshaft, through gearing, is indicated by the illustration. This magneto gives a low voltage to permit using make-and-break igniters without deterioration of electrodes. The magneto's speed is comparatively slow, and it is constructed to give a high electrical efficiency, so that a spark can be generated for starting while turning the engine slowly by hand. The igniter electrodes are brought into frictional contact by the wiping action of a revolving blade, which is designed to keep the sparking surfaces clean and prevent fouling. The magnets used in this magneto are made from tungsten steel and consist of a set of six bars, 5/16 by 1 1/2 inch. The armature is laminated, being made of special soft sheet iron. The armature windings are of high-grade double-insulated wire. The collectors for the current bear on smooth polished surfaces. An alternating current is produced having two "peaks" for each revolution of the armature. The current generated during the rest of the revolution is too weak to produce a spark. The relative position of the two peaks is fixed and synchronized by setting the armature in proper relation to the engine. It is claimed that the reason that magnetos have not been used heretofore on stationary engines, is because the electrical efficiency has been too low to generate a hot spark at slow speeds.



Foos Gas Engine Magneto and Direct Drive

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Users of the advertising pages should note that the location of the page of foreign dealer advertisements has been changed from 12 to 224.

A QUESTION IN SHAPER DESIGN—A REPLY

We have no intention of entering into any extended controversy with the writer of the article, "A Question in Shaper Design" published in the December issue of MACHINERY. In our opinion, this article would be of more value if the statements and criticisms came from an authority who had no self-interest to influence his judgment, and, as it might possibly be misleading to those who are not familiar with the Stockbridge shaper, we feel obliged to take exception to most of the statements made. We shall consider these statements as briefly as possible. In the first place, the article which appeared in the October number, was merely a study in kinematics and no one will question but that it was published with no desire to prejudice. The sincerity and honesty of the article is beyond question. Therefore the first statement in the comment appearing in the December number, that the former article "does not properly set forth the merits of the plain slotted crank," we can dismiss as out of place. The following is another quotation of the article in question: "Fig. 1 shows the construction of our simple quick-return mechanism." The "simple quick return" referred to is a small increase of speed during the return stroke, due to the inclined position of the rocker-arm when the shaper is on its longest strokes. As the length of stroke is shortened, the return speed is reduced very rapidly as the rocker-arm approaches more nearly a vertical position. The quick return of a regular crank shaper when on a stroke less than one-half its full length stroke, is so small that for all practical purposes it may be neglected. A quick return is of the greatest value on its shorter strokes. The Stockbridge "two-piece crank" motion maintains this quick return even down to a 1-inch stroke. Why does our competitor lay so much emphasis on the quick return in his advertising and at the same time argue that a quick return is not desirable?

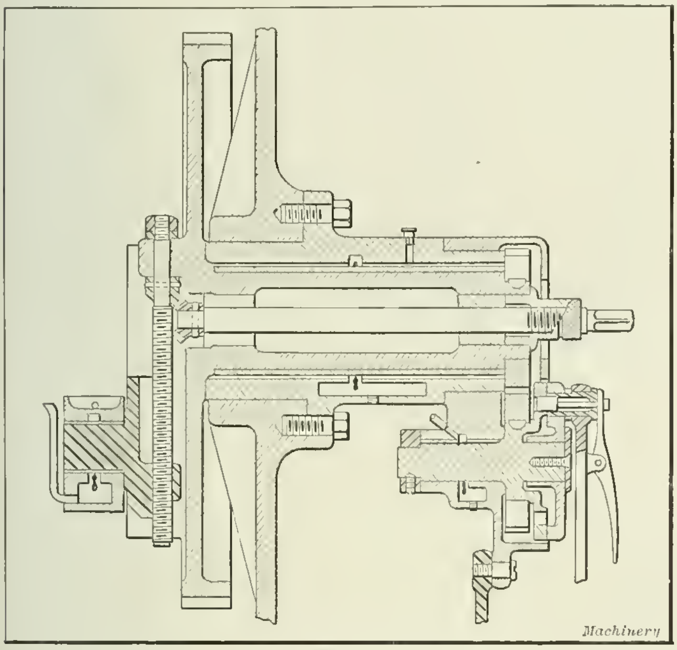


Fig. 1. Queen City Shaper Crank Mechanism

Attention is called to the fact that in the regular crank shaper there is only one bearing surface for the bull gear. Compare the unsupported gear, Fig. 1, with the construction shown in Fig. 2, and note that the gear in the latter illustration has a bearing on its periphery. With this construction all strain and, consequently, friction is taken off the crank hub and the hub is practically free from wear. The advantage of our construction over that of Fig. 1, with a small diameter hub as compared with the diameter of the gear is, in our opinion, too evident to need comment. The question of friction is one that can only be determined by tests. To us, however, this question of the number of bearings does not seem to be so important a factor in friction, as the question of rigidity of parts and the way in which they are supported against cramping. The friction of stiff, free-running parts is a small matter when compared to the friction and troubles due to too much overhang or to any other defect in design that allows spring or cramping. Our patented main bearing support for the bull gear (Fig. 2) eliminates all possibility of spring or cramping and we believe it to be the better construction.

The following table of tests was not made by us, but by H. P. Fairfield, of the Worcester Polytechnic Institute—a man whose authority and reputation gives it value. The difficulty of making any comparative test is to get all the conditions absolutely the same, and a comparison of tests made on different machines under different conditions is valueless. The comparisons mentioned in our competitor's article are for this very reason of no value—there is no basis of comparison. To make a fair comparison, every condition must be identically the same. Mr. Fairfield, in his tests, made use of the same machine, changing it into a regular crank shaper by simply bolting the crank and gear together, and thus eliminating all the parts which make up the "two-piece crank." In the first place, tests were made with the "two-piece crank," about twenty-five readings being made for each test, and an average taken; then the gear and the crank of this same shaper were bolted together, making a regular crank shaper. In other words, in the latter test, the friction of sliding blocks and the extra bearing surfaces of the "two-piece crank" shaper were eliminated. These tests were made on identically the same machine, the same material was worked upon, and the same cutting tool used, etc. The results of these tests are given in the accompanying table. The tests prove that any increase of friction because of the additional parts of a "two-piece crank" is more than offset by the gain of power.

Depth of Cut, Inch	Length of Cut, Inches	Feed per Cut, Inch	Cutting Speed, Feet per Minute	Horsepower, Stockbridge Two-piece Crank	Horsepower, Regular Crank
3/8	12	0.0294	15	2.10	3.08
1/8	12	0.0294	17	2.68	3.35
3/8	12	0.0294	25	3.22	3 62
1/8	12	0.0294	30	4.02	4.16

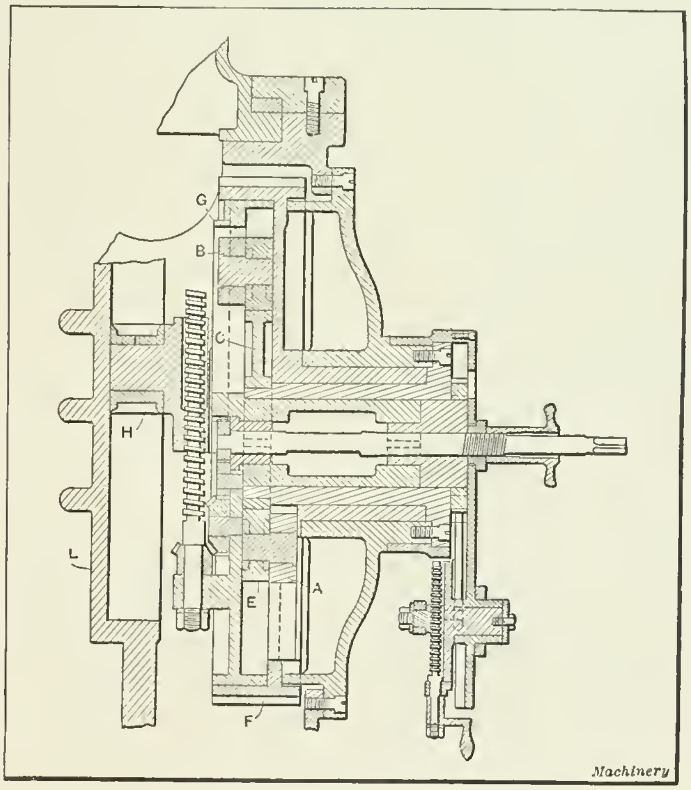


Fig. 2. Stockbridge Shaper Crank Mechanism

The parts which are actually required to make up the "two-piece crank" are the eccentric *C* (Fig. 2), eccentric ring *E* with two blocks *A* and *B*, crank *G* and gear *F* which is used in both constructions. By referring to Fig. 2, it will be seen that the assembled parts are just as compact as a regular crank. The extra parts used are not numerous or complex, as anyone can see, and we know the advantages obtained are altogether out of proportion to the disadvantage—which is the cost of manufacturing.

That the Stockbridge crank does produce the results claimed, our competitor freely admits; however, the motion does not seem to be fully understood by him, judging from further remarks in regard to the accelerated motion of the Powell planer. He draws the inference that if the accelerated motion of the Powell planer is an advantage, the even cutting speed which we get is not. A study of the velocity curve in the October issue will show that what we accomplish is practically what Mr. Powell accomplishes in his accelerated motion. The velocity starting at cipher increases gradually, but does not come up to full speed on the length of stroke shown, until it has traveled about 2 inches, and as ¾ inch is all that is required for tool clearance, it will be seen that the tool enters the work at a slow speed and then comes up to its maximum and maintains that speed until it almost reaches the end of the stroke. The speed then drops off gradually, thus accomplishing practically what the Powell motion does on a planer. The following quotation is also taken from the former article: "If the quick return is so important, why the variable speed planer with the constant return?" This comparison is misleading and hardly fair. In the construction of the planer, the thing that has been worrying designers is to get a number of forward or cutting speeds. The shaper already has the varying forward speeds. The constant return speed of the planer is the maximum speed at which the table can be returned. This is just what we are aiming at in our "two-piece crank" motion—to return the ram at the fastest possible speed at which it can be returned and as near a constant speed as possible. It makes no difference whether the stroke is 2 inches or 24 inches, the Stockbridge crank motion maintains more nearly than any other crank motion, a high, uniform return speed.

Our competitor states, "The real question at issue is how much work can be produced in a given time and at what expenditure of power?" Consider a 24-inch shaper on an 8-inch stroke, 40 strokes per minute. The regular crank shaper on this length of stroke would, practically speaking, have no quick return; with the Stockbridge crank, the return ratio would be a little over 2 to 1. Each complete revolution of gear would require 1½ second. The regular crank requires about ¾ second on the cutting stroke and nearly the same on the return stroke, for each revolution of the gear, whereas the Stockbridge crank requires 1 second on the cutting stroke and ½ second on the return stroke for each revolution of the gear. The rate of the regular crank tool movement over the work, per second, $= \frac{8}{1} \times \frac{4}{3} = \frac{32}{3}$; and the cutting speed $= \frac{32}{3} \times \frac{60}{12} = 53\ 1/3$ feet per minute. The rate of the tool movement over the work is 8 inches per second with a Stockbridge crank, and the cutting speed $= \frac{8}{1} \times \frac{60}{12} = 40$ feet per minute. If at a given cut and feed, the tool will stand 53 1/3 feet per minute on an 8-inch stroke, with the regular crank shaper, one of three gains can be made with the Stockbridge shaper on the basis of the foregoing figures. First, the length of the stroke can be increased to 10 2/3 inches and still maintain the same cutting speed. Second, the number of cutting strokes per minute can be increased to 53 1/3 and still maintain the same cutting speed. Third, a larger cut or feed can be used and more stock be removed, and still maintain the same number of strokes of the ram with no more power used.

We leave it with the impartial reader to decide whether these gains of 33 1/3 per cent are of value in the day's production. We have shapers that have been working constantly, day in and day out, for twelve years (the oldest shapers we have), making a saving with every stroke and they are running today without, in the meantime, one cent having been expended for repairs—and after all is said, that is the real answer.

Stockbridge Machine Co.

Worcester, Mass.

GRINDING ALUMINUM CASTINGS ON A VERTICAL SPINDLE DISK GRINDER

It is generally considered rather difficult to machine aluminum castings, similar to those shown in the illustrations, because of the action of aluminum on cutting tools and its tendency to spring when being clamped for machining on the miller, shaper or planer. Some interesting results of tests made in the experimental department of the Gardner Machine Co., Beloit, Wis., in connection with the grinding of large aluminum castings on the Gardner vertical-spindle disk grinder, are given in the following.

The aluminum gear-case and cover shown to the left in Fig. 1, each has a surface area to be ground consisting of a band 1 inch wide having the general shape of a rectangle measuring approximately 38 inches by 21 inches. The lugs or ears at the side also add about 12 inches of area to this surface. The case was finished on a vertical spindle machine having a 53-inch disk wheel, in seven minutes and the cover required eight minutes. The castings were ground from the rough, and a clean straight surface produced, as indicated in the view to the right, which shows the parts fastened together by small clamps placed near one end.

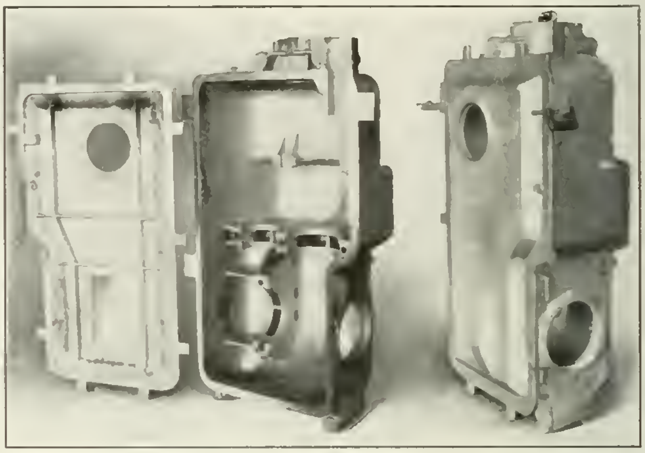


Fig. 1. Aluminum Gear-case and Cover

When castings are ground in a machine of this type, they are fed against the wheel by gravity pressure. This pressure should be at least two pounds per square inch of aluminum surface to be ground. The weight of the gear-case was sufficient to give this pressure, but the cover, which had just as much area to be ground, required an additional weight of forty pounds. In this connection, it should be mentioned that the Gardner Machine Co. emphasizes the importance and advantage of reducing the surface area wherever practicable. For example, it is claimed that if the lugs or ears of the part shown in Fig. 1 were depressed below the finish line and if a shallow groove, say ¾ inch wide, extended entirely around the center of the 1-inch band, both the case and its cover could be ground to a practically perfect surface, in from three to five minutes each. Depressions in the patterns having a

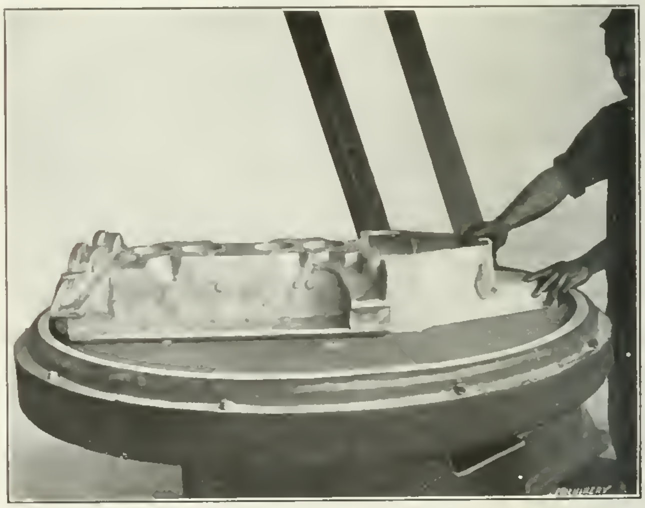


Fig. 2. Grinding Motor Crank-case

depth of from 1/32 to 1/8 inch, according to the size and accuracy of the casting, would produce the desired result.

Fig. 2 shows the method of grinding the upper half of an aluminum crank-case for a four-cylinder motor. The entire length of the surface being ground is 49 inches and the maximum width 13 inches. It required ten minutes to produce a straight and clean surface. If the surface area, however, had been reduced, as suggested in the foregoing, the time required for grinding could, according to a conservative estimate, have been diminished two or three minutes for each casting. This illustration shows very clearly the method of handling work of this class on the vertical spindle machine.

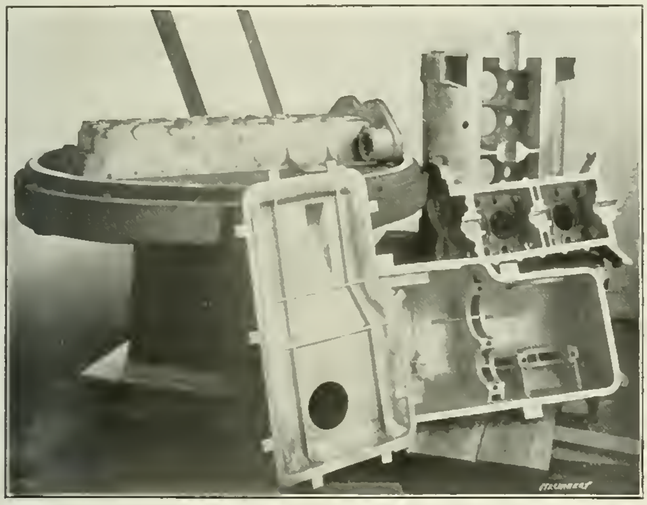


Fig. 3. Another Example of Aluminum Grinding

Fig. 3 illustrates a group of aluminum pieces all of which have been machined. The casting shown on the disk-wheel is the upper half of a motor crank-case, and it measures, diagonally, 51 inches. The suggestion in regard to the reduction of surface area, also applies to all of these parts and particularly to the one standing on end in the rear. This casting required thirteen minutes for finishing, but by depressing a portion of the surface area, it should be done in five minutes at the most.

BEST MFG. CO.'S NEW PLANT AT OAKMONT, PA.

The new plant of the Best Mfg. Co. is located at Oakmont, some twelve miles up the Allegheny River from Pittsburg. This plant is devoted to the manufacture of valves, pipe fittings, pipe bends, special castings, etc. The plant is located between the tracks of the Pennsylvania Railroad and the bank of the Allegheny River, and is served by a spur track radiating from its own special station, Edgewater.

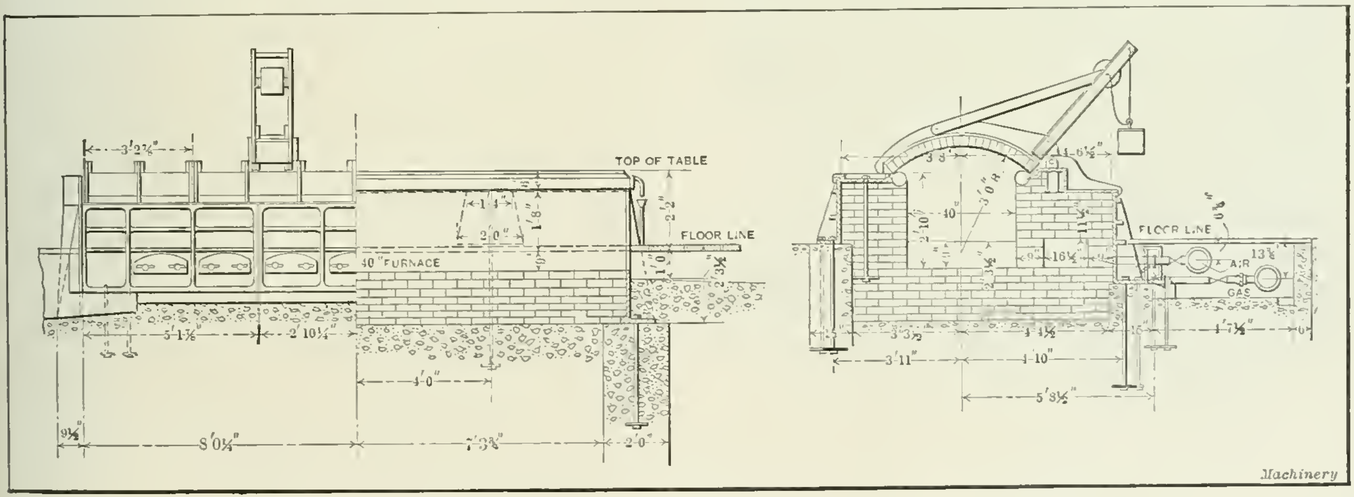


Fig. 2. Elevation and Section of the Furnace in which the Pipe is heated previous to Bending

The main buildings are the machine shop, foundry and power house. The machine shop is 432 feet long by 128 feet wide; the foundry 320 feet long by 176 feet wide; and the power house 128 feet long by 55 feet wide. The machine shop, foundry and power house are of steel frame construction with brick curtain walls and cement tile roofs on steel trusses. These buildings are provided with exceptionally high windows, giving excellent lighting at all points in the building.

The foundry is equipped with molding machines, metal flasks for standard work, special shaped patterns, and metal core boxes for smaller work. The foundry is also supplied with jib traveling cranes to serve the ladles and handle the lighter local traffic. The two cupolas which are located in the south bay of the foundry have a capacity of 12 and 30 tons per hour; they are charged from the second story floor and served by a hydraulic plunger elevator.

In the machine shop electric drive is used throughout, the larger tools having individual motors and the smaller ones being driven in gangs from countershafting. The machine shop is equipped with the following tools: one open-side planer, one vertical and horizontal boring mill, smaller boring mills, turret lathes, ordinary lathes, large and small tapping machines, double-head facing lathes, multiple-spindle drills, single drills, a gang of pipe threading machines, and other special tools.

In the pipe shop is located an interesting furnace and bending table for bending large pipes. The pipe to be bent is filled with sand by gravity from an overhead hopper. The ends are plugged and the pipe placed in the gas furnace shown in Fig. 1, where that portion which is to be bent is heated to the proper temperature. This furnace is of interesting construction as can be seen by referring to Figs. 1 and 2. The top of the furnace consists of a number of iron segments lined with fire-brick and provided with weights which practically counterbalance the weight of the segments. When the pipe is heated to the proper temperature, an electric crane lifts the pipe vertically out of the furnace, the segments dropping back to allow it to be removed easily. The pipe is removed from the furnace and is placed on the bending table, where, by means of an electric winch, it is bent around pins which are placed in such a position that they give the pipe the proper curve or angle. The object in filling the pipe with sand is to prevent it from buckling while being bent. After the pipe is bent, the sand is emptied into a tank below the floor level, from which it is blown upward to the gravity hopper.

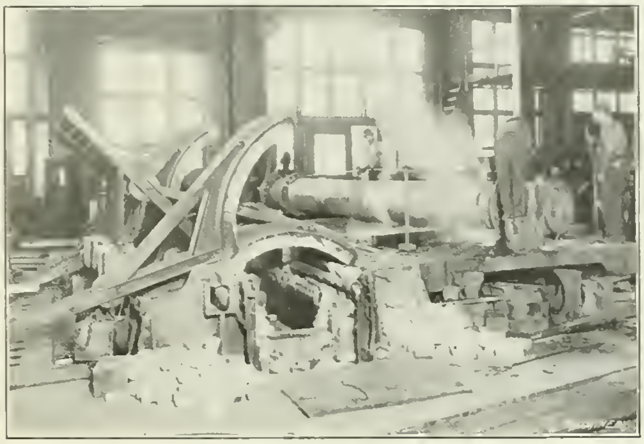
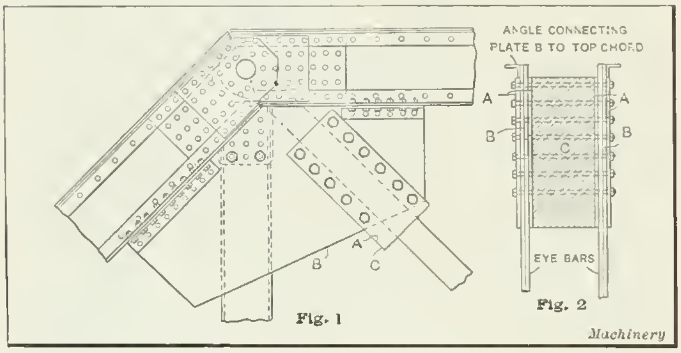


Fig. 1. Pipe in the Process of being bent

AN EXCEPTIONAL BRIDGE REPAIR JOB

One of the most interesting bridge repair jobs on record, both from a mechanical and a financial standpoint, was recently performed on one of the Chicago bridges of the Chicago, Milwaukee & St. Paul Railroad. The bridge in question is situated on the north branch of the Chicago river, between Division Street and North Avenue, and it was built in 1902. On account of the small width of the river and the necessity of keeping an open channel, a "through truss swing type" of bridge was used. It is two hundred and thirty feet in length, has unequal arms, and is pivoted on the north bank. The long arm extends across the river and is counterbalanced for overhang.

Due to vibration and other intermediate forces, the pins and bearings became so worn that it was deemed advisable to replace them. Previous to this time, all such jobs had been performed by driving piling and erecting false work, under which conditions the members were removed to the shop and rebored. Even under the most favorable circumstances, such a rush job would have hindered navigation for several days, and the expense would have been enormous. On account of the river traffic, some trouble was experienced in receiving Government permission to shut off navigation, so it was finally decided to try a new scheme for boring out the holes and replacing the worn pins with larger ones, without removing any of the members.



Figs. 1 and 2. Method of Holding Bridge Members while Holes were being bored

Preparatory to removing each pin, it was necessary to clamp the members at the joint as shown in Figs. 1 and 2, to secure them during the boring operation. Four steel plates *A* were used to hold the eye-bars, and these were placed on each side of the eye-bars with a block of wood *C*, fitting tightly between the inner two, while the outer two reinforced the plates *B* which were directly in contact with the eye-bars. The whole was bolted together by one-inch bolts, thus developing enough friction between the plates to take care of the dead load stress on the eye-bars. The two plates *B* were fastened to the lower flange of the top chord and to each end post by angles and bolts, and the hanger was supported by bolts as shown. In this manner all the members were rigidly clamped in position, so that the pins could be driven out.

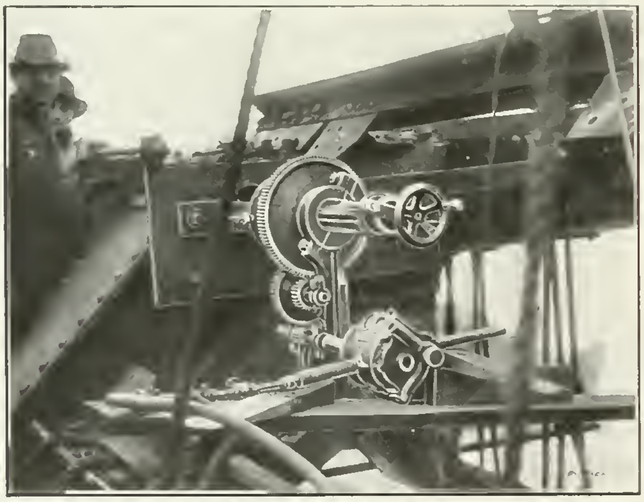


Fig. 3. Ryerson Boring-bar in Position for Boring Holes

Upon removing the pins, they were found to be considerably worn and their bearings somewhat enlarged. The holes were rebored from the original 5-inch diameter to 5¼-inch diameter by using one of the portable boring-bars made by Joseph T. Ryerson & Son of Chicago. This type of boring-bar, as is well known, is designed primarily for boring locomotive cylinders in the shop. Fig. 3 shows the boring-bar in position and the manner of bracing and centering it with one of the holes. Fig. 4 is a view from below. The power plant consisted of a section car, containing a gasoline engine and air compressor. The boring-bar was directly driven by a small air drill which operated the shaft and furnished the required power.

Fig. 4. View showing Boring-bar at Top of Bridge

Work on this job was started at 6:00 A. M. on the morning of November sixth and by 8:15 P. M. of the same day, the four pins had been removed, holes rebored, new pins inserted, and traffic was passing over the bridge. This is the first time that the use of such a method of reboring bridge work has ever been brought to our notice. The time taken for the actual work was remarkably short, and the whole experiment proved a decided success.

* * *

ANNUAL MEETING OF THE A. S. M. E.

The thirty-second annual meeting of the American Society of Mechanical Engineers was held in the Engineering Societies Building, New York, December 5 to 8 inclusive. The meeting was one of the most successful in the society's history. The attendance was large, the registration being 687 members and 1212 total, including guests. The papers presented covered a wide diversity of subjects including three by the first subcommittees appointed—those on textiles, cement manufacture and machine shop practice.

The technical excursions included inspection of the White Star steamer *Olympic*, the largest vessel afloat; Edison laboratories at West Orange, N. J.; Bush Terminal Co.'s plant in Brooklyn; Brooklyn Navy Yard; E. W. Bliss Co.'s plant, Brooklyn; J. H. Horton's ice cream plant, New York; Ward Bread Co.'s plant, New York, etc. These excursions were so arranged as not to interfere with the regular sessions. The technical program was as follows:

"The Engineer in the Future," by Col. E. D. Meier (president's address).

"The Turret Equatorial Telescope," by James Hartness.

"Expense Burden," by Sterling H. Bunnell.

"Standard Cross Sections," by H. deB. Parsons.

"Tests of Large Boilers at the Detroit Edison Company," by D. S. Jacobus.

"Strain Measurements of Some Steam Boilers Under Hydrostatic Pressures," by James E. Howard.

"Herringbone Gears," by P. C. Day. (Contributed by the sub-committee on machine shop practice.)

"The Dust Problem in Portland Cement Plants," by Otto Schott.

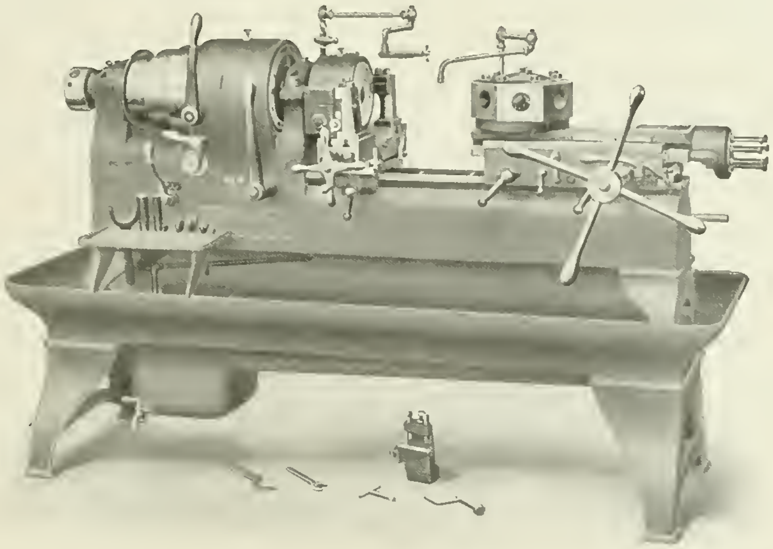
"Confirmation of the Advantages of Electricity to the Cement Manufacturer," by J. D. Porter.

"Electrical Power in Cement Plants," by Frederick H. Lewis.

"Protection of Laborers from Accidents and Injury to Health in Cement Plants," by Otto Schott.

"Methods and Appliances for Prevention of Accidents in Cement Plants," by J. G. Bergquist.

These machines are adapted for the rapid production of duplicate parts in small lots.



B.&S. Wire Feed Screw Machines

Unless the volume of any one kind of work in a shop is sufficient to warrant the installation of automatic machines, the wire feed type is the most economical to employ. Because they are adapted for such work, they embody many conveniences to aid in setting up and operating.

A glance at the sizes of the machines in the line will emphasize their range. They are as follows:

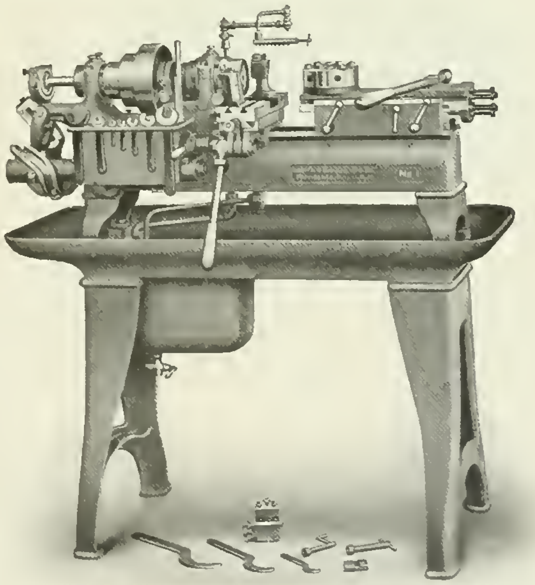
No. 0 takes stock ⅜″ diameter; turns to 2¼″ length.

No. 1 takes stock ⅝″ diameter; turns to 3″ length.

No. 2 takes stock ⅞″ diameter; turns to 4″ length.

No. 4 takes stock 1¼″ diameter; turns to 8″.

No. 6 takes stock 1½″ diameter; turns to 10″.



See our Catalogue for detailed descriptions. Sent on request.

BROWN & SHARPE MFG. CO.
Providence, R. I., U. S. A.

"Geo-Dynamics or the Mechanics of the Formation of Worlds," address by Dr. Robert Simpson Woodward, president of Carnegie Institution of Washington.

"The Core Room: Its Equipment and Management," by Henry M. Lane.

"Tests of a Sand-Blasting Machine," by Wm. T. Magruder.

"Die Castings," by Amasa Trowbridge.

"Variable-Speed Power Transmission," by G. H. Barrus and C. M. Manly.

"Oil Engines," by H. R. Setz.

"Test of an 85-H. P. Oil Engine," by Forrest M. Towl.

"Design Constants for Small Gasoline Engines," by Wm. D. Ennis.

"1000-KW. Natural Gas Engine: Tests, Construction and Working Costs," by E. D. Dreyfus and V. J. Hulquist.

"The Development of the Textile Industries of the United States," by Frank W. Reynolds. (Contributed by the sub-committee on textiles.)

"Rational Psychrometric Formulas: Their Relation to the Problems of Meteorology and of Air Conditioning," by W. H. Carrier.

"Air-Conditioning Apparatus," by W. H. Carrier and F. L. Busey.

"Experiences with the Pitot Tube on High and Low Air Velocities," by Frank H. Kneeland.

* * *

DR. ALEXANDER C. HUMPHREYS

Dr. Alexander C. Humphreys, president of Stevens Institute of Technology, and one of the foremost of American gas plant engineers, was installed as president of the American Society of Mechanical Engineers, December 5. Col. E. D. Meier, the retiring president, made the installation address in which he outlined Dr. Humphreys' career, as follows:

Dr. Alexander C. Humphreys

"Mr. Humphreys entered Stevens Institute of Technology with the class of 1877, handicapped as few men ever were. It had been twelve years since he had last attended school and that at the age of fourteen. Besides the necessity of providing for his young wife and two children, he had been elected to several positions of trust and honor in the town of Bayonne, New Jersey, all of which drew upon his time and strength. In the face of all these circumstances, which would have seemed insurmountable to the average man, Mr. Humphreys graduated from Stevens Institute with the class of 1881, having accomplished for the most part at night, after a day's work had already been done elsewhere, what normal students fresh from advanced schooling accomplish only by the unremitting application of all their working time.

"Soon after graduation, he became chief engineer of the Pintsch Lighting Co., of New York. In 1885, he was made superintendent of construction for the United Gas Improvement Co., and shortly afterward took the position of general superintendent with headquarters in Philadelphia. Eventually he assumed control of the entire commercial management of all the company's works, including the Welsbach Incandescent Lighting Co., which at that time was a subsidiary of the United Gas Improvement Co.

"In August, 1894, Mr. Humphreys retired from his official relations with the United Gas Improvement Co., to establish the firm of Humphreys & Glasgow, of New York, recently succeeded by the firm of Humphreys & Miller, Inc., of which he is president. In June, 1902, he was elected president of Stevens Institute of Technology, by unanimous vote of the trustees. In 1903, the degree of doctor of science was conferred upon him by the University of Pennsylvania and the degree of doctor of laws by Columbia University. New York University also conferred the degree of doctor of laws in 1906 and Princeton University in 1907.

"Dr. Humphreys has been chief executive officer of more than fifty-five gas and electric light companies, and is now president of the Stevens Institute of Technology, Humphreys & Miller, Inc., gas engineers, and the Buffalo Gas Company. He is a director in the Equitable Life Assurance Society, a member of its executive committee, and a trustee member of the executive committee of the Carnegie Foundation for the Advancement of Teaching. He is a member of almost every prominent technical society in this country; of the Delta Tau Delta Fraternity, and of many clubs and philanthropic societies."

* * *

PERSONALS

C. L. Eshleman has been appointed publicity manager of the Adams-Bagnall Electric Co., Cleveland, Ohio, with headquarters in Cleveland.

Harry A. Hey, associate editor American Society of Mechanical Engineers, New York, has been made office manager of the society, succeeding S. E. Whitaker resigned.

William Dayton of the Excelsior Needle Co., Torrington, Conn., will leave, the first part of January, for a business trip through Germany in the interests of his company.

William H. McIntyre, formerly fourth vice-president of the Equitable Life Assurance Society, has been elected first vice-president of Manning, Maxwell & Moore, Inc., New York.

J. G. Pomeroy, formerly Western sales manager of the Adams-Bagnall Electric Co., Cleveland, Ohio, has been appointed sales manager of the company with headquarters in Cleveland.

Thomas L. Carter, for several years assistant foreman of the small motor department of the Lynn works of the General Electric Co., has been appointed foreman of the general tool-making department of the Lynn works, succeeding A. A. Fountain, who recently resigned.

D. M. Motherwell, formerly general superintendent of the Whitman & Barnes Mfg. Co., Akron, Ohio, is now superintendent of the Armstrong Bros. Tool Co., Chicago, Ill. Mr. Motherwell is engaged in designing a new and complete line of drop-forged wrenches which will soon be placed on the market by the Armstrong Bros. Tool Co.

Lionel Samuel, director and joint manager of Cammell Laird & Co. of New York, is not seeking re-election next year, his personal affairs requiring his entire attention. As general agent of the English company, he established its offices here some years ago. Mr. Samuel is not only well known in New York, but also in Mexico and Central and South America, with some of whose governments he has had large business relations.

Walter B. Snow, Boston, Mass., announces the recent addition to his staff of Mr. Sidney G. Koon, for four years editor of *International Marine Engineering*, and later metallurgist with Jones & Laughlin Steel Co., and also the addition some time since of Mr. John S. Nicholl, lately with the New York Edison Co., and formerly acting manager for F. W. Horne, importer American machinery, Yokohama, Japan. Both are members of the American Society of Mechanical Engineers.

Donald D. Simonds (W. P. I., '08), for the past three years with the Reed & Prince Mfg. Co., Worcester, Mass., has taken a position as assistant superintendent with the F. W. Bird & Sons Co., Walpole, Mass., in charge of the company's box factory. Mr. Simonds was presented with a fine black walrus skin bag equipped with the customary toilet articles, and a silk umbrella with a silver mounted handle, by the department foremen previously under his supervision, as an evidence of their friendship.

Ira Gould Hoagland has been appointed editor and manager of *Insurance Engineering* and assumed his new duties January 1. Mr. Hoagland was born in Brooklyn, N. Y., 1877, and was educated in the Brooklyn public schools and Pratt Institute where he took the electrical and mechanical engineering courses. He entered the insurance business in 1896, and gained experience with the several concerns with which he was connected in various capacities that well fits him for his present responsible position.

R. T. Wingo, a well-known mechanical expert has joined the Hupp Corporation, Detroit, Mich., automobile manufacturer, as assistant general manager in charge of production, and acting master mechanic and consulting engineer. Mr. Wingo was for ten years employed with the Brown & Sharpe Mfg. Co., working successively as machinist, inspector, foreman and machine designer. He spent two years abroad with one of the large tool manufacturing concerns of Germany, and upon his return to America joined the engineering staff of the Cadillac Motor Car Co., of Detroit, from which he went to the Hupp Corporation.

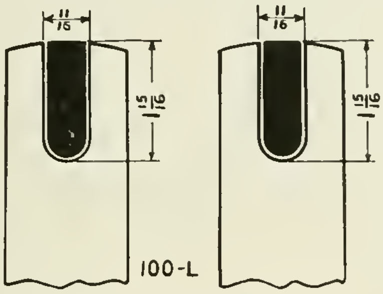
* * *

OBITUARIES

Caryl D. Haskins, manager of the lighting department of the General Electric Co., Schenectady, N. Y., and one of the

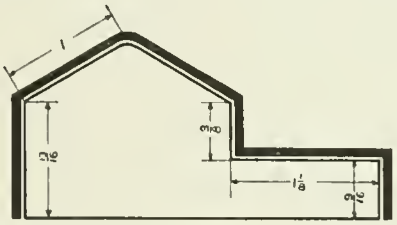
Some Examples of Work done on the

No. 2 Plain Cone Driven Cincinnati Miller



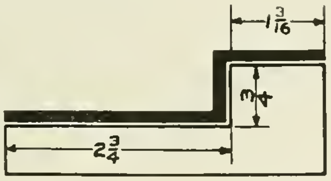
100-L

Material, 40 Carbon Steel.
Size of cut, 11-16″ wide, 1″ deep, 1 15-16″ long.
Cutters, 6″ in diameter.
Two Pieces are milled at one time.
The work is held horizontally and fed directly into the Cutter at a travel of 1″ per minute.



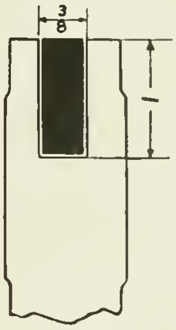
148-L

Material, Cast Steel.
Total width of cut, 5″.
Depth of cut, 1-16″ to 3-32″.
Thickness of piece, ⅞″.
Largest Cutters, 5½″ diameter, 53 revolutions.
Feed, 2.9″ per minute.
Four Pieces are held in a jig at one time.
Total time per piece, 1¼ minutes.



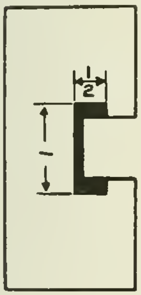
190-L

Material, Cast Iron.
Total width of cut, 4 11-16″; depth of cut, ⅛″; length of cut on each piece, 1⅛″.
Cutters, 4½″ and 3″ diameter.
Twenty-four Pieces are held in a string jig at one time.
Feed, 1⅞″ per minute.
Finished surfaces are accurate within .001.″



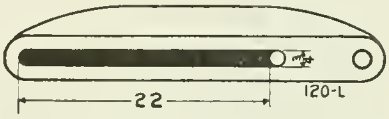
169-L

Material, Steel Forgings.
Cut consists of a slot 1″ deep, ⅜″ wide at a table travel of 4″ per minute.
Cutter, 3½″ in diameter, ⅜″ face, 53 revolutions.
The pieces are of irregular form and 5 of them are held in a string jig at one time. The length of cut in each piece is approximately 1″.



168-L.

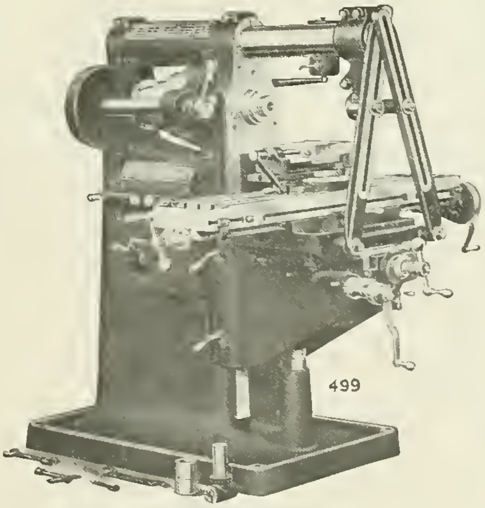
Material, Cast Iron.
Cut consists of undercutting T slots, with a Cutter 1″ diameter, ½″ face, running 286 revolutions. Our average rate of feed on this work is 15¾″ per minute.



120-L

Material, Cast Iron Bars. 1″ thick.
A slot ¾″ wide is cut through the solid at one cut, starting from a drilled hole with a ¾″ diameter, 3 fluted end mill at 3⅝″ table travel per minute.
Metal removed per minute is equivalent to a bar 1″ x ¾″ x 3⅝″ long. Actual cutting time for slots 22″ long, 6 minutes.

For the usual Tool Room work; for repair work; for manufacturing small machine parts—in fact, for all work on which the cutting is light, a modern Cone Driven Miller will bring you bigger returns for your investment than a Single Pulley Drive Machine.



We have redesigned ours, brought them up to date, made them handier than ever before, and we are offering a full line for all that work for which they are especially adapted.

We also make a full line of single pulley High Power Millers for the heavier classes of milling.

The Cincinnati Milling Machine Company

CINCINNATI, O., U. S. A.

foremost electrical engineers of the country, died of pneumonia in Salt Lake City. November 18, aged forty-four years.

Richard N. Durborow, general superintendent of motive power, Pennsylvania R. R., east of Pittsburg, died December 8 at the Hotel Walton, Philadelphia, of acute pneumonia after an illness of only a few hours, aged fifty-one years. Mr. Durborow held the office of superintendent of motive power of the Eastern division of the Pennsylvania R. R., from 1901 to 1911, and was promoted to the position of general superintendent of motive power a few months ago, succeeding A. W. Gibbs, promoted to the position of chief mechanical engineer. Mr. Durborow was educated at Cheltenham Academy and the Maryland Military Institute. In 1879 he entered the services of the Pennsylvania R. R., in the West Philadelphia shops, as an apprentice. He served in that capacity until March, 1880, when he was transferred to the Altoona shops in Altoona, Pa., where he worked until 1883. He then entered the drafting-room and remained there until 1890. The two succeeding years he was employed as an inspector in the West Philadelphia shops, and from 1892 until the close of 1895 he was the assistant general foreman of the West Philadelphia shops. In November, 1895, he was then appointed acting master mechanic of the West Philadelphia shops, which position he held until 1900. For a short time in 1900 he was superintendent of motive power of the Philadelphia, Baltimore & Washington R. R., and from August 1, 1900 to October 1, 1901, he was superintendent of motive power of the Buffalo & Allegheny Valley division, Pennsylvania R. R., at Buffalo. Mr. Durborow married Miss Helen McCormick in 1887. He died leaving no children. Mr. Durborow's death is keenly felt in Altoona, both in the shops and in the town. The feeling is that they have lost one who was deeply and sincerely interested in the growth of the town and the advancement of the company's employes.

* * *

COMING EVENTS

January 6-13.—Passenger automobile exhibition, Madison Square Garden, New York.

January 10-17.—Combined passenger and commercial car exhibition, Grand Central Palace, New York. S. A. Miles, manager, 7 East 42nd St., New York.

January 15-20.—Commercial vehicle exhibition, Madison Square Garden, New York.

January 18-20.—Annual meeting of the Society of Automobile Engineers in New York. Coker F. Clarkson, general manager, 1451 Broadway, New York.

January 27-February 3.—Passenger automobile exhibition, Coliseum and First Regiment Armory, Chicago, Ill.

February 5-10.—Commercial vehicle exhibition, Coliseum and First Regiment Armory, Chicago, Ill.

May 14-17.—Sixth annual convention of the Master Boiler Makers' Association at the Fort Pitt Hotel, Pittsburg, Pa. J. R. Flannery, of the Flannery Bolt Co., Frick Bldg., Pittsburg, Pa., secretary and treasurer of the general committee of arrangements.

June 12-14.—Annual convention of the American Railway Master Mechanics' Association at Atlantic City, N. J.

June 17-19.—Annual convention of the Master Car Builders' Association at Atlantic City, N. J.

August 20.—Annual convention of the International Railroad Master Blacksmiths' Association at Hotel Sherman, Chicago, Ill. J. E. Carrigan, Rutland Railway, Rutland, Vt., chairman of the executive committee.

September 2-7.—Sixth congress of the International Association for Testing Materials at the Engineering Societies Building, 29 W. 39th St., New York. One of the important functions of this association is to establish standard specifications for materials used in manufacture and construction. The cooperation of engineers and others who are engaged in the purchase and use of the raw materials of the trades, is requested. The annual dues are $2, with no initiation fee. Mr. H. F. J. Porter, secretary, 1 Madison Ave., New York.

SOCIETIES AND COLLEGES

Williamson Free School of Mechanical Trades, Delaware Co., Pa. Bulletin No. 8, containing an outline of the machinist's trade course. Outside of the practical features of the machinist's trade in which instructions are given, shop talks on various subjects touching upon mechanical work are a feature of the instruction. Subjects touched upon are: motion study; tool making as a part of the machinist's trade; jig and fixture data; machine shop calculations, etc. The bulletin also gives a detailed review of the courses.

National Metal Trades Association. Draft of a proposed bill to regulate the manufacture of explosives prepared by the legal department of the association. The bill provides that any person, partnership or corporation manufacturing, handling, storing, selling or dealing in dynamite, gunpowder, giant powder, nyalite, joveite, masurite, nitro explosive, and other high explosives shall be subject to certain regulations affecting the manufacture, selling, handling and dealing in said explosives. It is proposed to secure the enactment of the bill by the legislatures of the various states. Copies of the bill can be had by application to Robert Wuest, commissioner of the National Metal Trades Association, New England Bldg., Cleveland, Ohio.

NEW BOOKS AND PAMPHLETS

Mechanical World Electric Pocketbook for 1912. 224 pages, 4 by 6 inches. 80 illustrations. Published by Emmott & Co., Ltd., 65 King St., Manchester, England. Price, 6d.

The 1912 edition of this pocketbook has been enlarged by the addition of sixteen pages containing matter of importance to the electrician. A number of improvements have also been effected in various sections of the work. Thus the matter devoted to lighting has been entirely rewritten, and a new section on motor starters has been introduced, as well as one on static transformers and on the construction, rating and testing of high tension apparatus. Several new tables have also been included.

Technology and Industrial Efficiency. 486 pages, 6 by 9 inches. Published by the McGraw-Hill Book Co., New York. Price, $3.00.

This book contains a series of papers presented at the Congress of Technology held in Boston, Mass., during April, 1911, in celebration of the fiftieth anniversary of the granting of a charter to the Massachusetts Institute of Technology. About seventy papers are included, forming a valuable and up-to-date record of the present state of the industrial sciences, and a presentation of some modern industrial problems and their probable solution. The six sections into which the congress was divided are represented by papers on scientific investigation and control of industrial processes; technical education in its relations to industrial development; administration and management; recent industrial development; public health and sanitation, and architecture.

Railroad Operating Costs. By Suffern & Son. 82 pages, 8 by 11 inches. Numerous diagrams and plates. Published by Suffern & Son, New York. Price, $2.00.

The purpose of this book is to present some facts relating to railroad operation which will throw some light on the operating costs, through comparisons of vital factors in the management of leading railways. It is divided into six chapters, of which Chapter I deals principally with general conditions of railway operation, such as capitalization, earnings, density of traffic, percentage of operating expenses, etc. Chapter II deals with general divisions of operating expense; Chapter III, with the maintenance of way and structures, and Chapter IV, with the maintenance of equipment. Chapter V is devoted specifically to the conditions met with in conducting transportation proper, and deals with the cost of supervision, cost of fuel, claims, damages, trainmen's wages, etc. Chapter VI consists of a general summary.

NEW CATALOGUES AND CIRCULARS

Blanchard Machine Co., Cambridge, Mass. Circular of the Blanchard oil engine, designed by Walcott Remington. The engine is of the two-stroke cycle type and uses crude oil fuel. It is made in sizes from 8 to 100 horsepower for stationary and marine use.

Gould & Eberhardt, Newark, N. J. Circular of the vertical cutting type automatic gear cutting machine for spur, bevel and face gears having capacity for spur gears 24 inches diameter, 8 inches face, and 36 inches diameter when stripped of the mandrel supports.

Universal Boring Machine Co., Hudson, Mass. Catalogue of Universal (horizontal) boring machines built in Nos. 2½ and 3 sizes. This machine is of the right-handed type, the head being placed on the right-hand side. The catalogue illustrates details of construction throughout.

National Automatic Tool Co., Richmond, Ind. Illustrated circular descriptive of the National adjustable multiple-spindle drilling machine, type M, with independently changeable spindle speeds. Different sized holes can be drilled simultaneously with each drill running at its approximately proper speed.

Tapley Specialty Co., New York. Card illustrating the Tapley elevating truck for handling materials in shops, mills and factories. The truck is used in connection with platforms on which the materials are supported in position to be instantly loaded when requiring to be removed. The system saves much time and labor in handling.

Hess-Bright Mfg. Co., 2111 Fairmount Ave., Philadelphia, Pa. "The Requirements of a Ball Bearing Grease," by Herbert L. Towle. The character of lubricant used with ball bearings is highly important, and the points to be observed in the selection of a grease are emphasized. Users of ball bearings will find the matter of considerable value.

Cincinnati Milling Machine Co., Cincinnati, Ohio. Bird's-eye view of the new factory at Oakley, a suburb of Cincinnati. The company's new buildings contain 275,000 square feet of floor space (exclusive of the power plant) and represent the most advanced ideas in factory construction as to lighting, heating, ventilation and routing of materials.

General Electric Co., Schenectady, N. Y. Bulletin No. 4892 on battery truck cranes for shop, factory, dock and warehouse use. The machine is a short, heavy, storage battery vehicle, having mounted on its forward end a swinging crane, the hook of which is raised and lowered by a one-ton hoist operated by the battery. See Machinery, November, 1911, for illustrated description.

South Bend Machine Tool Co., South Bend, Ind. Catalogue No. 41 of foot and power screw-cutting engine lathes, comprising 9-inch, 11-inch, 12-inch and 13-inch swing, equipped for countershaft or foot power. The 9-inch swing lathe is also made with short legs for use on a bench. Lathes are furnished with gear cutting attachment, spindle turret, turret on lathe carriage, or turret on bed, to order.

Joseph T. Ryerson & Son, 16th and Rockwell Sts., Chicago, Ill. Catalogue, 8½ by 11 inches, of Rockford heavy duty, variable speed and motor-driven planers, illustrating, with specifications, the 24-inch, 28-inch, 32-inch and 36-inch sizes; also the 32-inch size with variable speed motor drive. The catalogue shows several interesting details of Rockford planer construction which merit the attention of planer users generally.

H. W. Johns-Manville Co., 100 William St., New York. Catalogue No. 50 on the "Audiffern" refrigerating machine for use in residences, hotels, dairies, grocery stores, hospitals, etc. The machine is extremely simple; it embodies a mechanical principle which eliminates all stuffing-boxes, valves and other openings to the atmosphere, hence the possibility of leakage of the refrigerating medium, sulphur dioxide, is eliminated.

Wiley & Russell Mfg. Co., Greenfield, Mass. Catalogue of "Lightning" and "Green River" screw-cutting machinery and tools, listing a large line of screw plates, including many sets in leather rolls and wood cases for automobile repair purposes. The catalogue also lists the company's large line of taps, spiral and straight fluted reamers, and other tools and machines. It contains in addition twenty pages of data particularly valuable to all mechanics.

Ingersoll-Rand Co., 11 Broadway, New York. Four-page bulletin, form 4108, on rock drills, descriptive of the B-104 Sergeant rock drill, which is a machine especially adapted for driving small headings, stoping or similar work requiring light and powerful machines. This drill has a 2½-inch cylinder, and will drill a 1-inch to 1½-inch diameter hole to a depth of 20 inches without change of steel. The bulletin illustrates the component parts of the drill and gives full specifications and details.

G. A. Gray Co., Cincinnati, Ohio. Catalogue of constant speed and variable speed Gray planers, built in standard dimensions from 22 by 22 inches to large sizes, and of various combinations of width and height. The catalogue illustrates forms of drive including motor drive mounted on top of the columns and on the floor, with and without the Gray patented speed variator; it also shows horizontal and vertical independent housings for increasing width and height capacity of standard planers.

When we first began to advertise the LUCAS TYPE Boring, Drilling and Milling Machine (THE "PRECISION"), we strongly and continuously EMPHASIZED the fact that the SPINDLE HEAD and the TAIL BLOCK AUTOMATICALLY rise and fall TOGETHER, but have lately found a few (of the younger generation) who did not understand this—so again we say:

The Spindle Head and Tail Block are Raised and Lowered Together, being Connected by a shaft and Planed Bevel Gears.

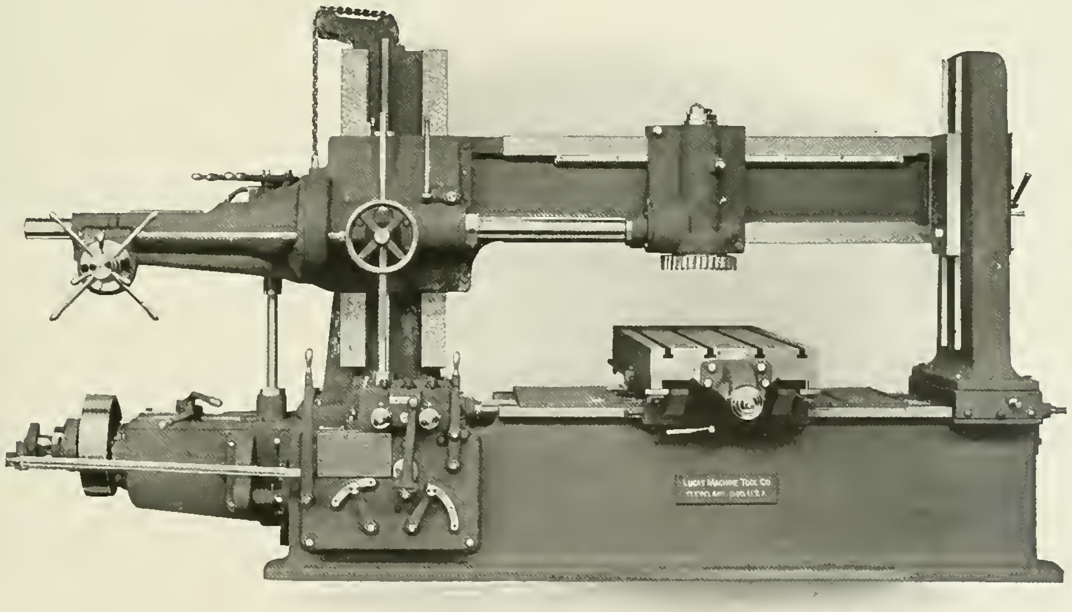
If it were NOT so, we would not have the courage to bring out the

VERTICAL MILLING ATTACHMENT

which of course can be fed up or down and returned QUICKLY by POWER, the same as every other part of the machine is fed and returned.

Now do you realize the possibilities of the

"PRECISION" BORING, DRILLING and MILLING MACHINE?



COME AND SEE IT WORK IN OUR SHOP—
IT'S A SURPRISE EVEN TO US.

Lucas Machine Tool Co., NOW AND ALWAYS OF Cleveland, O., U.S.A.

AGENTS—C. W. Burton, Griffiths & Co., London. Alfred H. Schutte, Cologne, Berlin, Brussels, Paris, Milan, Barcelona, Bilbao. Donauwerk Ernst Krause & Co., Vienna, Budapest, Prague. Overall, McCray, Ltd., Sydney, Australia. Andrews & George, Yokohama, Japan. Williams & Wilson, Montreal, Canada.

Schrock & Squires, 291 Pearl St., New York. Catalogue and price list of Edgar Allen & Co., Ltd., crucible steels, comprising Allen's "Imperial" special high-speed steel; Allen's air-hardening high-speed steel; Allen's self-hardening high-speed steel; Allen's "Imperial" cast steel; Allen's class E extra refined cast steel; Allen's "Stag" cast steel; Allen's solid and hollow mining drill steel; "S and S" oil hardening tool steel; and valuable information on forging, hardening, oil hardening, annealing, pack-hardening, case-hardening and tempering steel.

Hyatt Roller Bearing Co., Newark, N. J., has for some time made a practice of issuing bulletins covering in detail the ratings and capacities, indicated uses and actual application of its flexible roller bearings. Separate issues cover the different types, such as the long series for machine tools and similar work; short series for automobile service, standard shafting, special work, etc. These bulletins are at the call of anyone interested, and form a collection of special information on anti-friction bearings of value to all concerned with the transmission and use of power.

S K F Ball Bearing Co., 50 Church St., New York. Bulletin No. 1 on S K F radial bearings which embody the feature of self-alignment. The bulletin lists light, medium, heavy and extra heavy types, having capacities from 108 pounds at 2400 revolutions per minute to 17,400 pounds at 300 revolutions per minute. Light and medium type adapter bearings are also listed. These bearings are made with a collapsing bushing which grips the shaft and fixes the bearing in place when the collar nut is screwed up. The bulletin explains the construction peculiarities, particularly the provision for self-alignment.

Cincinnati Electrical Tool Co., 650-652 Evans St., Cincinnati, Ohio. Catalogue of "Peerless" electric drills built in many sizes and styles for use in every class of drilling in iron and steel up to 2¼ inches, and in wood up to 3 inches. These tools comprise portable electric hand and breast drills for direct and alternating current; portable reamers; Scotch radial drills; air-cooled portable toolpost grinders for external and internal grinding; air-cooled portable bench grinders with one and two wheels; air-cooled floor grinders; air-cooled portable aerial buffer or grinder, all adapted to alternating or direct current.

O. K. Tool-Holder Co., Shelton, Conn. Catalogue No. 4 of the O. K. tool-holders for lathes, planers, shapers, boring mills and other machine tools. The O. K. tool-holders are put up in suitable boxes with various assortments of tools and fixtures suitable for all classes of work. Special sets for lathes, planers, and boring mills are illustrated. The catalogue also describes a remarkable test made with O. K. tools, and illustrates the lathe and the chips produced. Other matter of interest to mechanics, foremen, superintendents and others, makes the catalogue of unusual value to everyone concerned with machine shop practice.

Hendey Machine Co., Torrington, Conn. Booklet entitled "Helps on Change Gearing and Thread Cutting for Users of Hendey Lathes." This booklet should be generally appreciated by users of Hendey lathes. It illustrates the standard index plates showing range of threads and feeds; metric transposing plates; index plates for metric engine lathes, and diagram of feed gears for 12, 14, 16, 18, 20 and regular engine lathes. Formulas are given for figuring gears for threads not given in index, and for figuring gears for metric threads in metric lathes. Other data and descriptive matter complete a booklet of value for engine lathe users.

Charles Churchill & Co., 9 Leonard St., London, E. C. Catalogue of Churchill grinding machines, including cylindrical grinders of plain and universal types, internal grinders, vertical surface grinders and special ring-grinding machines. The principal features of these grinders are described in detail and carefully illustrated. There is also a great deal of practical information on grinding, covering such subjects as the care of the machine, preparation of the work, use of steadyrests, adjustment of machine for grinding, wheel and work speeds, causes of error, importance of wet grinding, internal grinding, selection of wheels to secure efficient results, etc. In addition, typical examples of external and internal work are illustrated, and many practical points given. There are also a number of useful tables and miscellaneous data.

Kearney & Trecker Co., Milwaukee, Wis. Catalogue No. 18 of "Milwaukee" universal, manufacturing and plain milling machines. Interesting details of construction are shown and described, comprising box knee; table, swivel carriage and saddle; standard, right angle and electric drives; the lubrication system by which every bearing is automatically flooded with lubricant; tumbler support and spindle reverse; feed box; feed reverse; feed interlocking device, etc. Various examples of milling are also shown. The accessories comprise: vertical spindle attachment, vertical spindle with rack cutting attachment, universal milling attachment, slotting attachment, plain centers, universal centers, spiral universal centers, rotary table, etc. Several pages are devoted to operation instructions, including diagrams for determining pulley speeds and cutter speeds without calculation.

Cincinnati Planer Co., Cincinnati, Ohio. Placard emphasizing seven points that make for planer quality, as follows: 1.—Adopt every improvement which will increase the efficiency of our machines regardless of cost. 2.—Let every workman know that we want quality first, last, and all the time. 3.—Never hesitate to discard a piece that has a defect in material or workmanship. 4. -Verify all tests made and never accept any work from another department that has a slight defect in workmanship. 5. Provide all workmen with the best of facilities, high grade gages, measuring instruments, etc. 6.—Purchase only the best materials that can be had for the purpose, and verify their quality by laboratory tests. 7.—Each machine must test inside the limits of error specified, and test card made out and sent to the office. All machines must be belted and operated under actual working conditions before shipping.

Dodge Mfg. Co., Mishawaka, Ind. Wall poster in colors showing the covers of twenty-two catalogues, circulars and advertising devices embracing practically everything required for the mechanical transmission of power. The catalogues shown are as follows: Catalogue C-7, Library Edition; Catalogue C-7, Pocket Edition; Power and Transmission (Dodge Monthly Magazine); No. 18, A Remarkable Test of an Iron Center Wood Rim Pulley; No. 99, Condensed Price List of the Dodge Line; No. 56, Dodge Calculator; No. 101, Dodge Keyless Compression Couplings; No. 20, Dodge Pulleys; No. 116, Friction Clutches; No. 77, From Log to Line Shaft; No. 115, Hanger Bulletin; No. 92, Hanger Price List; No. 3, Hardwood Lagging; No. 98, Harnessing Water Power; No. 108, Roadbed for Power; No. 123, Safe Construction and Speeds for Flywheels; No 62, Something About Friction Clutches; No. 86, Standard Iron Split Pulley Price List; No. 57, The Construction of a Modern Cement Mill; No. 107, The Conversion of Mr. Pennywise; No. 76, Twenty-five Years of Rope Driving; No. 104a, Wood Split Pulley Price List.

TRADE NOTES

Kerr Turbine Co., Wellsville, N. Y., states that over 700 Kerr turbines, aggregating more than 50,000 horsepower, are in service, and that the company has more unfilled orders booked than at any previous time in its history.

E. M. Eliassen, Aarstad pr. Bergen, Norway, is in the market for machinery and appliances for machine blacksmithing and a drop forge plant, and wishes to receive catalogues and prices from reliable makers of these lines.

Westinghouse Electric & Mfg. Co., Pittsburg, Pa., has received an order from the New York, New Haven and Hartford R. R. Co., for twelve 113-ton articulated truck type locomotives equipped with 8-408-C motors with type USB control.

Michigan Twist Drill Co., 1215-1219 Bellevue Ave., Detroit, Mich., reports that its factory is being operated day and night in order to supply its rapidly increasing business in high speed and carbon twist drills, reamers and milling cutters.

St. Louis Machine Tool Co., 1209-11 Gratiot St., St. Louis, Mo., has sold its Coe drill and St. Louis drill patterns to the Perry Machine Tool Co., Perry, Mich., and will hereafter devote its energies exclusively to developing its line of grinding and tapping machinery.

Cincinnati Paecision Lathe Co., Cincinnati, Ohio, has been incorporated with $50,000 capital stock to manufacture a precision lathe designed by J. M. Tatman. The officers of the company are M. H. Stewart, president, W. C. Tatman, secretary, and J. M. Tatman, vice-president and general superintendent.

Adams-Bagnall Electric Co., Cleveland, Ohio, has opened a Boston office under the management of Mr. E. R. Bryant, formerly connected with the company's New York office. The company will carry a stock of all its lines in Boston, and hopes in this manner to render its New England trade an improved service.

Perry Machine Tool Co., Perry, Mich., has purchased the Coe drill and St. Louis drill patterns owned by the St. Louis Machine Tool Co., St. Louis, Mo. Mr. H. G. Porter and associate compose the Perry Machine Tool Co. Mr. Porter, who is a well-known mechanical man of ability, intends to develop the drill business extensively.

Treadwell Mfg. Co., Easton, Pa., has installed an electric furnace in its new plant for the manufacture of steel castings. The electric furnace for the production of steel castings is new in America, although it has been in use about seven years in Europe, where there are now over one hundred electric furnaces in use. Electric furnace steel can be made with any carbon content, with phosphorus content reduced if desired to 0.01 to 0.02 per cent, and the sulphur content within the same limits.

Carborundum Co., Niagara Falls, N. Y., has been advised through the Department of the Interior at Washington that the Grand Prize for the exhibit of abrasive materials has been awarded by the Jury of Awards of the Turin Exposition to the Carborundum Co. The great Italian Exposition was held from April 15 to October 31, 1911, and many American manufacturers were represented. The carborundum exhibit showed a complete line of carborundum wheels, aloxite wheels, carborundum dental wheels, carborundum sharpening stones and razor hones of all descriptions.

Reading Steel Casting Co., Reading, Pa., and the Bayonne Steel Casting Co., Bayonne, N. J., were consolidated December 1 under the name of the Reading-Bayonne Steel Casting Co. The officers of the new company are: Wm. D. Sargent, chairman of the board of directors; J. Turner Moore, president; A. E. Williamson, vice-president; and D. W. Yeckley, secretary and treasurer, all of whom have been engaged in the steel casting industry for many years. The new company has an authorized capital of $750,000. The combined capacity of the two plants is from 800 to 1000 tons per month, and both are well located for serving the Schuylkill Valley and Greater New York districts. Both companies have large thoroughly equipped plants for the manufacture of medium and light weight Tropenas steel castings.

National Automobile Show of automobiles and commercial vehicles will be held in the new Grand Central Palace, January 10-17. The management has secured quarters which in beauty, area of floor space, convenience and safety are an improvement upon any exhibition building heretofore existing in New York City. The building is located only a few blocks north of the New York Central station and fronts on Lexington Avenue, between 46th and 47th streets. It occupies a block 200 feet by 275 feet, and reaches to the height of thirteen stories. It is built of gray stone and brick construction with a steel skeleton, and cost nearly $1,750,000 including the ground on which it stands. Further information can be obtained from Mr. H. W. Perry, manager of the publicity department, truck section, 7 East 42nd St., New York City.

Youngstown Sheet & Tube Co., Youngstown, Ohio, has recently placed an order with the Westinghouse Electric & Manufacturing Co., East Pittsburg, Pa., for a total of ninety-nine motors to be used in connection with its open hearth plant. The motors will be used on cranes, charging machines, strippers, transfer tables, screw downs, and blooming mills. The Youngstown Co. formerly used the Bessemer process, and is now installing the open hearth process and blooming mill for taking care of the open hearth process output. An interesting point of this order is that fifty six of these motors are of the new Westinghouse type M. C. direct-current mill type motor equipped with commutating poles. This line has been designed to parallel the well known M. T. alternating-current motor which has proved so successful in mill service.

Lumen Bearing Co., Buffalo, N. Y., recently made the following changes in its organization: H. P. Parrock, formerly Western representative, has been appointed sales manager, succeeding Allen Kendall, resigned; H. F. Russell, formerly purchasing agent, has been appointed sales representative, covering central and western New York and eastern Pennsylvania; Albert Lockwood succeeds him in the office of purchasing agent; Louis S. Jones, for many years with the Prentiss Tool & Supply Co., has been appointed sales representative in New England; H. O. Schwaner has been appointed sales representative in the Pittsburg district; Fred Ganderton, formerly with the Aluminum Casting Co., has been appointed sales manager of the Toronto plant. The business of the company is growing to such an extent that it has been found necessary to materially enlarge the organization both in its selling and operating forces. Recent additions and improvements have been made both in the Buffalo and Toronto plants.

American Industries, 30 Church St., New York, contains, in the December number, an analysis of business conditions prepared by the editor, Mr. Henry Harrison Lewis. Letters were sent to 10,000 manufacturers and business men, including the members of the National Association of Manufacturers. The replies representing the various industries are tabulated. Practically every industry closely allied with railroad construction is depressed. These include structural iron and steel, lumber, paints and varnishes, cement and clay, plate and window glass, builders' hardware, woodworking machinery and iron-working machinery. Industries directly connected with the manufacture of necessities, such as cereals and their by-products, preserved foods, and sugar and its by-products are practically normal. The conditions in the agricultural implements are unsatisfactory notwithstanding the apparent general prosperity of the farming community. The inferences drawn from the replies of changes required are as follows: 1. Cessation of political agitation. 2. Cessation of tariff agitation. 3. Amendment or improvement of the Sherman Act.

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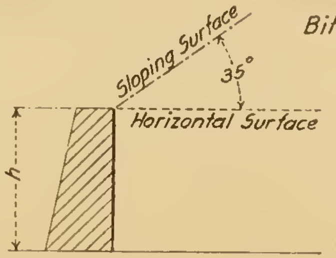
PRESSURE OF COAL ON STORAGE BINS—I



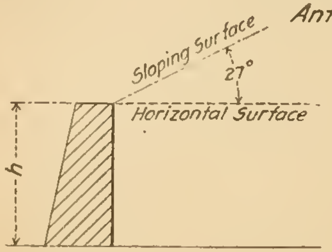
Bituminous Coal Bins.

The table gives the horizontal pressure (in pounds) exerted by bituminous coal against a vertical retaining wall, per foot of length, both for horizontal and sloping surface of coal stored. Weight of coal, 47 pounds per cubic foot.

Depth h in feet	Horizontal Surface		Sloping Surface		Depth h in feet	Horizontal Surface		Sloping Surface	
	Total Pressure	Pressure on lowest foot	Total Pressure	Pressure on lowest foot		Total Pressure	Pressure on lowest foot	Total Pressure	Pressure on lowest foot
1	64	6.4	10	10	26	4305	325	6760	510
2	25	19	40	30	27	4641	338	7290	530
3	57	32	90	50	28	4993	350	7840	550
4	102	45	160	70	29	5358	363	8410	570
5	159	57	250	90	30	5732	376	9000	590
6	229	70	360	110	31	6122	389	9610	610
7	312	83	490	130	32	6523	401	10240	630
8	407	96	640	150	33	6935	414	10890	650
9	516	108	810	170	34	7362	427	11560	670
10	637	121	1000	190	35	7778	440	12250	690
11	770	134	1210	210	36	8253	452	12960	710
12	917	146	1440	230	37	8754	465	13690	730
13	1076	159	1690	250	38	9193	478	14440	750
14	1248	172	1960	270	39	9682	490	15210	770
15	1433	185	2250	290	40	10192	503	16000	790
16	1630	197	2560	310	41	10669	516	16810	810
17	1840	210	2890	330	42	11236	529	17640	830
18	2063	223	3240	350	43	11797	541	18490	850
19	2298	236	3610	370	44	12331	554	19360	870
20	2548	248	4000	390	45	12968	567	20250	890
21	2809	261	4410	410	46	13478	580	21160	910
22	3083	274	4840	430	47	14100	592	22090	930
23	3369	287	5290	450	48	14679	605	23040	950
24	3669	299	5760	470	49	15275	618	24010	970
25	3981	312	6250	490	50	15925	631	25000	990

Contributed by A. B. Bramble

PRESSURE OF COAL ON STORAGE BINS—II



Anthracite Coal Bins.

The table gives the horizontal pressure (in pounds) exerted by anthracite coal against a vertical retaining wall, per foot of length, for both horizontal and sloping surface of coal stored. Weight of coal, 52 pounds per cubic foot.

Depth h in feet	Horizontal Surface		Sloping Surface		Depth h in feet	Horizontal Surface		Sloping Surface	
	Total Pressure	Pressure on lowest foot	Total Pressure	Pressure on lowest foot		Total Pressure	Pressure on lowest foot	Total Pressure	Pressure on lowest foot
1	9.8	9.8	14.2	14.2	26	6611	499	9613	725
2	39	29	57	43	27	7129	518	10366	754
3	88	49	128	71	28	7668	538	11149	782
4	156	68	228	100	29	8225	557	11988	811
5	244	88	355	128	30	8802	577	12797	839
6	352	108	512	156	31	9398	597	13665	867
7	479	127	697	185	32	10015	616	14561	896
8	626	147	910	213	33	10650	636	15486	924
9	792	166	1152	242	34	11306	655	16439	953
10	978	186	1422	270	35	11980	675	17420	981
11	1183	205	1721	299	36	12675	694	18429	1010
12	1408	225	2048	327	37	13389	714	19467	1038
13	1653	244	2403	355	38	14123	733	20533	1066
14	1917	264	2787	384	39	14875	753	21629	1095
15	2200	284	3199	412	40	15648	773	22752	1123
16	2504	303	3640	441	41	16440	792	23904	1152
17	2826	323	4110	469	42	17252	812	25084	1180
18	3169	342	4607	498	43	18083	831	26293	1209
19	3531	362	5133	526	44	18934	851	27530	1237
20	3912	381	5688	555	45	19804	870	28793	1263
21	4313	401	6271	583	46	20695	891	30090	1297
22	4733	421	6882	611	47	21605	910	31412	1322
23	5174	440	7522	640	48	22533	929	32763	1351
24	5633	460	8191	668	49	23482	949	34143	1379
25	6113	479	8887	697	50	24450	968	35550	1407

Contributed by A. B. Bramble

MULTIPLICATION TABLE FOR RIVET SPACING—I

Spaces	Multiplication Table for Rivet Spacing.												
	1⅛	1¼	1⅜	1½	1⅝	1¾	1⅞	2	2⅛	2¼	2⅜	2½	2¾
2	2¼"	2½"	2¾"	3"	3¼"	3½"	3¾"	4"	4¼"	4½"	4¾"	5"	5½"
3	3⅜"	3¾"	4⅛"	4½"	4⅞"	5¼"	5⅝"	6"	6⅜"	6¾"	7⅛"	7½"	8¼"
4	4½"	5"	5½"	6"	6½"	7"	7½"	8"	8½"	9"	9½"	10"	11"
5	5⅝"	6¼"	6⅞"	7½"	8⅛"	8¾"	9⅜"	10"	10⅝"	11¼"	11⅞	1'0½"	1'1¾"
6	6¾"	7½"	8¼"	9"	9¾"	10½"	11¼"	1'0"	1'0¾"	1'1½"	1'2¼"	1'3"	1'4½"
7	7⅞"	8¾"	9⅝"	10½"	11⅜"	1'0¼"	1'1⅛"	1'2"	1'2⅞"	1'3¾"	1'4⅝"	1'5½"	1'7¼"
8	9"	10"	11"	1'0"	1'1"	1'2"	1'3"	1'4"	1'5"	1'6"	1'7"	1'8"	1'10"
9	10⅛"	11¼"	1'0⅜"	1'1½"	1'2⅝"	1'3¾"	1'4⅞"	1'6"	1'7⅛"	1'8¼"	1'9⅜"	1'10½"	2'0¾"
10	11¼"	1'0½"	1'1¾"	1'3"	1'4¼"	1'5½"	1'6¾"	1'8"	1'9¼"	1'10½"	1'11¾"	2'1"	2'3½"
11	1'0⅜"	1'1¾"	1'3⅛"	1'4½"	1'5⅞"	1'7¼"	1'8⅝"	1'10"	1'11⅜"	2'0¾"	2'2⅛"	2'3½"	2'6¼"
12	1'1½"	1'3"	1'4½"	1'6"	1'7½"	1'9"	1'10½"	2'0"	2'1½"	2'3"	2'4½"	2'6"	2'9"
13	1'2⅝"	1'4¼"	1'5⅞"	1'7½"	1'9⅛"	1'10¾"	2'0⅜"	2'2"	2'3⅝"	2'5¼"	2'6⅞"	2'8½"	2'11¾"
14	1'3¾"	1'5½"	1'7¼"	1'9"	1'10¾"	2'0½"	2'2¼"	2'4"	2'5¾"	2'7½"	2'9¼"	2'11"	3'2½"
15	1'4⅞"	1'6¾"	1'8⅝"	1'10½"	2'0⅜"	2'2¼"	2'4⅛"	2'6"	2'7⅞"	2'9¾"	2'11⅝"	3'1½"	3'5¼"
16	1'6"	1'8"	1'10"	2'0"	2'2"	2'4"	2'6"	2'8"	2'10"	3'0"	3'2"	3'4"	3'8"
17	1'7⅛"	1'9¼"	1'11⅜"	2'1½"	2'3⅝"	2'5¾"	2'7⅞"	2'10"	3'0⅛"	3'2¼"	3'4⅜"	3'6½"	3'10¾"
18	1'8¼"	1'10½"	2'0¾"	2'3"	2'5¼"	2'7½"	2'9¾"	3'0"	3'2¼"	3'4½"	3'6¾"	3'9"	4'1½"
19	1'9⅜"	1'11¾"	2'2⅛"	2'4½"	2'6⅞"	2'9¼"	2'11⅝"	3'2"	3'4⅜"	3'6¾"	3'9⅛"	3'11½"	4'4¼"
20	1'10½"	2'1"	2'3½"	2'6"	2'8½"	2'11"	3'1½"	3'4"	3'6½"	3'9"	3'11½"	4'2"	4'7"
21	1'11⅝"	2'2¼"	2'4⅞"	2'7½"	2'10⅛"	3'0¾"	3'3⅜"	3'6"	3'8⅝"	3'11¼"	4'1⅞"	4'4½"	4'9¾"
22	2'0¾"	2'3½"	2'6¼"	2'9"	2'11¾"	3'2½"	3'5¼"	3'8"	3'10¾"	4 1½"	4'4¼"	4'7"	5'0½"
23	2'1⅞"	2'4¾"	2'7⅝"	2'10½"	3'1⅜"	3'4¼"	3 7⅛"	3'10"	4'0⅞"	4'3¾"	4'6⅝"	4'9½"	5'3¼"
24	2'3"	2'6"	2'9"	3'0"	3'3"	3'6"	3'9"	4'0"	4'3"	4'6"	4'9"	5'0"	5'6"
25	2'4⅛"	2'7¼"	2'10⅜"	3'1½"	3'4⅝"	3'7¾"	3'10⅞"	4'2"	4'5⅛"	4'8¼"	4'11⅜"	5'2½"	5'8¾"
26	2'5¼"	2'8½"	2'11¾"	3'3"	3'6¼"	3'9½"	4'0¾"	4'4"	4'7¼"	4'10½"	5'1¾"	5'5"	5'11½"
27	2'6⅜"	2'9¾"	3'1⅛"	3'4½"	3'7⅞"	3'11¼"	4'2⅝"	4'6"	4'9⅜"	5'0¾"	5'4⅛"	5'7½"	6'2¼"
28	2'7½"	2'11"	3'2½"	3'6"	3'9½"	4'1"	4'4½"	4'8"	4'11½"	5'3"	5'6½"	5'10"	6'5"
29	2'8⅝"	3'0¼"	3'3⅞"	3'7½"	3'11⅛"	4'2¾"	4'6⅜"	4'10"	5'1⅝"	5'5¼"	5'8⅞"	6'0½"	6'7¾"
30	2'9¾"	3'1½"	3'5¼"	3'9"	4'0¾"	4'4½"	4'8¼"	5'0"	5'3¾"	5'7½"	5'11¼"	6'3"	6'10½"

Contributed by M. Joachimson

No. 151, Data Sheet, MACHINERY, February, 1912

MULTIPLICATION TABLE FOR RIVET SPACING—II

Spaces	Multiplication Table for Rivet Spacing. (Continued)											
	3	3¼	3½	3¾	4	4¼	4½	4¾	5	5¼	5½	5¾
2	6"	6½"	7"	7½"	8'	8½"	9"	9½"	10"	10½"	11"	11½"
3	9"	9¾"	10½"	11¼"	1'0"	1'0¾"	1'1½"	1'2¼"	1'3"	1'3¾"	1'4½"	1'5¼"
4	1'0"	1'1"	1'2"	1'3"	1'4"	1'5"	1'6"	1'7"	1'8"	1'9"	1'10"	1'11"
5	1'3"	1'4¼"	1'5½"	1'6¾"	1'8"	1'9¼"	1'10½"	1'11¾"	2'1"	2'2¼"	2'3½"	2'4¾"
6	1'6"	1'7½"	1'9"	1'10½"	2'0"	2'1½"	2'3"	2'4½"	2'6"	2'7½"	2'9"	2'10½"
7	1'9"	1'10¾"	2'0½"	2'2¼"	2'4"	2'5¾"	2'7½"	2'9¼"	2'11"	3'0¾"	3'2½"	3'4¼"
8	2'0"	2'2"	2'4"	2'6"	2'8"	2'10"	3'0"	3'2"	3'4"	3'6"	3'8"	3'10"
9	2'3"	2'5¼"	2'7½"	2'9¾"	3'0"	3'2¼"	3'4½"	3'6¾"	3'9"	3'11¼"	4'1½"	4'3¾"
10	2'6"	2'8½"	2'11"	3'1½"	3'4"	3'6½"	3'9"	3'11½"	4'2"	4'4½"	4'7"	4'9½"
11	2'9"	2'11¾"	3'2½"	3'5¼"	3'8"	3'10¾"	4'1½"	4'4¼"	4'7"	4'9¾"	5'0½"	5'3¼"
12	3'0"	3'3"	3'6"	3'9"	4'0"	4'3"	4'6"	4'9"	5'0"	5'3"	5'6"	5'9"
13	3'3"	3'6¼"	3'9½"	4'0¾"	4'4"	4'7¼"	4'10½"	5'1¾"	5'5"	5'8¼"	5'11½"	6'2¾"
14	3'6"	3'9½"	4'1"	4'4½"	4'8"	4'11½"	5'3"	5'6½"	5'10"	6'1½"	6'5"	6'8½"
15	3'9"	4'0¾"	4'4½"	4'8¼"	5'0"	5'3¾"	5'7½"	5'11¼"	6'3"	6'6¾"	6'10½"	7'2¼"
16	4'0"	4'4"	4'8"	5'0"	5'4"	5'8"	6'0"	6'4"	6'8"	7'0"	7'4"	7'8"
17	4'3"	4'7¼"	4'11½"	5'3¾"	5'8"	6'0¼"	6'4½"	6'8¾"	7'1"	7'5¼"	7'9½"	8'1¾"
18	4'6"	4'10½"	5'3"	5'7½"	6'0"	6'4½"	6'9"	7'1½"	7'6"	7'10½"	8'3"	8'7½"
19	4'9"	5'1¾"	5'6½"	5'11¼"	6'4"	6'8¾"	7'1½"	7'6¼"	7'11"	8'3¾"	8'8½"	9'1¼"
20	5'0"	5'5"	5'10"	6'3"	6'8"	7'1"	7'6"	7'11"	8'4"	8'9"	9'2"	9'7"
21	5'3"	5'8¼"	6'1½"	6'6¾"	7'0"	7'5¼"	7'10½"	8'3¾"	8'9"	9'2¼"	9'7½"	10'0¾"
22	5'6"	5'11½"	6'5"	6'10½"	7'4"	7'9½"	8'3"	8'8½"	9'2"	9'7½"	10'1"	10'6½"
23	5'9"	6'2¾"	6'8½"	7'2¼"	7'8"	8'1¾"	8'7½"	9'1¼"	9'7"	10'0¾"	10'6½"	11'0¼"
24	6'0"	6'6"	7'0"	7'6"	8'0"	8'6"	9'0"	9'6"	10'0"	10'6"	11'0"	11'6"
25	6'3"	6'9¼"	7'3½"	7'9¾"	8'4"	8'10¼"	9'4½"	9'10¾"	10'5"	10'11¼"	11'5½"	11'11¾"
26	6'6"	7'0½"	7'7"	8'1½"	8'8"	9'2½"	9'9"	10'3½"	10'10"	11'4½"	11'11"	12'5½"
27	6'9"	7'3¾"	7'10½"	8'5¼"	9'0"	9'6¾"	10'1½"	10'8¼"	11'3"	11'9¾"	12'4½"	12'11¼"
28	7'0"	7'7"	8'2"	8'9"	9'4"	9'11"	10'6"	11'1"	11'8"	12'3"	12'10"	13'5"
29	7'3"	7'10¼"	8'5½"	9'0¾"	9'8"	10'3¼"	10'10½"	11'5¾"	12'1"	12'8¼"	13'3½"	13'10¾"
30	7'6"	8'1½"	8'9"	9'4½"	10'0"	10'7½"	11'3"	11'10½"	12'6"	13'1½"	13'9"	14'4½"

Contributed by M. Joachimson

No. 151, Data Sheet, MACHINERY, February, 1912

MACHINERY

February, 1912

THE MANUFACTURE OF STEEL BALLS

MAKING THE BLANKS

By ROBERT H GRANT*

Robert H. Grant†

A REVIEW of the history of ball-making would take us back, it is claimed, more than four thousand years. The Chinese, who seem to have made everything first, are supposed to have made balls at that early date. This claim, however, is founded on a mere assumption and not on historical fact. Modern ball-making dates back to about 1870. Bicycles were then used to some extent in England, but as the bicycle was first made with a plain bearing, it was very laborious to propel; later cone bearings were introduced, and while these made the bicycle easier to work, it never became very popular until balls were used in the bearings. The first balls were made by the English workmen in their own homes, as was the custom in those days, by a very primitive method. A bar of steel of the proper size was placed in a chuck in a foot-power lathe. Then a ball was formed on the end of the bar by means of a hand tool, the long handle of which was pressed against the shoulder. The balls were made only a few thousandths of an inch larger than the finished size. They were then hardened and ground. The grinding was done between two cast-iron plates about eighteen inches in diameter. These plates were provided with concentric circular grooves, and the balls were placed in these grooves with oil and emery. The top plate was then revolved by hand; it was removed at intervals and the balls measured until found to be of the proper size. These balls were sold for 12 cents apiece. At the present time balls of the same size, and of a superior quality, can be purchased for 1/7 cent.

First Machines for Manufacturing Balls

The Simonds Rolling Machine Co., of Fitchburg, Mass., was the first company in the United States to engage in the manufacture of balls. This company was manufacturing a machine for making rolled forgings, and as by means of this machine it was possible to roll a very accurate ball, it was decided to start the manufacture of this product. In Fig. 1 is shown a 3-inch rolling machine of the type mentioned, the size (3-inch) indicating the width of the platens. These platens run in opposite directions, and are operated by racks in the back, which, in turn, are driven by pinions on the driving shaft. The driving shaft extends to the rear of the machine where the driving gears are located. The length of the stroke is changed by the dogs *A*, which can be moved to different positions in a grooved plate, as shown. The rest *B* supports the stock while it is being rolled. The platens make about one-hundred strokes per minute.

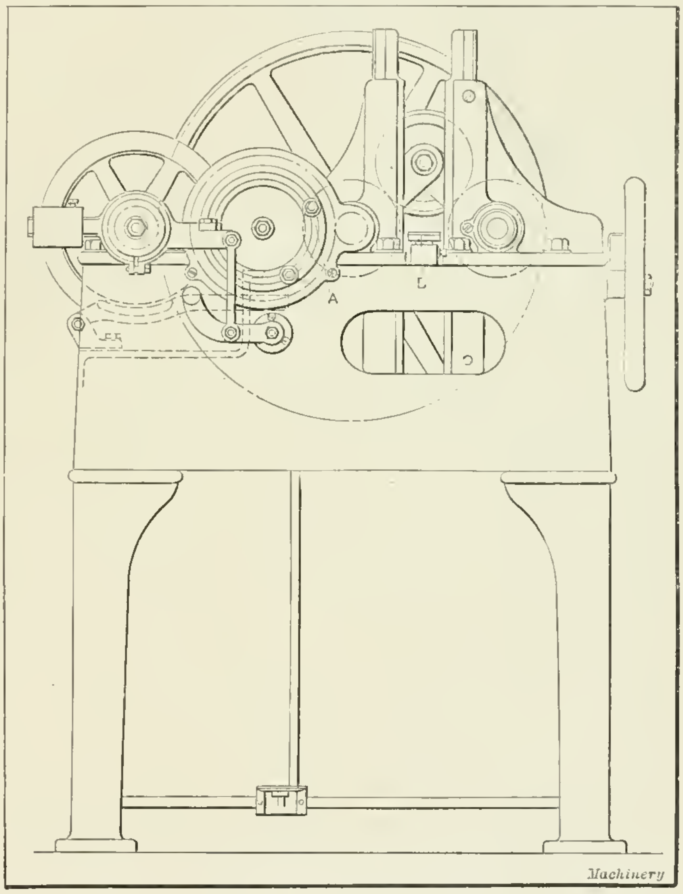


Fig. 1. Machine for Making Rolled Forgings, built by the Simonds Rolling Machine Co., Fitchburg, Mass., Some Twenty-five Years ago

In Fig. 2 is shown a die for rolling balls on the Simonds machine. This die is held in a shoe which is fastened to the platen. The 30-degree beveled face on the die is knurled so that when the work is rolled, it will not slide through the dies, but rotate properly. The knurling of the beveled face of the dies was one of the most important of the patents obtained by the company in connection with this development. The "invention," however, was incidental. During the early stage of the development of the machine, a workman had been trying to roll a certain piece, but the stock would keep sliding through the machine without rolling. The operator then lost patience and, determined to make the stock roll, took a cold chisel and roughed up the edges of the die, with the result that the die immediately produced perfect forgings. On the next set of dies made, he used a coarse knurl on the edges of the die to facilitate the proper movement of the stock. This method of knurling was patented in connection with the die, and this patent was considered one of the strongest in connection with rolling processes of this kind.

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† Robert H. Grant is a graduate of the Fitchburg High School and the Fairchild Institute of Flushing, N. Y. His mechanical training was obtained with the Pratt & Whitney Co., Hartford, Conn., and with the Simonds Rolling Machine Co., Fitchburg, Mass., where his father, John J. Grant, who built and equipped the first ball factory in America, was superintendent. With his father, Mr. Grant organized the Grant Anti-Friction Ball Co., which was later consolidated with the Cleveland Machine Screw Co., of Cleveland, O. This company was very successful and was sold for a large sum to a French syndicate. Mr. Grant then organized the Grant Ball Co., of Cleveland, O., which manufactured balls and screw machine products. This company was also successful, but as Mr. Grant did not have a controlling interest, he sold his stock to a company at Franklin, Pa., and became superintendent of the Standard Roller Bearing Co., of Philadelphia, Pa., which at that time had only a small factory employing fifteen men. Within three years this company acquired control of ninety per cent of the ball trade in this country and had built and equipped a plant covering several acres. After some years the control of this company was acquired by New York capitalists, changes were made in the management, and Mr. Grant severed his connection after having been about eight years with this concern. He is now designing machinery and equipping plants for the manufacture of balls and ball and roller bearings. In the last few years he equipped the Atlas Ball Co., of Philadelphia, Pa., the New Departure Mfg. Co., of Bristol, Conn., and the Flanders Mfg. Co., of Chelsea, Mich. He is now working on a large ball plant for this country and on two plants to be built abroad. In years past he also equipped two foreign plants, the Deutsche Waffen and Munitionsfabriken in Berlin, Germany, and the Clement & Cie, Paris, France, both of which concerns have been very successful.

The method of rolling balls, however, is very wasteful on account of the fact that the stock which revolves over the knurled part of the die is thrown away as scrap. For every ball that is made, a diamond-shaped piece, as shown in Fig. 3, of the same diameter as the stock, has to be made and thrown away. In the illustration referred to, *A* is the stock, *B* is the ball being rolled, and *C* the diamond-shaped piece which is wasted. Hence, it will be understood that this method is very expensive when used for ball-making, although the rolling method of forging can be used to advantage on long articles where the waste is proportionately small.

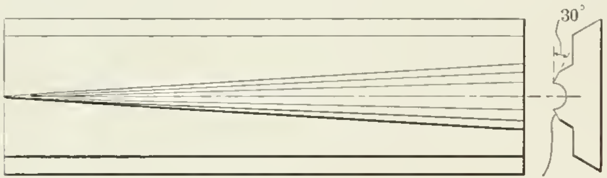


Fig. 2

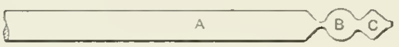


Fig. 3

Fig. 2. Die for 3/8-inch Ball, used on Machine shown in Fig. 1. Fig. 3. Ball and Scrap resulting from Rolling Balls

In rolling methods of this kind there is a decided tendency to "pipe" the stock on account of the difference between the speed at the largest diameter and that at the "centers" of the ball, where, as a matter of fact, the metal is simply crushed and does not roll. Frequently there will then be a hole or pipe right through the center of the ball which will show after the teats at the end have been ground off. As an example of the tendency to pipe, it may be mentioned that once in the writer's experience some spindles 12 inches long and 5/16 inch in diameter were rolled with pipes right through so that a string could be put through the center. For this and other reasons, although the Simonds machine was most interesting from a mechanical point of view, it had comparatively little value commercially.

Several other ball companies had no good blanking process, and, therefore, hired men who understood the rolling process from the Simonds Co. A number of machines were thus designed similar to the Simonds type. One of these had circular platens instead of straight ones, and was made with circular dies, one within the other. The die holders, of course, were running in opposite directions. This machine worked satisfactorily, but the dies were much more difficult to make on account of their circular shape, and also on account of the fact that the inner die was smaller than the outer. The company designing this machine did not have a good grinding process and the machine was, therefore, soon abandoned on account of discontinuing the manufacture of balls.

Another rolling machine constructed on the same principle was made with platens of circular form running horizontally instead of vertically. The dies were circular, but of the same diameter, and were placed on the platen near the outer periphery. There were four dies in all to take up the circumference. The platens were run in opposite directions to each other. This machine was very rapid in its action and continuous in its operation, as the dies always ran in one direction and did not have to reverse. Another rolling machine was made with two small circular disks with the dies cut in the periphery. These disks were keyed to spindles which were geared together and were made to run in opposite directions. This machine worked satisfactorily on small balls, and is still used by some of the smaller ball manufacturing firms.

A number of machines have been designed from time to time for the making of ball blanks; some of these have been rather ingenious although many of them have not been successful. In Fig. 4 is shown a machine invented by Mr. M. F. Christensen, of Cleveland, O. The slugs or blanks *H* are fed in at the upper end of a cone-shaped device. The cone *F* revolves, being driven from pulley *K*. The inner face of the casing *G* is provided with a spiral groove from top to bottom, the section of the groove being more and more that of a complete circle as it approaches the bottom of the cone. The blank, as it runs around the cone, is supposed to be gradually rounded as it approaches the bottom. The machine, however, never proved successful for several reasons. The distance that the slugs or blanks had to travel proved a disadvantage, because if the slugs were heated, they became cold before they had passed through the device and would not compress, but were simply split open; if the slugs were not heated, the grain of the material was so distorted or crystallized that the balls could not be used. Again, if the slugs did not roll, but commenced to slide, causing clogging, the machine would have to be entirely dismantled in order to locate the trouble. Hence, after long and extensive experiments, it was abandoned.

Machines for Turning Ball Blanks

On account of the piping and burning of the steel and the difficulty of removing the teats from the balls, the manufacturers next took up the turning process for making ball blanks. The first successful machine invented was designed by the writer and is shown in Fig. 5. This machine is an automatic ball turning machine with a regular draw-back collet and automatic feed for the stock. The special feature of the machine is the manner of forming the ball. There is no turret slide or feed mechanism, but simply a solid tailstock with a heavy faceplate having a cam cut in the face, as indicated in the views at *B* and *C*. This cam is driven from cone pulley *E* through gears *H*, *J* and *K*. On the tailstock a plate with three jaws *D*, *F* and *G* is fastened, each of these jaws holding a forming tool and being provided with a roller which fits into the cam groove in the faceplate. When the machine is in operation, each jaw with its forming tool comes forward and does its share of the work (as indicated at *L*, *M* and *N*), and is then moved back to allow the next jaw to come into action. The last or third jaw cuts off the ball and rounds the end of the stock so that there will be a proper surface on which to start the cut for the next ball. Another form of turning machine was provided with a head similar to a regular plain automatic machine, having for toolholders rocker arms operated upon by a shaft at the rear of the machine. The shaft allows the arms to descend onto the stock to form the ball and then moves them back while the cutting-off tool performs its work.

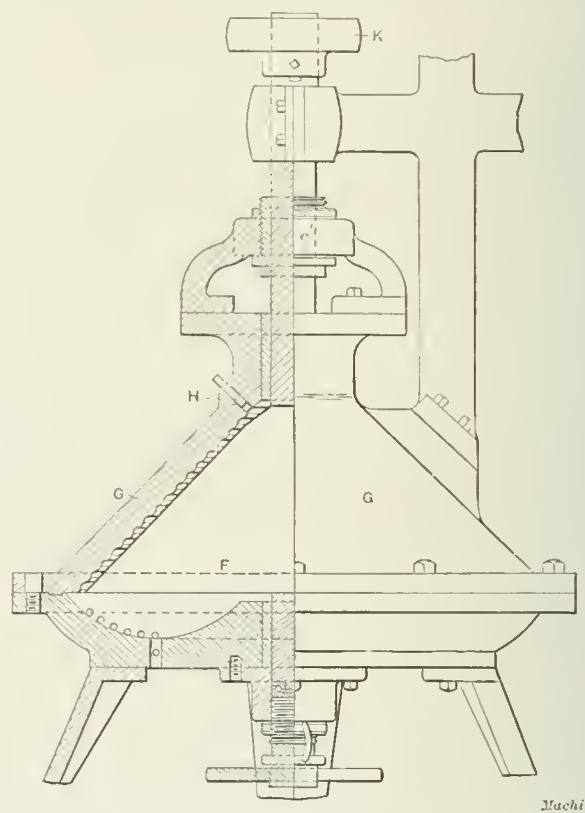


Fig. 4. The Christensen Ball Rolling Machine—U. S. Patent No. 632,336

The latest machine for ball turning is the Hoffmann machine shown in Fig. 6. This machine has two heads exactly alike, one at each end of the bed, these heads having regular automatic screw machine spindles. The slide in the middle of the bed is made very heavy because of being double and carrying two sets of forming tools. Four balls are formed at a time. The first ball from the stock end is about one-half finished, the second one, three-fourths finished, and the third one, completed, while the fourth ball is held in the second spindle, which is revolving at exactly the same speed as the first. This allows the forming tool to round the end of the ball so that it will be an accurate sphere. The ball is then fed on through the second spindle and drops into a pan. On account of

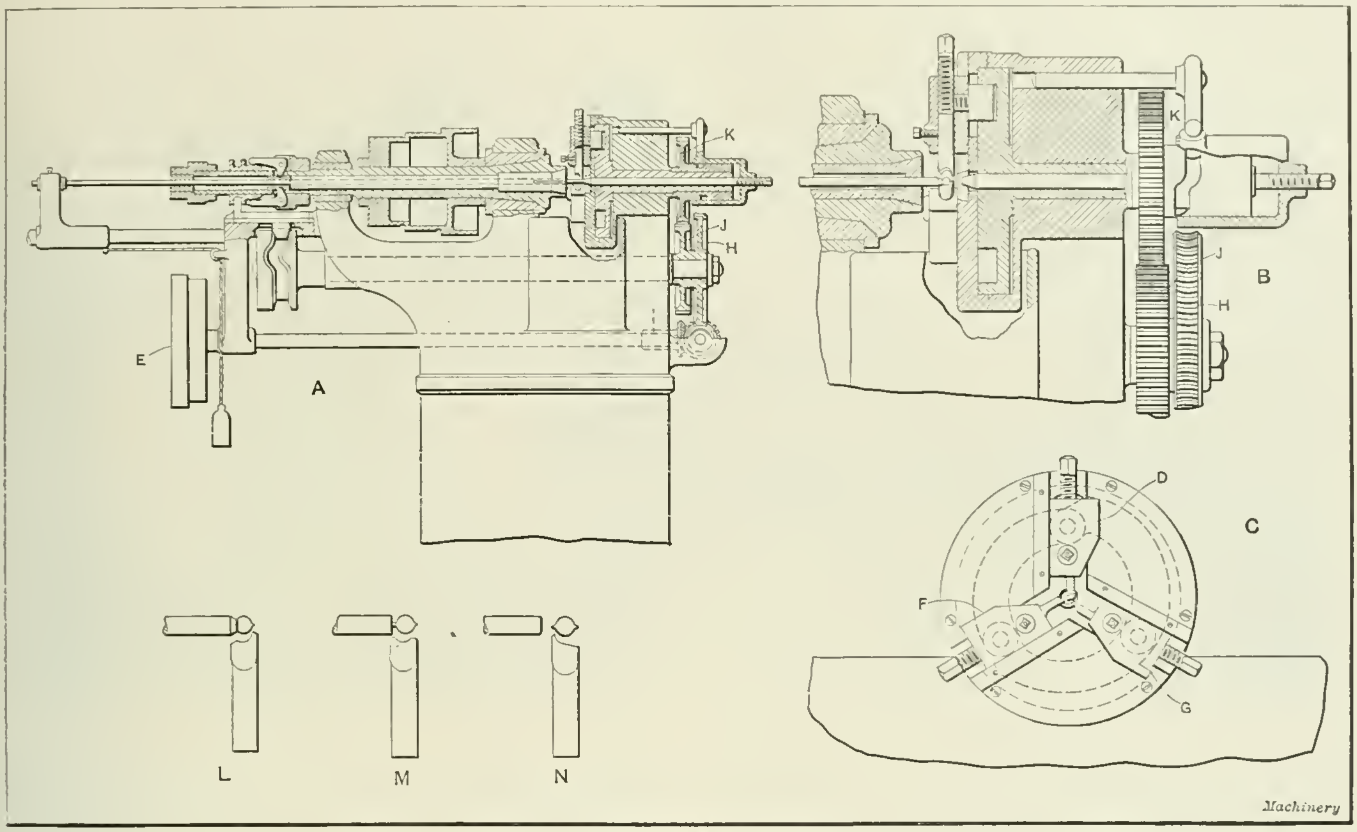


Fig. 5. The Grant Automatic Ball Turning Machine—U. S. Patent No. 517,004

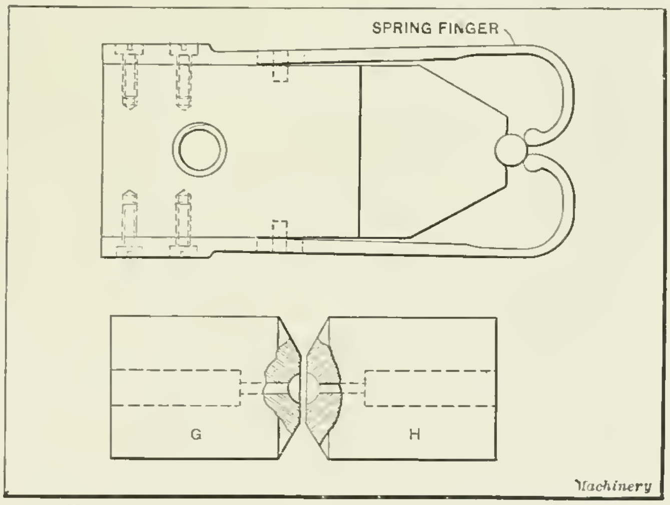
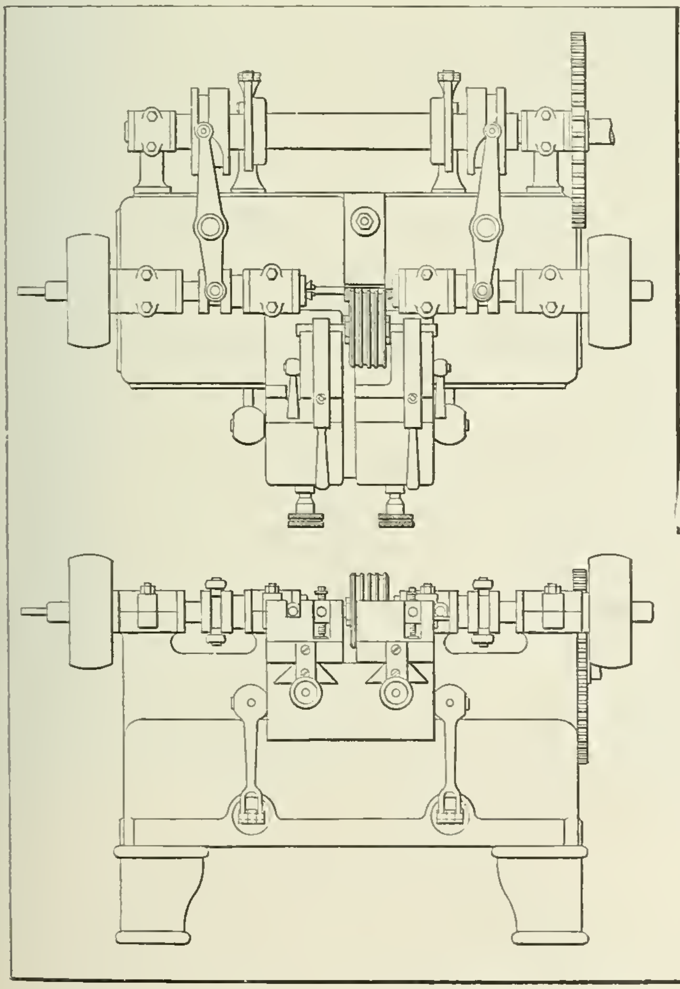


Fig. 7. Details of Cut-off Slide and Dies of Machine in Fig. 12



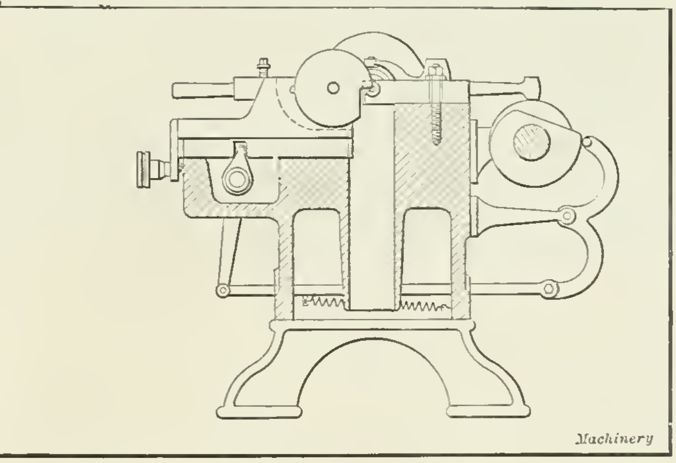


Fig. 6. The Hoffmann Ball Turning Machine—U. S. Patent No. 624,488

forming four balls at a time, a roller rest is used in the rear of the slide. This rest has two rollers made of hardened steel against which the stock revolves while the forming is being done. This allows the forming tool to form a perfect ball, as the stock cannot recede while the tools are at work. This is a feature of considerable value when balls are turned from tool-steel rods which it is impossible to fully anneal.

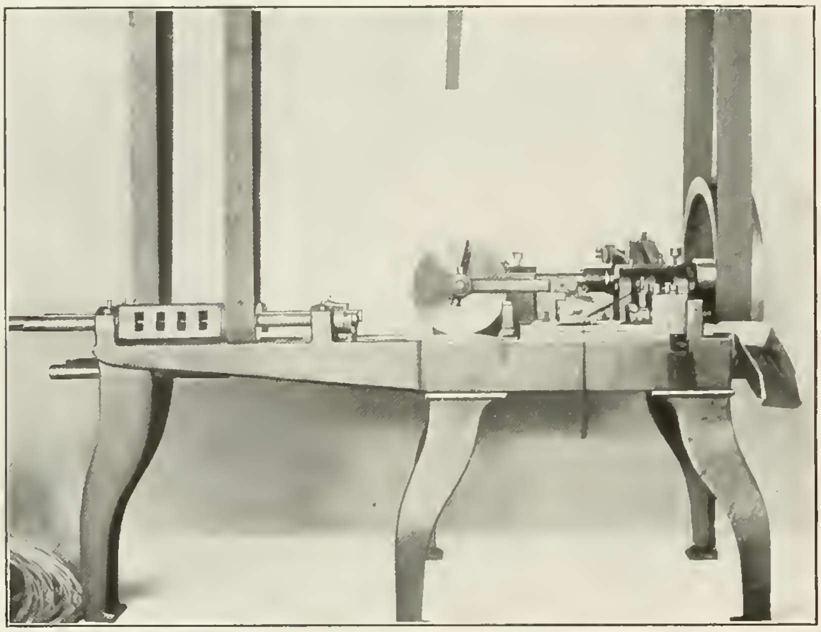


Fig. 8. Wire Straightening and Cutting-off Machine used for Cutting-off the Slugs for Pressing into Balls

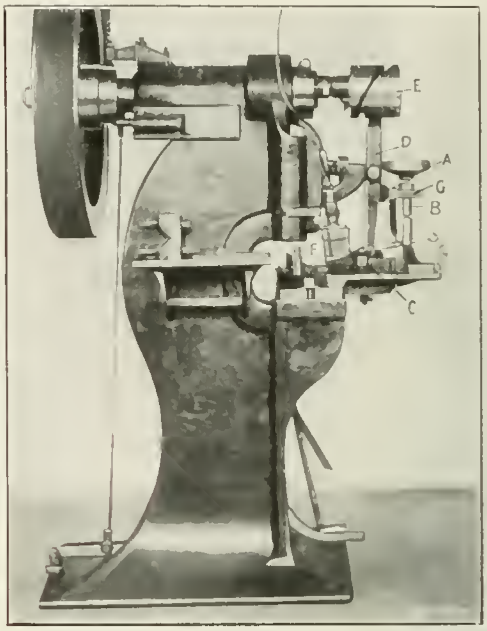


Fig. 9. Ferracute Press with Automatic Attachment for Pressing Balls

When turning balls by the method described, the stock wasted is greater than that which goes into the ball. The method is, therefore, used very little for balls over one-fourth inch in diameter, because the price of the steel becomes an important factor in the cost of manufacture when larger sizes are made. Another disadvantage is that balls cut from the bar are not as strong as when made by other methods. The direction of the grains or fibers of the steel wire is lengthwise of the bar; therefore, when the ball is formed, these fibers are cut and exposed at the surface, making a ball which is inferior in strength after hardening to balls made by other methods.

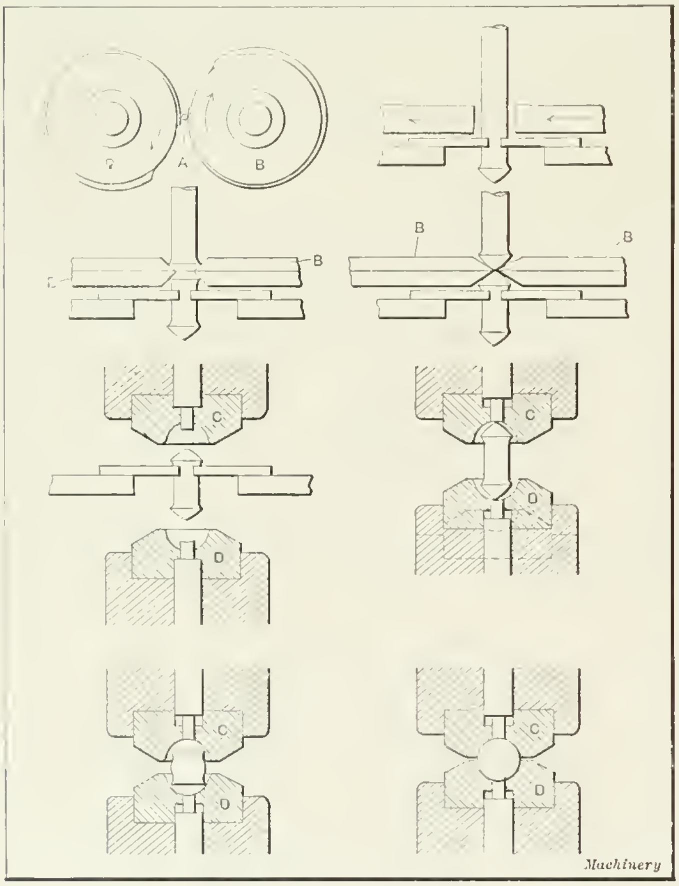


Fig. 10. Diagrammatical Views of the Various Stages of the Reid Process

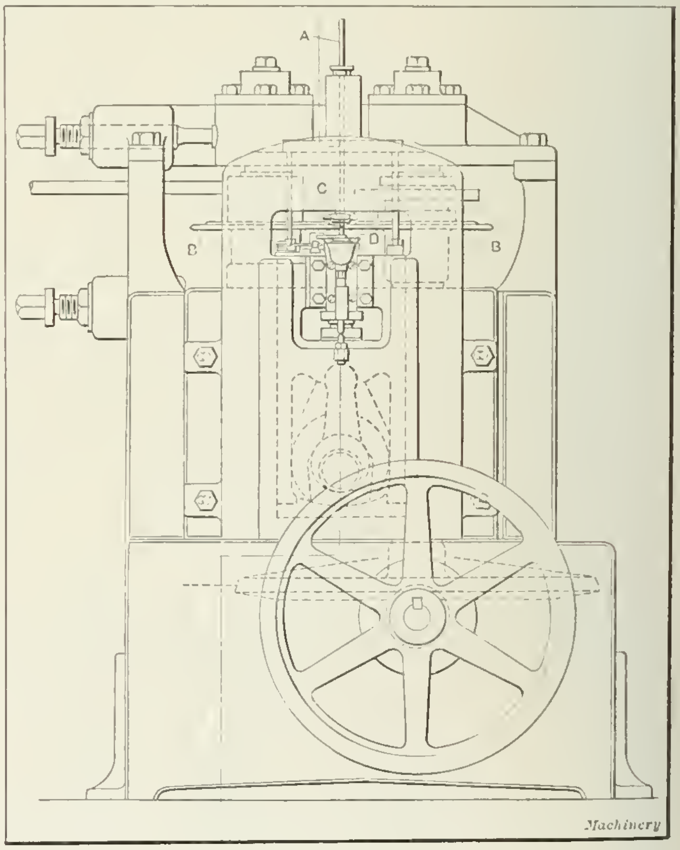


Fig. 11. The Reid Machine for Making Slugs with Tapered Ends and Pressing Balls—U. S. Patent No. 801,267

Pressing Balls

About fifteen years ago when the bicycle business was booming, the Cleveland Machine Screw Co., which was at that time one of the largest of the firms in the country manufacturing balls, was unable to make enough blanks by the turning process, so it developed a process of pressing the ball blanks. In Fig. 8 is shown a regular wire straightener and cutting-off machine by which a coil of wire was straightened and then cut into short lengths called "slugs." This cutting-off must be very carefully done as otherwise the ball made from the slug will be of poor quality, because of the ends or ragged parts being pressed into the ball and forming a cold shut. This may fall out during the grinding or hardening operations, the ball then having a pitted appearance. The length of the slugs also must be exact, otherwise the blanks will be badly out of shape. If the slugs are not square on the ends when placed in the die, they will crowd to one side, a lopsided ball being the result.

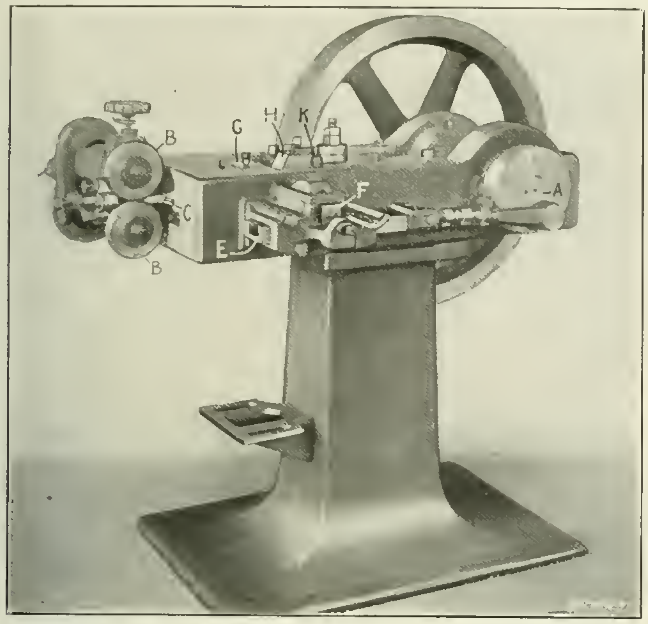


Fig. 12 The E. J. Manville Machine Co.'s Rivet Header arranged for Making Balls

In Fig. 9 is shown a regular No. 2 Ferracute press with an automatic attachment for pressing balls. This attachment is entirely automatic in its action, the slugs being fed down from the hopper and then conveyed by an arm to the die where the ball is pressed, after which the latter is ejected by the knock-out. At *A* is shown the hopper which holds the slugs, and at *G*, a fork which works the hopper up and down, keeping the slugs falling into the tube *B*. Fork *G* is operated through the lever *D* which is given a reciprocating motion by cam *E*.

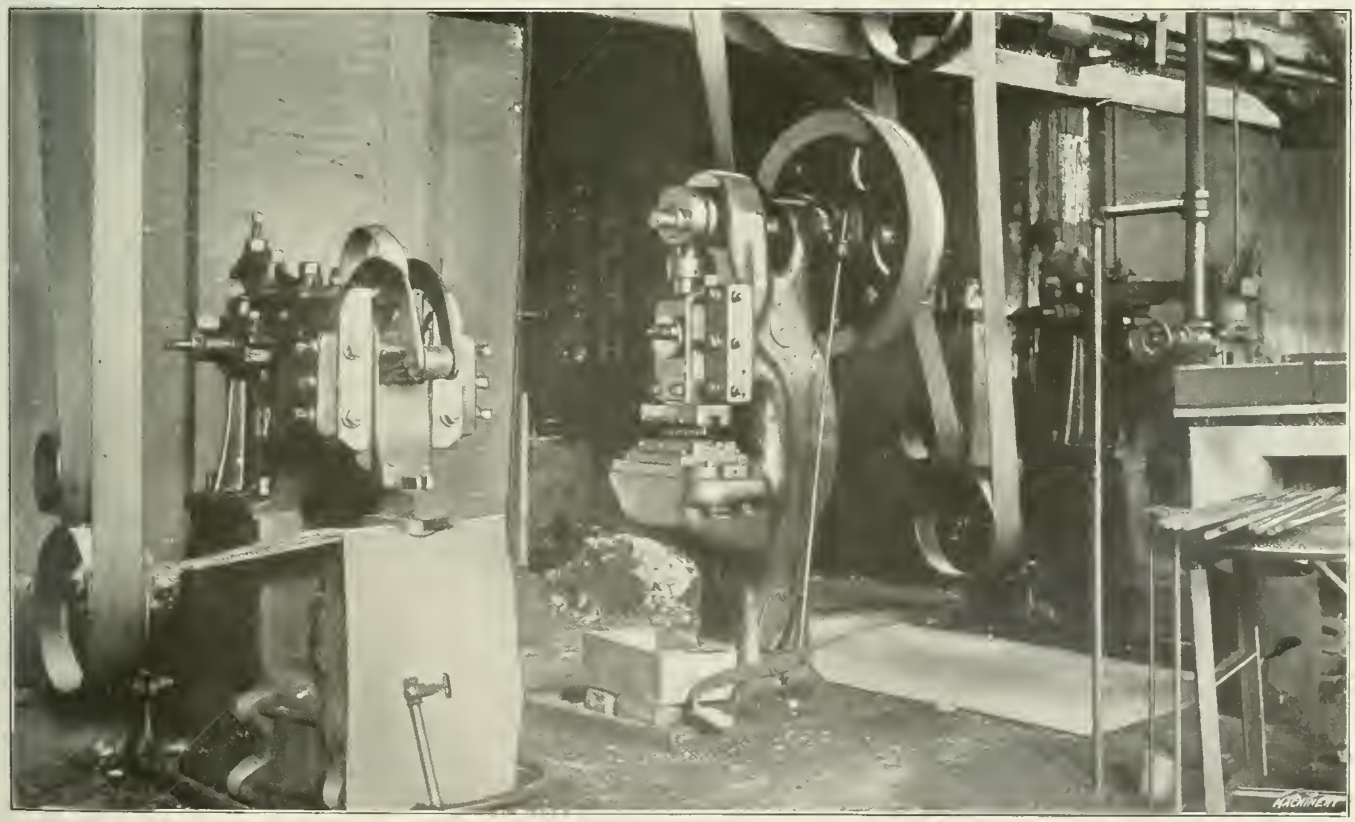


Fig. 13. Upright Helve Hammer and Press, arranged for String Forging of Balls

Lever *D* also moves a rack operating pinion *C*, which latter has an arm attached to it that carries the slug from the bottom of tube *B* to the dies in the press proper. The press is so timed that the slug is firmly held between the dies for a moment before the dies come together, thus giving the feeding arm time to pull away. While the pressing is being done, the arm receives another slug from tube *B*. This method of pressing is very cheap and very little material is wasted. On account of the press being of the regular open-front type, however, the blanks can be pressed only a small amount, because otherwise the machine will spring away from the work which is not heated. Hence when larger diameters are pressed, the balls are only approximately spherical, and a large quantity of stock is left for the dry grinders to remove. It has, therefore, not been practical to press balls by this method when they are larger than 3/8 inch in diameter.

The Reid Ball Pressing Machine

Fig. 11 shows a machine designed by Mr. M. Reid for cutting the slugs tapering at both ends, so that when pressing the ball no ragged edge can be pressed into it. The stock *A*, which comes in straight bars, is fed into the machine by gravity. Cutters *B* (shown also in Fig. 10), somewhat similar to pipe cutters, sever the stock and at the same time taper the ends. The stock is then fed to dies *C* and *D* and the ball is formed as indicated by the various illustrations in Fig. 10. As this process is done with heated stock, a very good blank is produced. The sharp edges usually formed when cutting off the stock, are done away with by this method, and only the central part of the ball has to be pressed up, as the tapered ends are simply rounded.

The Manville Machine

The latest and best designed machine for the manufacture of small ball blanks is made by the E. J. Manville Machine Co., Waterbury, Conn. This machine has a coining-press type of frame, except that it is horizontal instead of vertical. All the work is done inside of the frame, so that a very accurate blank can be produced on account of the rigidity thus obtainable. Fig. 12 shows one of the smaller sizes of these machines. This size is used for making balls up to 1/4 inch in diameter. The stock which comes in coils is first passed through the straightening rolls *B* and then through tube *C* into the cutting-off die. Slide *E* has a cam which carries the cutting-off device or tool *F*. This cutting-off tool is flat and has spring fingers as indicated in Fig. 7. These fingers overlap the groove at the end of the cut-off tool. After the stock has been cut off, these fingers hold the slug in position on the cut-off tool until the cam in slide *E* carries the tool with the slug over to the center of the dies. Die *G* is stationary and die *H* is mounted in movable slide *K*, which is carried forward by the eccentric on shaft *A*. As soon as the slug has been clamped between the two dies, the cut-off *F* moves back and allows the dies *G* and *H* to come together. The dies have holes drilled through them and are counterbored from the back to within one-half inch from the impression in the die. (See Fig. 7.) In these counterbored holes, knock-out pins are placed which are worked by levers on the under side of the machine, so that as soon as the dies draw apart these pins will knock out the ball, no matter which die holds it.

The machine is very rapid in its operation and regular 3/16-inch balls can be made at the rate of 100,000 to 125,000 per day, according to the grade of the stock and the character of the annealing. One man can run three or four of these machines; hence the labor cost is so small as to be almost negligible. As there is no waste, this process, for smaller sizes of balls, must be deemed the best as well as the cheapest in ball manufacture at the present time. The following table gives sizes of stock used for making different sizes of balls:

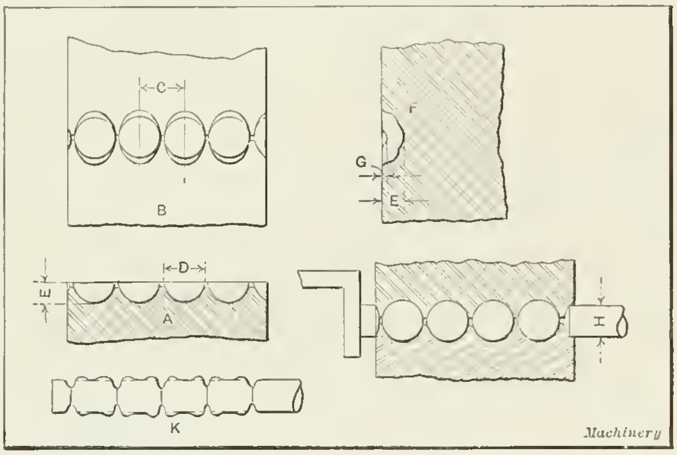


Fig 14. Details of Dies for String Forging

Diameter of Ball, Inch	Diameter of Stock, Inch	Diameter of Ball, Inch	Diameter of Stock, Inch
1/8	0.095	9/32	0.200
5/32	0.120	5/16	0.225
3/16	0.145	3/8	0.265
7/32	0.165	7/16	0.312
1/4	0.180	1/2	0.355

Ball Forging

The best known method of making ball blanks from ⅜ inch to 2 inches in diameter is known as string forging. Fig. 13 shows a regular upright helve hammer and a press, as well as a heating forge, the equipment being arranged for string forging. The bars from which the balls are forged are approximately 6 feet long. Twelve of these bars are put into the furnace at a time and are heated so that two sets of balls can be forged before putting the bar back into the furnace. By having a number of bars in the furnace at the same time, the heating can be done slowly and uniformly, and the bars are heated clear through to the center of the stock without burning or decarbonizing the surface. The forging of the balls requires some skill, as the bar must be turned and the hammer started at high speed, gradually slowing up as the blank begins to assume its proper shape. After being forged, the string of forged balls, indicated at *A* in Fig. 19, is placed in the trimming press where the whole row is forced through a series of holes, thus trimming off the fins and separating the balls into individual blanks. The balls drop directly into a box under the press, as indicated.

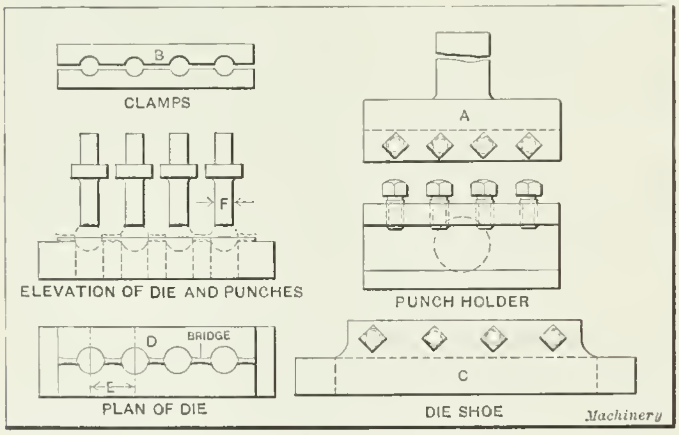


Fig. 15. Tools used for Trimming the Balls after Forging them in a String

Fig. 14 shows by a number of diagrammatical illustrations the manner in which the dies for string forging are made. At *A* is shown a section of a die with four impressions. The illustration also gives the notation of the die details necessary for use in connection with the following table. At *A*, for example, is indicated the diameter *D* of the cutter or cherry used in sinking the die, and also the depth *E* to which the cutter is sunk. In the view at *B* is given the distance *C* between the centers, so selected that when the proper size of stock is used, the die cavity will just be filled. It is also indicated here and at *F* that the die must be backed off or relieved on each side of the impressions, leaving only a small amount of land in the center to do the hammering. This backing off is done by moving the jig around on the milling machine or die sinking machine, and sinking the cutter or cherry into the die about 1/16 inch, leaving the width of the center about one-third of the diameter of the ball. At *G* is shown the depth of the bridge, which is very important, as the neck formed by the bridge must hold the balls together during the forging and not draw the stock near the neck, so as to cause a pipe, which is very easily done. At *H* is shown the size of the stock which is always smaller than the diameter to be forged. The stock must be close to the required size; otherwise difficulties will be met with. If under size, the balls will not fill out; if too large, extra hammering will be required, which causes the dies to soon wear out. In Fig. 14, four balls are shown forged at a time, but as this illustration is only diagrammatical, it is not implied that this is the correct number used in practice. The following table gives the number of balls that would be forged in a string for different sizes of balls, together with other dimensions required for the sinking of dies. At *K* is shown the stock after it has been slightly hammered to see if the dies are in perfect alignment. It is easily seen that when there are so many impressions in the dies, if the die warps in the hardening, the two dies will not match perfectly, and the balls at either end may be rather poor in quality. It is, therefore, very important to use a die steel that will hold its shape after hardening.

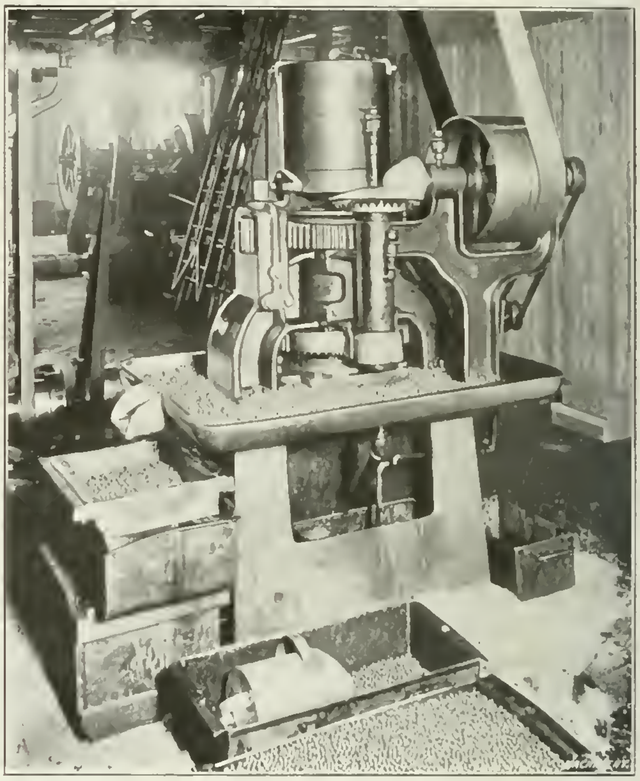


Fig. 16. "Flasher" or Rotary File used for Removing Fins from Forged Balls

The necessary tools for the trimming of the balls are shown in Fig. 15. At *A* is shown the holder for the punches, the shank fitting into the head of the press. At *B* is shown a plate with holes drilled to the same diameter as the shanks of the punches. This plate is sawed in two, and after the punches are placed in the holes, it is clamped in holder *A* and held in place by four set-screws. The diameter *F* of the punches is about one-eighth inch less than the diameter of the balls. At *C* is shown a bolster fastened to the press and at *D* a plan of the die that is drilled with the same distance *E* between the centers of the holes as the distance between the forged balls. A groove is provided between the holes drilled in the bottom die *D* so that the necks between the balls will not touch the top of the die. Die *D* is placed in bolster *C* and lined up with the punches as in ordinary stamping processes.

DATA FOR STRING FORGING OF BALLS

(See Fig. 14 for notation)

Size of Balls	Size of Stock, H	Diam. of Cutter, D	Distance Between Centers, C	Depth of Cavity, E	Depth of Bridge, G	No. of Balls
3/8	0.320	0.395	0.485	0.198	0.040	18
7/16	0.375	0.457	0.550	0.228	0.050	16
1/2	0.437	0.520	0.615	0.260	0.050	14
5/8	33/64	0.645	0.755	0.322	0.060	12
3/4	39/64	0.775	0.910	0.387	0.065	9
7/8	23/32	0.905	1.060	0.452	0.065	8
1	13/16	1.035	1.210	0.517	0.075	7

Furnace used for Heating the Bars

The furnace used for heating the stock is of a special oil burning type. The burner is placed on the side of the furnace midway between the front and the rear. By having a special form of baffle plate directly in front of the flame, the latter is distributed throughout the furnace before it comes out at the front. An air pipe is passed under the opening through which the stock is put in to be heated. This pipe has a number of small holes drilled in the side facing the opening, and when air is forced through these holes, the heat is diverted upward and kept away from the operator.

Large balls, from 2½ inches up, are usually forged under a steam hammer. Stock of the proper diameter is first cut off to the required length and both ends are chamfered. The length of the stock is determined by the weight of the finished ball, an allowance for finishing being added. The blanks are placed in an oil furnace and allowed to heat slowly. Each time a blank is forged, a new one is put into its place in the furnace. The dies for this kind of forging are of an entirely different form from those used for string forging. They are cupped out to the desired diameter, but are only sunk to a depth of one-quarter of the diameter of the ball to be forged, and are not backed off. When the blank is heated, the hammer man places it in the die, and the hammer is worked very slowly until the ball begins to take a spherical shape, at which time quicker and heavier blows are struck. On account of the impressions in the dies being so shallow, the operator has ample space to turn the ball in all directions, and can, therefore, produce an almost true sphere. Blanks 4 inches in diameter have been forged that have not been out of round over 0.005 or 0.006 inch.

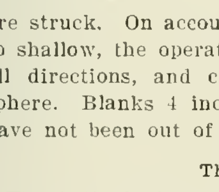


Fig. 17

Fig. 17. Principle of Multiple Ring Grinder

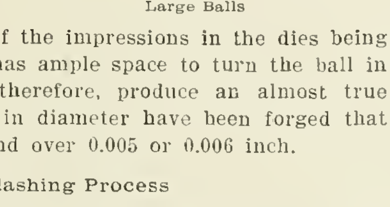


Fig. 18

Fig. 18. Method of Flashing Large Balls

The Flashing Process

The ball blanks as they come from the press or hammer are more or less out of shape and have a flash or fin or some other projection caused by the cutting-off or the wearing of the dies. These fins must be removed before the first grinding as they would otherwise mar the grinding rings. In Fig. 16 is shown what is known as a rotary file or flasher used for removing these fins. The balls are fed through the spindle by gravity and discharged from the rotary filing plates by centrifugal action. The head of the machine, which is run by a worm and worm-wheel, has a spindle to the end of which the rotary file is attached. As the spindle is hollow, the balls can be fed through it to the center of the plate. The lower plate is solid, but is adjustable up and down, allowing for different sizes of balls and for wear. The balls as they pass from the spindle to the center of the plate, are filed by the upper plate revolving and forcing them over the lower, and they fall out at the outer edge into a basket. The operation is repeated after the lower plate has been adjusted. The plates are kept from clogging by a mixture of lard and kerosene oil, circulated by a pump from a tank below to a reservoir above.

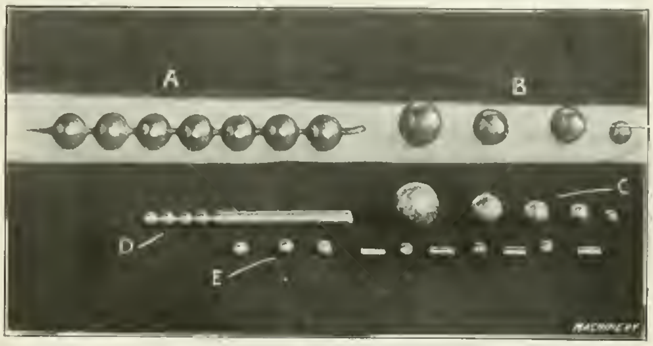


Fig. 19. Sample of Balls made by Various Processes at Different Stages of Completion

There is also another method of removing the flash or fin from the balls, known as the multiple ring grinding process. Fig. 17 shows a diagrammatical sketch of the principle of this method. Rings which are slightly grooved are placed on a heavy grinder similar to a drill press. The grooves are filled with balls and No. 36 emery or carborundum. The top ring is fastened to the spindle and allowed to revolve at a high speed while pressure is being applied. In a short time the balls are removed and found to be comparatively smooth and ready for the first dry grinding.

The larger balls are ground separately in a very simple but effective way, as indicated in Fig. 18. An upright *A* is bolted to the table of a small emery wheel grinder. This upright has a tapered hole through it into which the ball is pushed and adjusted so that the ball after the flash has been removed will barely touch the emery wheel. The operator, by means of a short pair of tongs, can turn the ball in all directions. As the ball cannot pass through the tapered hole in the upright more than a certain distance, flat spots cannot be ground, but the fin is simply removed and a smooth surface produced.

In Fig. 19 are shown a number of samples of balls made by various processes and at different stages of completion. At *A* is shown a string of forged balls, and at *B* forged balls after trimming. At *C* are shown a number of balls after being rough ground, at *D* the end of a bar operated upon in a Hoffmann ball turning machine, and at *E* a number of slugs and balls pressed from them.

Kind of Steel used in Ball-making

The most important thing to be considered in the manufacture of balls is the quality of steel used. One of the largest elevator companies in the United States tried 432 different samples of steel, obtained in this country and abroad. Balls from these samples were made and tested by being put into actual use. From these tests it was ascertained that the two grades of steel below (carbon and alloy) are best suited for making steel balls.

1.—Carbon, 1.12; silicon, 0.015; phosphorus, 0.017; manganese, 0.19; sulphur, 0.019; chromium, 0.25 per cent.

2.—Carbon, 0.95; silicon, 0.014; sulphur, 0.019; phosphorus, 0.018; manganese, 0.025; chromium, 1.25; tungsten, 0.25 per cent.

In the articles to follow the writer will take up the subject of rough grinding, hardening and finish grinding of steel balls, and also the inspection, grading and testing of balls, together with a review of the use of steel balls, and hints for purchasers regarding the quality of balls.

TOOLS FOR FOUR-SLIDE AUTOMATIC WIRE-FORMING MACHINE

By CHESTER L. LUCAS

At the factory of the Baird Machine Co., Bridgeport, Conn., the standard automatic wire-forming machines made by the company are "tooled up" for producing many interesting products of wire-forming. It is the purpose of this article to illustrate the important features of four-slide automatic wire-forming machinery, and to describe a few sets of wire-forming tools made in this factory and elsewhere.

Four-slide automatic wire-forming machines are made by many different companies, and although each make has some special features of its own, the underlying principles are the same. The Baird four-slide automatic wire-forming machine furnishes a good representative machine of this type. The general appearance of the machine is shown in Fig. 1, and its important working parts, such as the straightener *A*, the feed *B*, the cut-off *C*, the grip, the form-holder *D*, the stripper, slides and dies are illustrated in the plan view of the machine in Fig. 2.

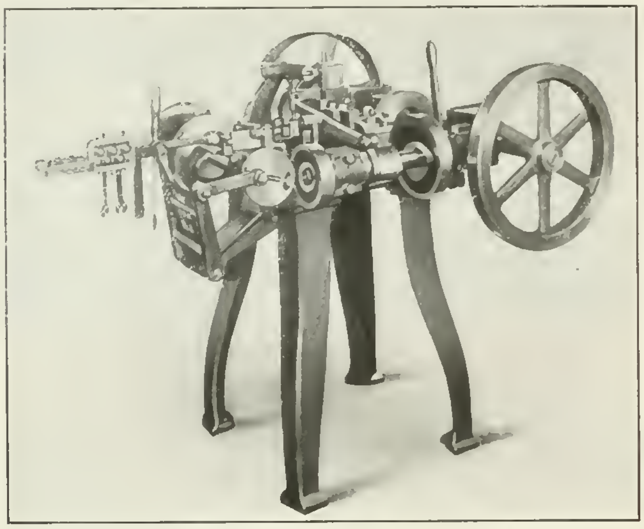


Fig. 1. A Typical Four-slide Automatic Wire-forming Machine

Straightener, Feed, Cut-off and Grip

The wire enters the machine at the straightener *A* indicated in Fig. 2. The object of the straightener is to take out kinks in the wire, so that it may go to the forming tools in good condition. The straightener consists of two sets of rolls, set at right angles to each other. These rolls are not located opposite each other, but are staggered. By means of set-screws, individual adjustment is available for each roll so that spring wire may be just as effectually straightened as soft copper wire.

The forward feeding of the wire is accomplished by a crank, best shown in Fig. 3, where *A* is a pin adjustable on the crank-plate by means of nut *B*. The adjustment permits any desired stroke to be given to feed-slide *C*, which feeds the wire forward at each revolution of the crank-plate. The gripping finger *D* is hinged so that at the beginning of the forward movement of slide *C* this finger grips the wire, pulling it through the straightener and forward with the slide. As soon as the return stroke commences, the wire is released, and the slide and gripping finger return to the starting position.

The cut-off, shown in detail in Fig. 4, is operated from the front of the machine. It consists of a slide *E*, whose end roller bears against a cam *F* on one of the four main cam-shafts. The cut-off is adjustable for different lengths of wire by means of an adjusting screw *G* terminating in a small pinion which, in turn, engages a rack *H*. The cut-off is held in position by means of the clamping bolt *I*, located beside the adjusting screw.

When the wire has been fed forward the proper distance, the gripping finger releases its hold upon the wire and starts on the return stroke. At this point the tension in the wire would cause it to relax slightly, especially in the case of spring wire, making it impossible to cut it to exact lengths. To overcome this trouble, a grip is provided that holds the wire during the time it is not being fed by the gripping finger. This grip, shown in Fig. 3, is at one end of an arm *J*, that is pivoted in the center. The other end of this arm is fitted with a roll *K* bearing upon a cam *L* on one of the main shafts of the machine, thus giving the grip a downward pressure on the wire at *M*, and releasing it at the instant the forward feed starts.

Form-holder and Stripper

The forming of most wire pieces necessitates the use of a center form or arbor, about which the wire is bent. This form is sometimes called the center die. The standard size for the body of the center form is 1¼ inch by 1½ inch. To support this form, a cast-iron form-holding bracket, shown in Fig. 5, is provided at the center of the machine. This bracket will accommodate either the rigid form or the swinging type of form, as desired.

For releasing the wire article from the form, after it has been bent, a stripper is provided. The stripper rod passes through the form and upon its lower end the stripping plates are held. These stripping plates are made of sheet iron from 1/16 to 1/8 inch thick. The stripper rod is reciprocated by an independent arm, in a manner similar to that in which the grip is operated.

The Forming Slides

The forming slides that operate from the four sides of the machine are the most important features of the machine, and it is from these slides that the machine derives its name. The slides are reciprocated by the cams on the four main shafts. Both cams and cam-rolls are faced with hardened steel to withstand wear. The forming tools or dies are bolted to the forward ends of these slides, and adjustment is provided for by means of set-screws bearing against the ends of the dies.

The cams that impart the reciprocating movement to the slides have dwells of 90 degrees. As these cams may be adjusted to any desired position with relation to the shafts, the movements of the tools may be regulated very closely.

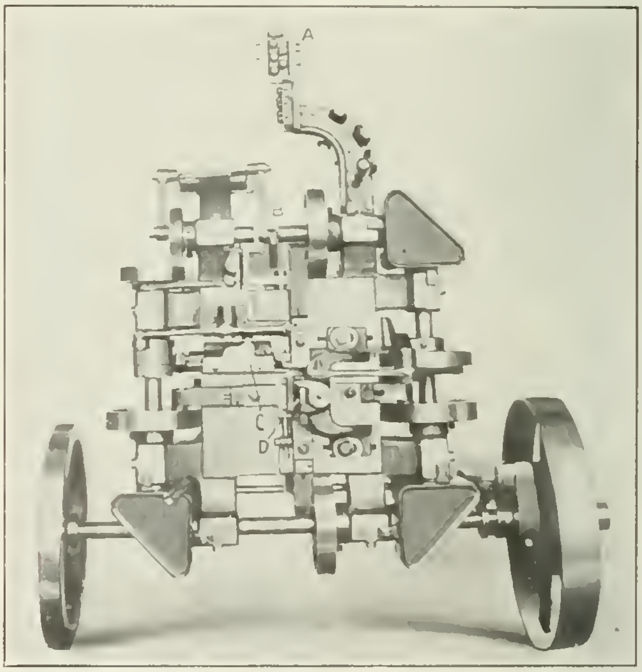


Fig. 2. Plan View of Four-slide Automatic Wire-forming Machine

Making the Tools and Starting a New Job

When the tools are to be made for a new piece of wire forming, the toolmaker usually receives a drawing of the piece, but it is a great help to him to also receive a sample of the work to be produced. He first studies the best way to face the tools in the machine, trying to get the simplest and strongest design that he can employ in the making of the tools.

The tools are generally made from low carbon steel, but for hard wire, spring wire or other stock that is liable to cause wear, the dies are made of tool steel, hardened and drawn to a brown color. To avoid marring the stock, as well as to guide the wire, grooves are cut in the faces of the tools to fit the wire, wherever the tools come in contact with it. The center arbor, however, is not grooved, because the wire would not strip easily if it were. Wherever possible the grooving operation is done with a cutter similar to a small T-slot cutter, but many places must be chipped, filed and worked out by hand. It is an excellent plan to stamp each die with the job number and the position of the tool in the machine. This will save trouble in locating misplaced tools, and prevent blunders in setting-up the tools in the machine. After the dies have been completed, they must be put into the machine and adjusted; usually they must be altered until the piece produced is correct. One of the difficulties that must be contended with is the varying tempers of the wire that must be worked, and this trouble does not apply to spring wire alone.

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* Associate Editor of MACHINERY.

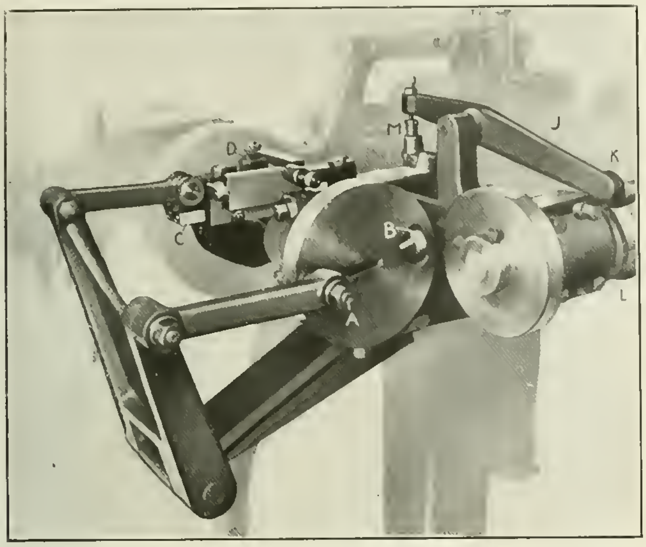

Fig. 3. Details of Wire Feed

An important part of the trying-out of a set of wire-forming tools is to ascertain the correct length of wire required to make the given piece. It is customary to figure out the length as closely as possible from the drawing, cut a piece of wire to this length, and bend it by hand to the shape required. If more stock is required, another piece, left a little longer, is tried, until the proper length is found. For spring wire, in addition to the developed length, the length must be increased an amount equal to one-half the diameter for each 90-degree bend, and one-fourth the diameter for each 45-degree bend.

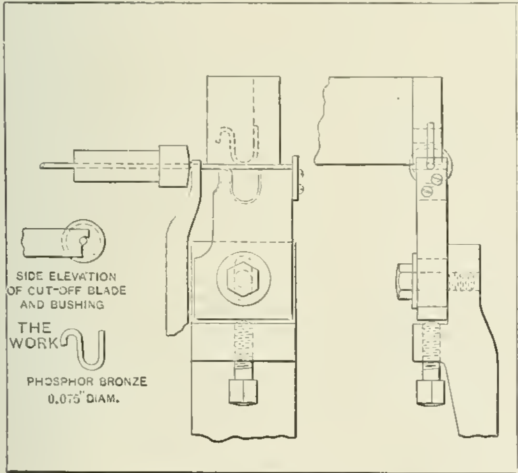

Fig 6. Tools for a Simple Job of Wire-forming

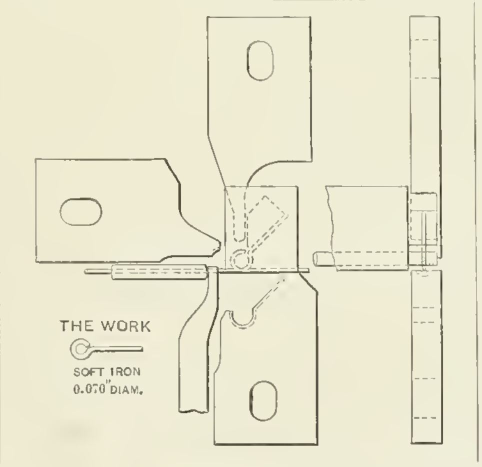

Fig. 7. Tools for Forming an Eye-pin

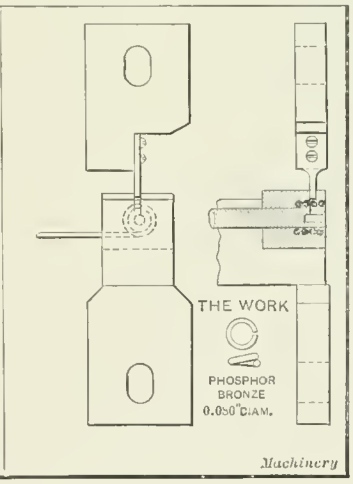

Fig. 8. Tools for Ring-forming

In setting up the cams on the machine, the feed should be given the first consideration, the feed, the grip and the tension on the straightener rolls being first adjusted. Next, the cut-off cam must be set so that the blade strikes the wire just as it comes to rest after being fed forward. The slides must then be set, and of these the front slide comes first. This slide should be set so that it will just catch the wire against the center die or form at the time it is cut off. The cam for the front slide has a long dwell, being designed so that it may be kept against the wire while the other slides are performing their work on the piece. Thus, the front slide acts like a vise in holding the wire while being bent. It often happens that one or more of the slides are not required for the work, in which case they are drawn back as far as possible and allowed to run idle. The stripper is adjusted to push the piece from the center form just after the slides have started to pull back.

The wire is cleaned and lubricated, as it enters the wire straightener, by a piece of felt soaked in oil and held against the wire by a simple clasp spring. The speed of wire forming operations varies with the class of work; the production may range from 50 to 200 pieces per minute, according to the diameter of wire. For pieces of average-sized wire, up to 3/32-inch diameter, 100 pieces per minute is good production.

Peculiarities of Different Wire

Without doubt the most satisfactory kinds of wire to work are soft brass and copper, with soft steel a close third. The reason the soft wires are so easy to work is that the stock "stays where you put it." Half-hard brass is also an easy wire to form and is used largely on general work. Tinned and galvanized wires present difficulties in the form of lumps and rough places due to the tinning and galvanizing. These lumps interfere with the working of the tools and are apt to injure the faces of the dies.

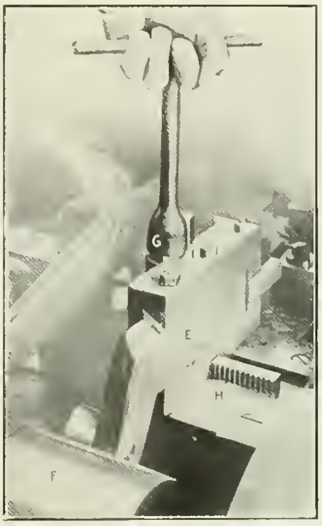

Fig. 4. Details of Cut-off

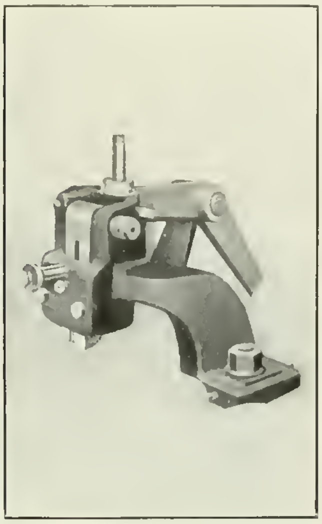

Fig. 5. Form-holder and Stripper

All hard wires are troublesome to form. Hard brass, and especially phosphor-bronze wire, object to being "kinked up." This objection manifests itself by the wire springing away from the forms after being bent, and by slipping through the feed and grip. To obviate the first trouble, the angles in the forms are made a little more acute than the requirements call for, and as the wire will not hold the exact shape imparted by the dies, the result is usually satisfactory. In every case there is more or less "cutting and trying" to be done. To overcome the slipping of the wire, the tension of the feeding finger is adjusted so that the slide and finger will get a stronger hold upon the wire in pulling it through the rolls. It is a frequent occurrence to find that in the same shipment of wire, different coils of the same grade will be of different tempers, necessitating the changing of the grip or tension rolls for each coil.

Steel spring or piano wire is the most difficult material met with in wire-forming. All the evils of hard brass and bronze are found in steel spring wire, and in addition it has a few bad features of its own. For small wire of this kind, especially, the dies must be hardened, or they will not stand up at all. The cut-off blade and bushing must be frequently ground to retain clean ends on the wire. The tension rolls must be adjusted to insure the wire coming through the cut-off bushing exactly straight across the front die, so that the dies will grip it in the proper position.

Ribbon stock, the name commonly applied to narrow sheet metal coming in coil form, may be conveniently worked in the automatic wire forming machine by altering the style of tension rolls on the straightener and providing suitable cut-off bushings and blades. As the machine is automatic, it is often possible to handle a sheet-metal job to better advantage than by the use of a press, in cases where bending operations are to be performed.

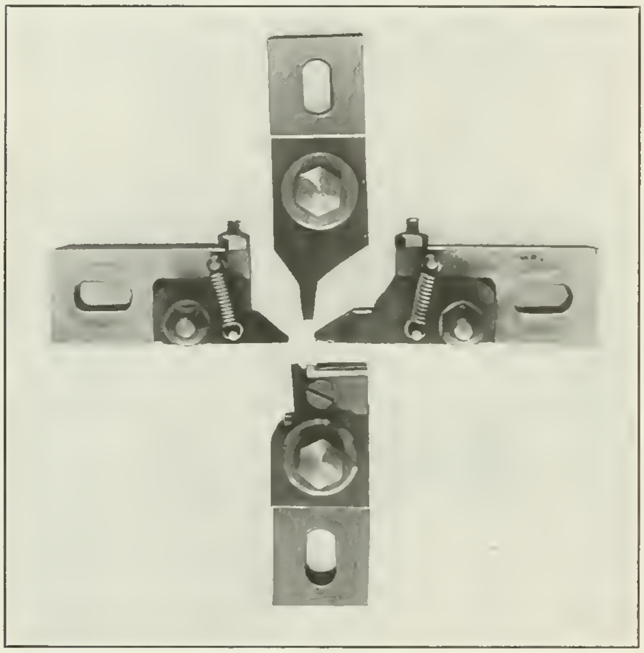
Fig. 9. A Set of Wire-forming Tools for a Very Small Link

When forming very light wire or thin ribbon stock, there is a certain amount of elasticity in the stock that causes it to draw back slightly if this "backlash" is not held in check. Between the releasing of the wire by the grip and the forward movement of the wire by the feed finger, there is just an instant when the hold on the wire is released, unless the timing is perfect. To obviate the necessity for minute adjustments of the cams to overcome this tendency, Mr. C. W. Kenerson, to whom the writer is indebted for assistance in preparing this article, has designed an auxiliary spring wire grip. This grip is placed just back of the feed finger upon the slide, and one of its halves is screwed to the slide frame. The other half slides on dowels driven into the first half. Springs between the two keep a steady tension on the outer half, which continually bears against the wire. Thus, at no time is the wire free to relax, and yet the pressure against it is not great enough to interfere with the feeding of the wire.

A Few Interesting Sets of Wire-forming Tools

In order to show the way in which wire articles are formed in the four-slide automatic wire-forming machine, a few representative sets of tools are illustrated. None of the jobs are very difficult, as will be gathered from the fact that the bending operations shown are all in one plane. Really difficult wire-forming involves bends in two planes.

A set of very simple wire-forming tools will undoubtedly be best for our first description. The double-bend hook shown in Fig. 6, together with the tools used in the machine, is a good example of a plain wire-forming job. The material is phosphor-bronze, 0.075 inch in diameter. As will be seen, but one of the slides is required for the bending. The forming tool, or die, as it is sometimes called, is mounted on the front slide. The method followed in holding the tools on the slides is also well shown in this illustration. An elongated slot in the tool permits a reasonable amount of adjustment by means of the set-screw behind the tool. The wire is cut off in the usual manner, the cut-off blade being off-set so as to cut the wire short enough for the pieces. The stop on the side of the front slide is necessary to steady the wire until the tools have gripped it firmly.

The wire feeds in and is cut off just as the front slide comes up, and is then caught between the projection on the center die and the tool on the slide. After the front tool has forced the wire into the center form, the slide retreats, and the stripper comes down and ejects the hook. In all of the illustrations the strippers are omitted for the sake of clearness. There is nothing complicated about the stripper for it is merely a piece of 3/32-inch sheet steel supported upon the stripper rod, serving to push the wire piece from the center die after the forming has been completed. In the drawings of the tools, the plan views are shown with the center die in place, as seen from above; hence the forming portions of this die are shown in dotted lines.

Tools for a Wire Eye-pin

Fig. 7 illustrates a familiar piece of wire bending that is often seen in many sizes and varieties. This particular piece is made of 0.070-inch iron and is 1½ inch long. To form this piece, three of the slides are used—front, back, and left. A point to be noted about this job is the movable arbor used in the center die when the eye bend is made.

The wire is fed in and cut off in the usual manner, the front die gripping the wire against the angular projection on the center die. At this time the central arbor is within the form and thus out of the way, leaving the path clear for the back tool to set the wire firmly into the depression in the front tool. As soon as this part of the forming has been done, the arbor drops into place and the left slide comes in, bending the end of the wire around this arbor and thus completing the eye. The front slide remains against the work while the other slides are at work. After the piece has been bent, the arbor that shapes the eye retreats into the center die, thus allowing the piece to drop without using a stripper.

Wire Forming Tools for a Small Ring

Fig. 9 shows a set of wire forming tools just removed from the machine. The illustration conveys a good idea of wire forming tools in general. These tools were designed to form a small link from 0.015 inch brass wire, the outside diameter of the link being only 3/32 inch.

It is evident that the wire must be cut off at a point just far enough from the first bend in the front dies to leave sufficient wire to complete the end of the piece. As the total length of wire required to form this link is about 5/16 inch, the wire must be cut off just 5/32 inch from the center of the front bend. It is obvious, therefore, that there is not room for a cut-off blade, so the cutting is done with a very thin strip of steel screwed to the side of the front die.

The order of operations is as follows: The front die comes up to the wire, forcing it around the arbor in the center die (not shown), the side slides come in together, shaping the sides, and, finally, the back die completes the ring. As these tools are delicate for a machine of this character, the side tools are hinged, being kept in normal position by spiral springs. This construction gives more latitude in adjusting the tools, for with rigid tools the slightest amount of over-pressure would break the tips of the tools.

Tools for a Miner's Lamp Hook

The tools for the special hook shown in the center of Fig. 10 are a little out of the ordinary in some respects. In this case there is plenty of room for a separate cutting-off tool, and the wire is cut independent of the front slide. The front die, as usual, makes the main bend and holds the wire against the center die while the left side die comes in to shape the sides of the hook.

The right and back dies are not required for shaping the hook, but they come into play in trimming the end of the hook. It is necessary that the square end of the hook be trimmed off very clean and square. This operation is accomplished by clamping the back slide stationary and mounting on it a hardened blade, the end of which is ground to match the blade on the left slide. The end of the hook is supported from the right slide by a pin that rests against the hook, and moves with the same speed as the trimming blade.

The end of this hook is pointed before being bent. The tools for the pointing are shown in the upper left-hand corner of the illustration. They are located at the cut-off, and come together on the end of the wire exactly like a pair of dies. The dies are relieved around the impressions, so that the excess metal is trimmed off as the point is formed. This method does not produce a very good point, but is satisfactory where a cheap blunt point is required.

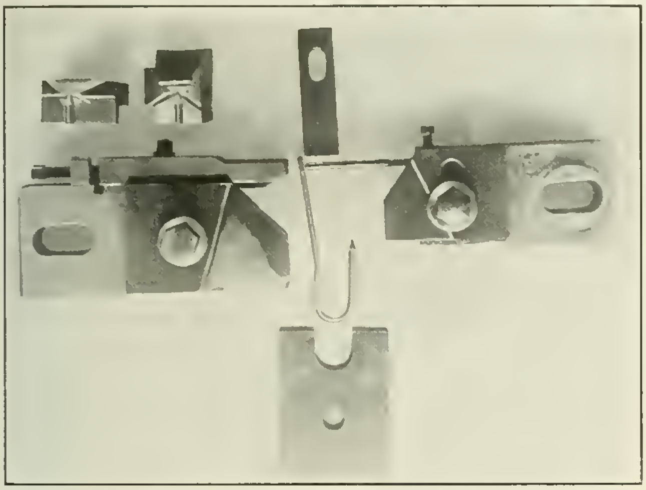
Fig. 10. A Set of Wire-forming Tools for a Miner's Lamp Hook

Tools for Forming a Tag-hook

While none of the wire-forming tools shown are really complicated, the tools shown in Fig. 11 are perhaps a little more intricate than any of the others that have been shown. The piece to be made is of bronze wire, 1/16 inch in diameter, having an eye at one end and a special form of hook at the other. The wire is fed in through the cut-off bushing and cut off as usual. As the wire is cut off the spring plunger in the front slide presses the wire against one of the pins in the center form. Still maintaining this hold, the front slide comes in, making the back side of the hook complete. Then the two side slides, right and left, working together, form the ends of the hook, leaving but little for the back slide to do. As in most wire-forming operations, the operation of the back slide comes last, completing the hook. The three forming pins are held by set-screws, and the work is stripped as previously described.

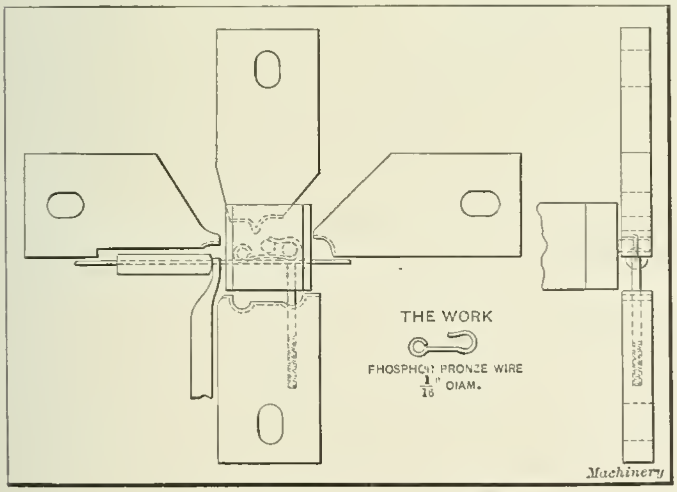

Fig. 11. Tools for Forming a Special Hook

Tools for an Oval Coupling

A set of tools that introduces the use of the movable center arbor is illustrated in Fig. 12. These tools produce the copper coupling shown, using ribbon stock, 7/16 inch wide and 0.030 inch thick. The operation of these tools involves all four slides and the movable center arbor. The object of a moving form is to lessen the risk of breakage on small work in case the adjustments of the slides are not exactly right.

The stock feeds in through the cut-off bushing, and runs in a channel cut in the face of the front die. As soon as it strikes the stop it is cut off and caught by the front die against the center form. At this time the back die is bearing against the center arbor, but as the front die advances, the back die retreats at a slightly slower rate; thus the front die very gradually closes the metal around the front of the arbor. By the time the arbor has reached the limit of its travel, the front die has closed the metal closely around the arbor, and by means of the dwell on the cam, remains stationary for a quarter of a revolution. Meanwhile, the back die recedes a little farther, leaving the rear side of the arbor clear while the two side dies complete the forming of the coupling.

Making Links on a Wire-forming Machine

An ingenious die for making links is shown in Fig. 8. Links may be made by ordinary wire-forming methods, but it is sometimes troublesome to make a perfect joint at the ends of the stock. This method does not make a closed joint, but the ends are exactly in line and the link requires only a slight side twist to make it perfect. Perhaps it would be plainer to say that the links are the same as if produced by winding a close coil and splitting it with a saw, except that there is no stock lost on account of the width of the saw.

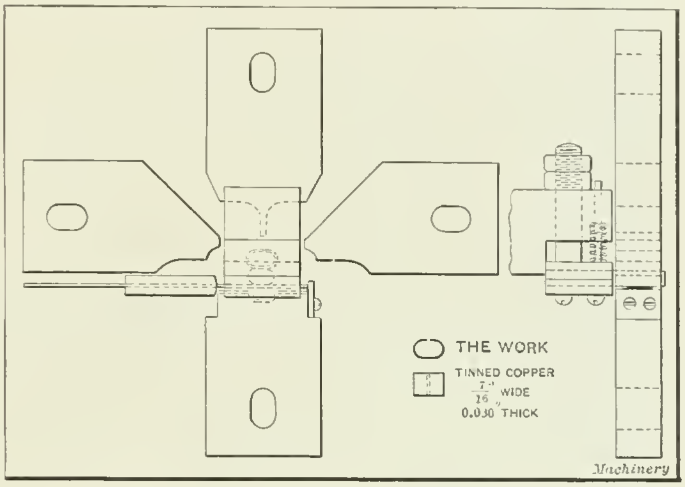

Fig. 12. Tools for Forming an Oval Coupling

The tools for this work are very simple, requiring but one slide for forming, although the front slide is used as a support, being permanently clamped in one position. The essential part of the tools is a block that we may call the center die, fitted to the form holder. This block has a hole running through it lengthwise, and in a portion opposite the tops of the slides, a "thread" is cut with a pitch equal to the distance from one convolution to the next of a close wound coil of the size of the wire. The thread is left-handed, and is cut with a tool having a semi-circular nose of the same size as the wire. At the same height as the first turn of this groove, a hole slightly larger than the wire runs toward the wire feed, tangent to the coil.

Below the two or three turns of the thread a hole is bored out to the body size of the coil. A central arbor of the same diameter as the inside of the link to be formed extends through this hole. The lower end of this arbor is bored out as shown, and a small square opening, slightly larger than the diameter of the wire, is cut in one side. The end of the arbor is hardened and tempered. The arbor is held in its proper position in the block by means of two taper pins. The square opening in the arbor faces the path of the rear die, and a clearance hole is made in the enclosing block to admit the punch that operates on the rear slide. This punch is made of sheet steel, so that it can be easily replaced if broken, and it is closely fitted to the die-opening in the arbor.

The wire is started in the hole leading to the internal groove, and by means of the feed it is advanced one turn plus an additional one-eighth inch. When the back slide comes in, which is the only slide that moves, the punch cuts off this short additional section, thus allowing one ring to drop from the hole. No stock is missing from the circumference of this ring, because enough additional stock has been supplied to make up for the piece cut out. Naturally, these rings may be turned out very fast by this method, for with but one slide working, the machine may be speeded up considerably.

THE BENCH LATHE AND ITS USES

By EDWARD K. HAMMOND*

The modern bench lathe finds wide application in the manufacture of small metal products, such as parts of the mechanism of meters and clocks, and in fine tool work, where its facility of operation and its accuracy make it an ideal tool. The bench lathes have been developed to the same high standard of efficiency as the heavier types of lathes, and the design of various attachments has broadened the field of these machines so that they are able to handle a wide range of work. The operations described in the following are performed on the Cataract precision bench lathes, manufactured by Hardinge Bros., Chicago, Ill. In addition to their adaptation to regular bench lathe work, these machines may be equipped with attachments for milling and grinding, for chasing, cutting, and milling screw threads, and for turret work, filing, and a variety of other operations. Besides building bench lathes and attachments, the Hardinge plant is engaged in the manufacture of watchmen's time clocks and watch-maker's tools, and in a great variety of contract work. Consequently, a description of some of the machining operations handled by bench lathes in this company's shop will show the rapidity and accuracy with which these machines can deal with the work for which they have been designed. Before entering upon the uses of the bench lathe, however, a brief description of the important features in the design of the Cataract lathe will prove of interest.

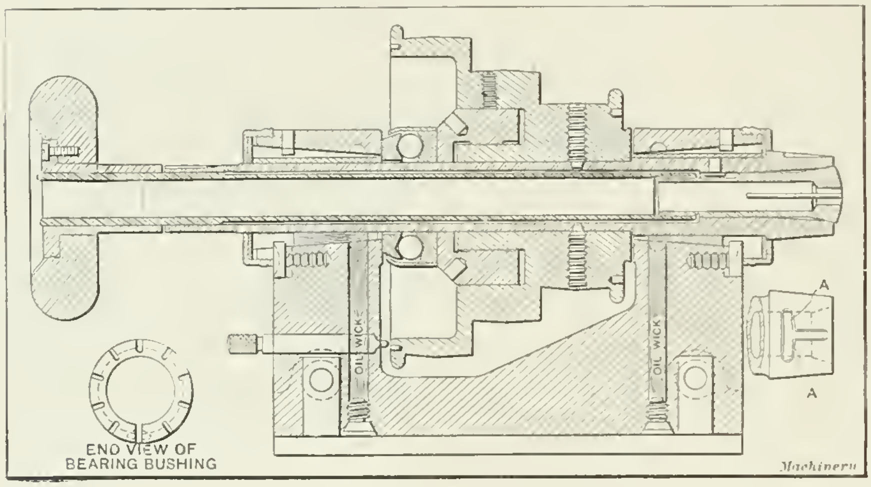

Fig. 1. Cross-sectional View of Bench Lathe Head

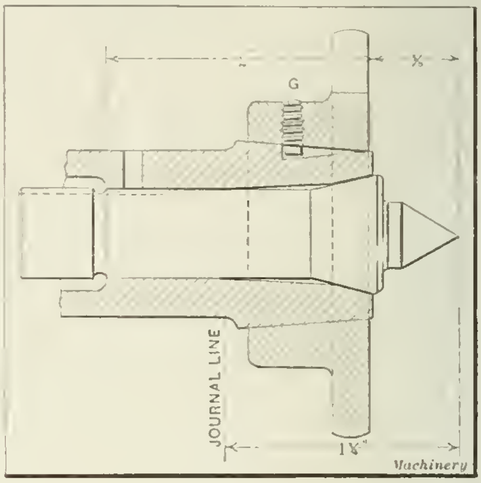

Fig. 2. Detail View of Spindle Nose

In designing machinery, it is important to combine the greatest number of advantages without leaving out any features of vital importance or complicating the machine with unnecessary fixtures. Thus, in the case of the bench lathe, the best equipment is the one which can handle all of the work for which it is required without having any unnecessary attachments. Hence all the parts and attachments should be interchangeable. This enables a shop operating several lathes to use a given attachment on any machine on which it may be required; it also makes it possible for additional fixtures to be purchased from stock at any time.

Experience has shown that a proper countershaft equipment adds greatly to the efficiency of any bench lathe. In order to obtain the best possible results, the countershafts should be mounted on a pipe frame attached to the bench and ceiling. This frame is made of ordinary 1¼-inch gas pipe, threaded at the ends for feet that are bolted to the bench and ceiling. The countershafts used with these frames are designed with sockets which fit the pipe frame, and can be adjusted to any desired point. This makes it possible to use an endless belt for the three speeds of the countershaft and to adjust the belt tension by raising or lowering the countershaft on the vertical supports. With this system, only one belt is required for driving from the line-shaft, whether one, two, or three lathes are mounted on the same bench, and a motor may be attached for independent drive. Another advantage of this system is that the pipe frame offers very little obstruction to the light in cases where the lathes are set up in front of a window to take full advantage of the daylight.

Probably the most important consideration for the user of bench lathes is that of the capacity and strength of the chucks and the spindle which carries them. The spindle must be designed to resist any strain which the gripping power of the chucks may place upon it. It should be of the hollow type in order to permit operating on bar stock.

The hollow spindle of the Cataract lathe is designed for draw-back chucks for handling bar stock, and for jaw chucks and wheel chucks for miscellaneous classes of work. The spindle is designed with the patent nose shown in Fig. 2, which drives either in the right- or left-hand direction. The absence of threads enables the spindle to be hardened and ground true, and as the nose is smooth, it can easily be kept clean. Referring to Fig. 2, key *G* in the chuck is slipped into the keyway in the spindle nose. The chuck is then turned so that the key enters the groove *A*, Fig. 1, which tightens the chuck upon the taper nose of the spindle. The drive is obtained entirely through friction between the spindle nose and the chuck, the key taking no part in the drive after the chuck has been tightened.

Lubrication of the bearings is accomplished by an arrangement of oil cups and wicks as illustrated in Fig. 1. The oil cups are placed at the back of the head and communicate with the bearing through a 9/32-inch hole. This hole contains the wick which terminates in a recess cut in the bottom of the journal. As the oil has to pass up through the wick to reach the bearing, it is always quite clean, the action of the wick being equivalent to that of a filter. By this arrangement, the oil wells are constantly supplying oil to the bearings in just the proper quantity to secure perfect lubrication. The action of this device is so perfect that machines lubricated in this way may be run for at least a month on one supply of oil.

The Use of the Bench Lathe

One of the regular products of the Hardinge factory consists of a brass gear for use on automobile magnetos. As shown in Fig. 3, these gears have four spokes, the space between two of the spokes having sufficient metal left for the holes *A* and *B*. A slot is milled in one of the spokes adjacent to the holes *A* and *B*. The centers of the two holes must be exactly 25 degrees apart, and the center line of the slot must be 45 degrees from a point midway between the holes *A* and *B*.

The regular bench lathe equipment, provided with a compound rest and a three-jaw chuck, is used for the first machining operations on the gear blanks, which are in the form of rough castings. These blanks are machined in lots of several hundred at a time and the first step consists of mounting each successive blank in the chuck, facing one side of the blank and machining the inside of the rim. After this operation has been completed on all the blanks, the jaws of the chuck are adjusted to hold the blank by the machined inside of the rim. While held in this position, the other side of the gear is faced, and the face of the gear machined. The cored hole in the center of the gear is then bored by means of a one-lipped tool held in the lever tailstock. The spindle of this tailstock is designed to hold different tools, and a lever is provided which enables the spindle to be advanced to bring the tool into contact with the work. The compound rest used in these operations has hand feeds with dials reading to 0.001 inch. The two dial feeds enable the entire side of a gear wheel to be machined at one setting, still keeping the dimensions within the most rigid specifications.

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After these machining operations have been completed, the blanks are transferred to a Hardinge automatic gear cutter. This machine is equipped with a special arbor which has been designed to locate the space between two gear teeth exactly opposite the center of the spoke in which the slot is to be cut. This is necessary in order that the slot may be properly located in the jig used in the milling operation. The blanks are mounted on the arbor of the gear cutter in stacks of seven, and after the machine has been started, they require no further attention until the operation is completed.

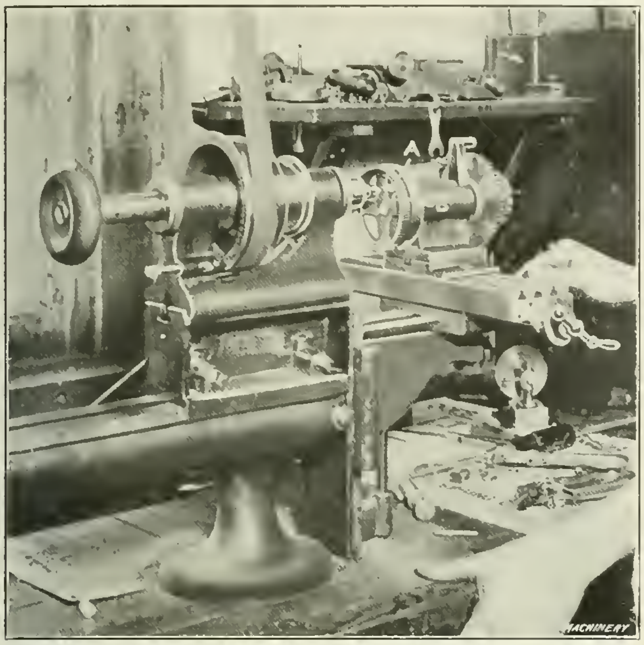

Fig. 3. Boring Holes A and B by the Bench Lathe Milling Attachment

The Milling Attachment

After the teeth have been cut, the work is transferred to a lathe equipped with a milling attachment, as illustrated in Fig. 3. In setting up the milling attachment on the lathe, the frame is mounted at the right-hand end of the bed and is held in position by means of two eccentric-headed bolts. The lathe head is then removed from its usual position and mounted on the frame of the milling attachment. This brings the lathe spindle over the table of the milling attachment, where it serves as the spindle of the milling machine. The countershaft for driving a machine which is to be used with a milling attachment, is provided with a second pulley. This pulley is raised to the proper height above the regular lathe pulley so that the same belt may be used for driving the lathe and the milling attachment. All of the feed-screws of the attachment have independent micrometer dials reading to 0.001 inch. An angular attachment has been provided for use with this milling attachment, which is secured to the faced edge of the table by means of eccentric-headed bolts held in the T-slot. The head and the tailstock of the attachment can be mounted on this, and swung around to any angle with the table, as indicated by the graduated index on the attachment. This enables milling to be done at any angle which may be required.

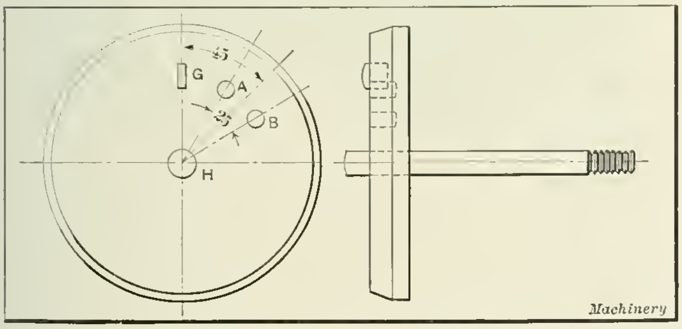

Fig. 4. Jig used for Locating the Holes A and B, Fig. 3

The jig shown diagrammatically in Fig. 6 is used for the first milling operation on the gears, which consists of cutting the slot in the spoke, the jig being used to locate the slot in the proper relation to the holes *A* and *B*. This jig is clamped to the table of the miller. The pin *D* fits into the hole in the center of the gear; second locating pin *E* is situated as shown in the illustration. In mounting the work in this jig, after pin *D* is fitted into the center hole, the gear is rotated until the spoke comes into contact with pin *E*. This brings the gear into approximately the correct position for milling the slot. The final setting is then effected by the locating screw *F*. This screw is advanced into the space between the gear teeth, which was located opposite the center of the spoke when the teeth were cut. The tapered end of the screw acts as a wedge between the teeth and rotates the gear the the required amount to bring the center of the spoke under the milling cutter. The work is then fed up against the milling cutter and the slot is milled.

The next step is to finish the holes *A* and *B*; the jig illustrated in Fig. 4 is used to locate them in the proper relation to each other and to the slot. The jig in this case is mounted in the head of the milling attachment by means of the threaded shank that fits into the draw-in spindle. The gear is carried by the central pin *H*. The pin *G* fits into the slot in the gear spoke and acts as the point of reference in locating holes *A* and *B*. The gear is laid out with a line passing through the slot and the center of the gear, and is then clamped in the jig and the latter rotated until the datum line is perpendicular with the table of the miller. The dividing head is then used to locate hole *A* at 32½ degrees from the slot, and with the gear in this position, the work is traversed to the

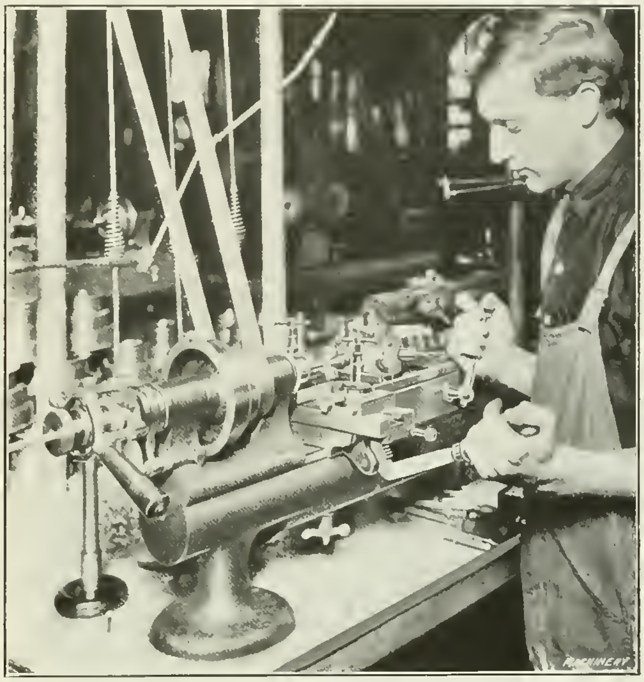

Fig. 5. Bench Lathe equipped with Turret Attachment, Double Tool Cross-slide and Automatic Chuck-closer

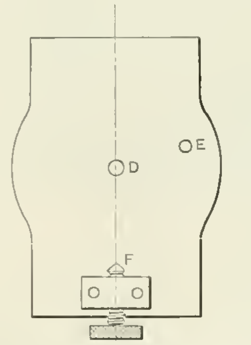

Fig. 6. Jig used when Milling Slot in Gear in Fig. 3

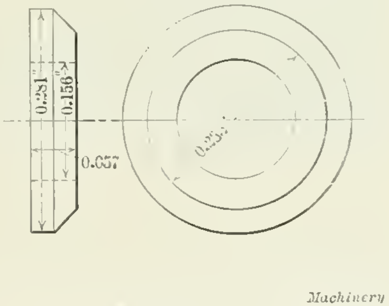

Fig. 7. A Small Brass Washer made on the Turret Lathe

boring tool in the spindle and the hole is bored. The work is then withdrawn from the tool and rotated through another 25 degrees, and hole *B* is bored.

The jig is now removed from the milling attachment and replaced by a wheel chuck of the proper size to hold the gear. The boring tool in the spindle is replaced by a tap, and the central hole in the gear tapped, thus finishing the machining operations.

An Example of Turret Work

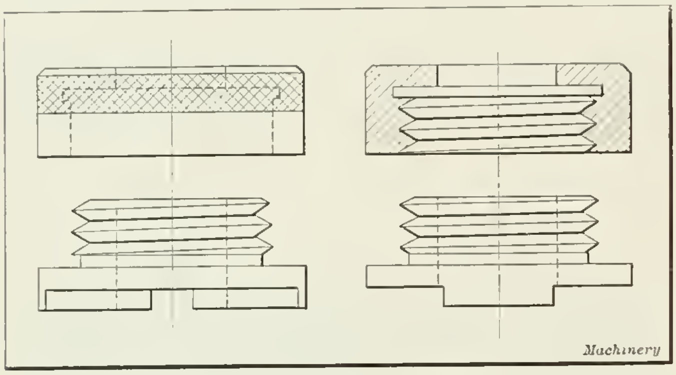

Fig. 8. An Example of Work done by the Chasing Attachment

In the manufacture of small screws, studs, and many other pieces, there is a series of operations, such as centering, drilling, and tapping, where a marked advantage is secured by having a series of tools available for performing successive operations on a piece of work at one setting. In order to meet the requirements of such work, the bench lathes mentioned have been equipped with a six-hole turret attachment and a double tool cross-slide, thus giving the machine a capacity for eight tools. The turret is mounted on a slide and is provided with rack and pinion feed, as this design has been found to be best suited for the requirements of the sensitive work which is done on a turret of this size. An adjustable stop is placed at the back of the slide to check the tools at the desired point, or independent stops may be used for each tool. The double tool cross-slide has a T-slot running across it in which the two toolposts are mounted. Each of the toolposts are secured by two bolts and may be adjusted to any height by means of a threaded block at the base. The cross-feed of the slide is operated by means of a hand lever, and adjustable stops are located at each end of the slide.

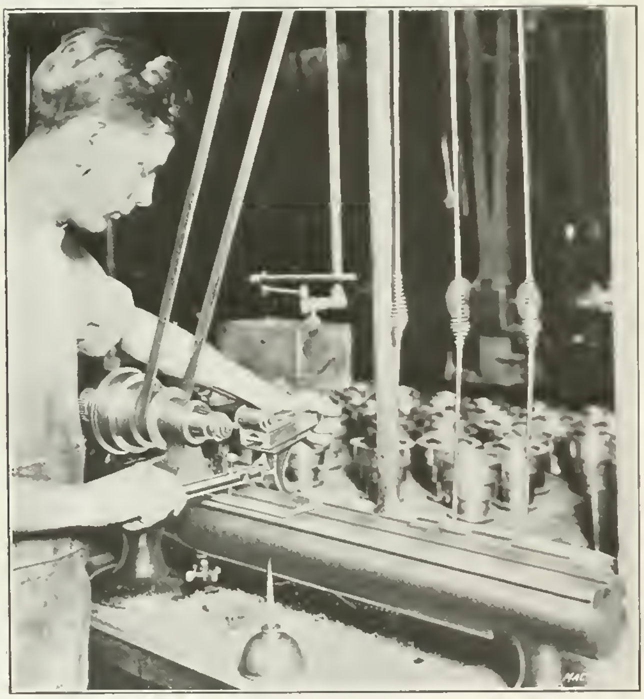

Fig. 9. Bench Lathe equipped for Thread Chasing

An automatic chuck-closer is used in connection with the turret and double tool cross-slide when operating on bar stock. This device is used in place of the regular draw-in spindle, and closes the chuck by simply throwing over a hand lever. The chuck-closer fits over the outside of the spindle at the rear end and is keyed in position. It enables the machine to be run continuously, without stopping to adjust the chuck, the stock being fed through the spindle as required.

A bench lathe equipped with these three attachments is illustrated in Fig. 5. This machine is used for making small brass washers for clock movements, one of which is shown enlarged in Fig. 7; these washers are made from bar stock. Three tools are used in the turret, namely, a stop, a centering tool, and a drill for the hole. A forming tool for beveling the edge of the washer, and a parting tool for cutting it off from the bar, are used in the double tool cross-slide.

With the stock in the spindle and the attachments adjusted, the operator throws over the lever of the turret attachment with his right hand. This brings the stop against the end of the stock and pushes it back through the spindle until the stop on the turret slide is reached. The operator then closes the chuck by throwing over the lever on the automatic chuck-closer with his left hand. He then throws over the lever on the turret to center the stock, and does so a second time to drill the hole. The lever of the double tool cross-slide is then pushed down to bring the forming tool into contact with the work to bevel the washer. The final step then consists of pulling up the lever on the cross-slide to bring the parting tool into action to cut off the finished washer from the bar.

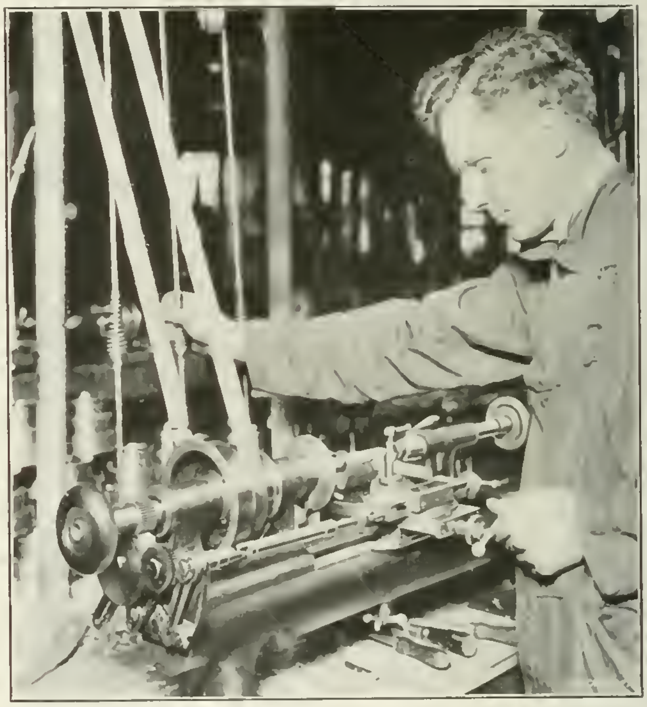

Fig. 10. Cutting a Special Tap with the Screw-cutting Attachment

It will be noticed from the preceding description that the stops on the attachments regulate all of the operations, so that the operator does not have to pay any attention to the dimensions of the work. This greatly increases the output on work of this character. On the operation just described, an average workman can turn out three hundred washers per hour. It is a relatively easy matter to design the necessary tools to handle any given piece of work, and after such tools have been made, a turret lathe equipment of this kind can be used to great advantage in the manufacture of many pieces that are now being produced in a far slower way.

The Chasing Attachment

The chasing attachment which has been designed for use with this bench lathe is bolted to the faced and T-slotted surface at the back of the bed, adjustable brackets and eccentric clamp bolts being used for this purpose. The chasing bar extends the entire length of the bed and is provided with an adjustable collar for governing the position of the cutter when engaging the work. The tool-holder is adjustable along the chasing bar so that it can operate in any position over the bed. This tool-holder carries circular cutters for both inside and outside thread chasing, and has a finely graduated feed-screw for making adjustments. The regular cutters used with this attachment work in a hole of from $\frac{1}{2}$ inch up, but special cutters may be made to chase a thread on the inside of a much smaller hole. The stop collar on the chasing bar may be set so that it stops the cutter at any desired point, and this makes it possible to work a clean thread right up to a shoulder on either inside or outside work. This collar can also be set to prevent the cutter from injuring the thread on the opposite side of a hole when the tool is being withdrawn.

The lead-screw used with this attachment is fluted for a distance of 1 inch from the end, thus forming a hob for cutting the leading nut. In cutting a nut in this way the blank is fastened in the socket carried by the chasing bar, and is then held against the hob, which is driven by the regular gearing provided for driving the attachment. The lead-screw is carried on a geared mandrel, and the lathe can be arranged to cut from one to eight integral multiples of the number of threads on the lead-screw.

This attachment offers a rapid method of cutting threads, as the leading nut can be lifted out of engagement with the screw to allow the tool to be quickly returned by hand to the beginning of the cut, without the necessity of either stopping or reversing the lathe. The attachment is so arranged that it does not interfere with the regular lathe work or with that of any other attachment. Consequently it can always be kept mounted on the machine, where it is ready for immediate use.

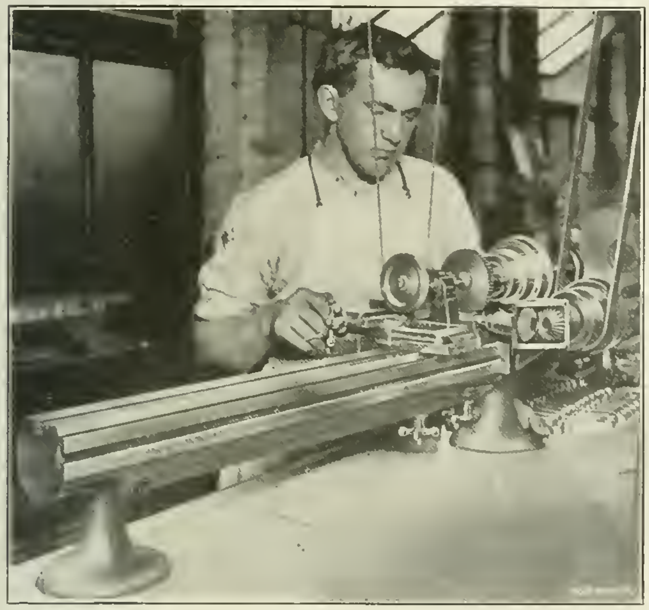
Fig. 11. The Thread Milling Attachment, showing the Driving Mechanism

A description of one job which is regularly handled in the Hardinge factory will explain the use of the attachment. In machining the threaded block shown in Fig. 8, which is used for adjusting the height of the toolposts on the double tool cross-slide, the block is made in two parts. The blanks from which the bases are made are first mounted in a wheel chuck, carried in the spindle of a lathe equipped with a chasing attachment, and the hole for the toolpost is bored and faced. After this operation has been completed the work is mounted on an arbor chuck, where it is faced and necked. The tool-holder on the chasing bar is then adjusted to bring the tool into the proper position and the stop collar is set to check the tool when it has reached the shoulder. After making these adjustments the chasing tool is brought into service, as shown in Fig. 9, and the thread is chased. The work is then transferred to a miller, where the base is milled to fit in the T-slot of the closs-slide. The knurled cap for these blocks is started on a screw machine, which roughs it out on the inside and then cuts the piece off from the bar stock. The work is then transferred to a bench lathe and mounted in a wheel chuck, after which it is bored and necked. The chasing tool is then brought into action and the thread is chased on the inside of the cap. The caps are later mounted on a plug and knurled. After this operation has been completed the caps and bases are screwed together and faced off, thus completing the machining operations.

The Screw Cutting Attachment

The screw cutting attachment used for cutting a great variety of threads is illustrated in Fig. 10, engaged in making a special form of tap. It will be noted from this illustration that the attachment consists of a universal-jointed rod, which is geared to the lathe spindle by gears mounted on a bracket screwed to the end of the bed. Change gears are provided with this attachment which make it possible to cut from 5 to 150 threads per inch. The feed of the tool over the work is obtained by means of the universal-jointed rod, which fits over a nut on the end of the longitudinal feed-screw in the regular compound rest, and as this compound rest may be set to any desired angle by the graduated swivel, it is possible to cut a thread on any taper. The work is held between centers and driven by means of a driving dog and plate, as shown in the illustration.

How the Thread Milling Attachment Operates

The bench lathe equipped with a thread milling attachment has been found especially useful for milling small worms, threaded parts of meters, and for a variety of other similar work. This attachment is illustrated in Fig. 11, engaged in threading a part of a meter mechanism. The lathe equipped for screw cutting, as illustrated in Fig. 10, provides for the feed of the milling cutter, which is carried on a spindle running in a bearing bolted to the top of the compound rest. The driving pulley on this spindle is belted to a pulley on the countershaft, as indicated in the illustration. The speed of the work is regulated by the worm-wheel mounted on the lathe spindle nose. This worm-wheel is driven by a worm which in its turn is driven by the pair of bevel gears and a cone pulley belted to the countershaft, as shown. The bracket which carries the bevel gears and cone pulley is held in the same T-slot that carries the thread chasing attachment.

An automatic stop is provided which can be set to throw the worm out of engagement with the wheel and thus stop the feed of the cutter at any desired point. A little ingenuity on the part of the mechanic will enable him to vary the minor details of this equipment so that he can accomplish anything in thread milling within the capacity of the machine.

* * *

UNIT COSTS OF CONCRETE BUILDINGS OF VARIOUS TYPES

Lockwood, Greene & Co., architects and engineers for industrial plants, Boston and Chicago, estimate the approximate unit costs of reinforced concrete buildings of various types as per the figures in the table below. These figures coming from a firm that has had such an extensive experience in this line are of more than usual value.

Type of Building	Dimensions	Live Load, Pounds per Sq. Ft.	Cost above Foundation		Cost including Foundation	
			Sq. Ft.	Cu. Ft.	Sq. Ft.	Cu. Ft.
Mch. Shop..	120x50 4 sto.	150	$1.05	$0.08	$1.17	$0.09
Mch. Shop..	220x100 1 sto. sawtooth skylights		1.65	0.09	1.75	0.10
Cartridge Factory...	223x56 2 sto.	300	1.40	0.09	1.55	0.10
Cotton Mill.	550x129 2 sto.	75	0.99	0.07	1.06	0.075
Weave Shed	341x231 1 sto. sawtooth skylights	125	1.66	0.064	1.79	0.07
Power Ho...	90x62		2.53	0.115	2.67	0.12
Store Ho....	181x56 4 sto.	150	1.08	0.065	1.15	0.07
Store Ho....	256x100 12 sto.	150	0.90	0.09	0.98	0.105
Store Ho....	223x56 2 sto.	300 and 1000	1.20	0.08	1.35	0.09

Coal pockets above 3000 ton capacity cost from $6.00 to $7.50 per ton. Reinforced concrete stand-pipes above the foundation cost from 2½ to 3 cents per gallon.

* * *

An English contemporary mentions that of every $100 paid for employers' liability insurance in Germany, $77.70 is returned to injured workers or their dependents; $9.50 goes to a relief fund; and only $12.80 is used for the administration of the insurance funds.

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FEBRUARY, 1912

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MACHINERY is published in four editions. The practical work of the shop is thoroughly covered in the Shop Edition, $1.00 a year, which comprises approximately 700 reading pages. The Engineering Edition—$2.00 a year, coated paper, $2.50—contains all the matter in the Shop Edition, about 300 pages a year of additional matter and forty-eight 6 x 9 Data Sheets filled with condensed data on machine design, engineering practice and shop work. The Foreign Edition, $3.00 a year, comprises the same matter as the Engineering. The Railway Edition, $2.00 a year, is a special edition including a variety of matter for railway shop work—same size as Engineering and same number of Data Sheets.

MAKING STEEL BALLS

The series of articles on steel ball making, beginning in this number, should be of unusual interest to all classes of readers because of the common use of the product. Written by an engineer of international reputation they have all that which goes with the work of an acknowledged authority. Mr. Grant is the designer of the principal machines used in making and finishing balls, and has equipped the principal ball making plants in America and several abroad. His father, a well-known machine tool designer and builder, did pioneer work in ball-making and has ably assisted in the development of ball-making machinery.

To make a steel ball polished and spherical within one-ten-thousandth inch limits, is no easy task. We doubt that any toolmaker using the common machine tools can make a one-inch steel ball, hardened, tempered, polished, free from all flaws and perfectly spherical within these limits. But granted that it can be done, attempt the more difficult task of making a one-fourth inch ball, and when that is accomplished, let the expert try making a thousand—nay, a hundred thousand. This is manifestly a class of work that absolutely requires special machinery—machinery of a type unlike the common machine tools used for the most difficult and accurate toolmaking.

The paucity of published matter on ball-making and the inherent interest of the machines and methods make these articles notable contributions to the science of mechanical engineering. MACHINERY feels honored in being selected as the journal fitted to present these articles.

* * *

THE "EFFICIENCY ENGINEER"

The last decade has been marked by the development of the investigating spirit in engineering work with reference to the promotion of greater efficiency of men and methods. This development was early given the name of "scientific management," simply because the elements of production were segregated and classified. The term is unfortunate in that it causes many who pass snap judgment on everything new to them to consider it as being something impracticable and unsuited to ordinary factory conditions. As a matter of fact, so-called "scientific management" is simply engineering skill applied to specific problems for the purpose of securing higher efficiency. It secures higher efficiency by eliminating unnecessary movements, providing proper tools, giving simple and accurate directions, and paying workmen higher wages.

Now if "scientific management" is a misnomer, how much more so is the term "efficiency engineer." The natural assumption is that a new race of engineers has been developed whose sole idea is efficiency. But any engineer worthy of the name must prove his efficiency. His training is, or should be, such as will enable him to produce a desired result easier, quicker, cheaper and better than the untrained man. Why then should any engineer arrogate to himself the magic word "efficiency" when to deserve the appelation is, and always has been, the desire of the ambitious engineer?

Of course a different order of experience and executive ability is required to carry on the manufacture of typewriters, for instance, than to erect a steel frame building, and the system of management may differ widely in details—but not in principle. No doubt certain engineers can specialize advantageously on certain phases of management, but with the famous definition of Tredgold: "Engineering is the art of organizing and directing men and controlling the forces and materials of nature for the benefit of the human race" before them, let them take some other special name than "efficiency engineers."

* * *

A MODERN CONCEPTION OF BUSINESS

The ethics of a horse trade are too well known to need description. It is *caveat emptor*—let the buyer or trader beware. The old idea of a business deal was the same; once consumated, there was no backing out. The buyer had to be content with his purchase, no matter how badly it fitted his needs. When the modern department store principle of "money back if not satisfied" was introduced, it meant more than a mere departure from the established methods of selling dry-goods or groceries. It embodied a new system of trade ethics that is destined to permeate every avenue of trade and business relation.

In the engineering world the idea is gaining ground that the selling of machines or apparatus is the selling of service. If the machine does not meet the buyer's need he has not secured the service that he wanted, and it is up to the concern to give it to him. Some go so far as to make the apparatus a secondary matter. They contract to furnish a service, and the concrete form in which it will be delivered may not be known to anyone when the contract is made, and becomes known only after those particular needs are studied in detail and a service to fit them has been planned.

The machine tool business lacks somewhat of homogeneity in rendering complete service. Jones sells Brown a boring mill, Smith sells him a lathe, Gray sells him a milling machine, and so on. Finally Brown has an aggregation of tools more or less well fitted to his particular needs, depending upon his ability as an organizer and engineer. What Brown wants is not a machine shop as such, but a means of securing a result; it may be the building of steam engines or cream separators. How can he get the best service? Only from the cooperation of those who specialize in the making of machine tools with a full appreciation of the proper relation of their tools to other machines and the general conditions of shop practice.

* * *

THE JOURNEYMAN

Years ago the approved method of learning a trade was to indenture the apprentice for a term of years, during which he was virtually the chattel of his master. He worked for no pay, save his board and clothes, and in some cases even paid a premium for the privilege of serving an arduous apprenticeship. When his time was served he became a journeyman, that is, one who traveled from shop to shop to gain experience and knowledge of methods not taught or known in his master's shop. These were years of privation and hardship, but they were endured to the end that he might become a master workman.

The tradition still survives that a mechanic must work in more than one shop to be a good all-around workman; and it is largely true, but the necessity for a man to travel to know the mechanical world no longer exists. Some of the ablest mechanics have worked in a few shops or in only one, but they have an advantage—a means of education—that the old-time workman did not possess, and that is the trade journal. The modern trade journal of the best type brings to him the news of the world of trade, and gives him an outlook that he could never acquire by simply traveling from shop to shop.

But unfortunately not all men are fitted to absorb from the printed page what they would readily mentally grasp in concrete form. That which fits them is early education. Hence the importance of continuation schools and other educational means that inculcate habits of reading and understanding in apprentices. The workman who can read a blueprint, a trade catalogue, or a technical journal has at his command the elements necessary for success in his calling, if his personal equation is of that quality which commands common respect.

* * *

SAVING TIME IN MACHINE WORK

The laying of bricks is one of the oldest arts dating back into the past. Until the last decade no one had the temerity to intimate to the skilled and conservative bricklayer that there was even a remote possibility of conserving his effort, making his work easier and enabling him to lay more bricks in a day. But it was done by Gilbreth, who devised ways and means for cutting out movements of the hand and body.

This lesson has not been lost on mechanical engineers. The fact that even a bricklayer's work can be simplified, made easier and more productive by eliminating motions not absolutely necessary, has set many minds at work.

In drilling holes, for example, the operator must pick up the piece, lay it on the table, clamp it in place, seize the spindle lever and pull the drill down to the work; and throw in the feed. When the hole is drilled the movements are repeated in reverse order. Now the handling of the work by the operator may be regarded as absolutely necessary in most cases, but a drilling machine can readily be made to perform automatically the functions of lowering the spindle, feeding the drill, throwing out the feed and raising the spindle, and rotating a turntable carrying the work parts.

The carrying out of that idea has resulted in a drilling machine in which all the functions are automatically performed so far as the movements of the drill, feed mechanisms and table are concerned. The work of the operator is simplified to almost the last degree, being the placing of parts on the revolving table, clamping in place, unclamping and removing the drilled pieces.

The example has much significance, and while the principle is by no means new, it has not yet been carried out to the extent that practicable and economical design calls for.

* * *

PLANETARY REDUCING GEARS

A form of back or reducing gear that has been used frequently in machine construction is that having a spur gear meshing with two or more compound gears mounted on a spider, which, in turn, mesh with a smaller spur gear on the driving shaft. When the spider is locked stationary, the speed of the driven shaft is reduced in the continued ratio of the driving gear, the compound gears and the driven gear. When the gears are locked and the spider is released, the driving pulley and the gears and shaft revolve as one.

While on the face this form of reducing gearing appears to have the advantages of compactness and outward simplicity, it is not to be generally commended. In the first place the construction is essentially weak. The space available for the reduction gears is small, and an adequate support for the bearing studs is not available—that is, support for both ends of the studs. Another and perhaps more serious fault is the difficulty of setting the studs so that all the gears carry their due proportion of the load, the result commonly being that one gear carries the larger part of the load until destructive wear has developed.

Of course it will be objected that in the first-class construction the setting of the gear studs will be properly done, but unless jigs and fixtures of rather costly construction are provided, it is not so easy to accomplish as it might seem. Where reducing gears of this form are made in comparatively small numbers, the methods common to the job shop are likely to be employed—with the resulting deficiencies mentioned.

* * *

A MACHINE SHOP WITHOUT COMPRESSED AIR

By FRANK RICHARDS*

A month or two ago the writer made a call at a machine shop with which he was quite familiar some twenty-five years ago. It is not a big shop, employing less than one hundred, all told. It was a prosperous business a quarter of a century ago, and it was growing; its prosperity has not deserted it in all these years, but there has been little, if any, growth.

In talking with the superintendent, compressed air was mentioned and the multiplicity and variety of its uses in these days referred to. It then appeared that this shop has absolutely no compressed air in use, nor any means of supplying it. That, to the writer's mind, seemed to explain why the concern had not been growing. A shop needs compressed air in order to develop activity and push. The absence of compressed air implies the lack of other facilities of business which alert management not necessarily "scientific"—brings together for the increase of efficiency and output.

Indeed, there is a single job in that shop which alone would pay for the installation and maintenance of a compressor, receiver, piping and all appurtenances. A single air hoist is all that would be required. There is a special machine built in considerable quantities which, in the assembling, makes necessary the hoisting of two or three rather heavy pieces. In the testing of these machines there are peculiar conditions which make it necessary to take each machine apart and put it together two or three times. Consider what it means to do the hoisting with a chain hoist and trolley on a short run of overhead track. The use of this hand-operated hoist necessitates an additional helper on the job, and it means also much slower movements for the hoisting and lowering operations. Then there are some large machine tools, a big planer, some big lathes, and a boring mill, but there are no air hoists for them—to say nothing of the pneumatic tools, hammers, drills, etc., which the shop would have use for, and the special applications of compressed air which would inevitably develop if the air was handy.

Without going into figures in detail, one dollar a day would liberally cover the interest upon the cost of installation, the maintenance, and the power cost of operating a compressed-air equipment for such a machine shop as has been mentioned. Where is the shop that can afford not to spend the dollar? There is absolutely not the slightest suggestion of experiment in the matter, as the value of compressed air as a shop cost reducer has been demonstrated wherever it has been employed. Its record in this respect is unique. No one has ever heard of any shop once adopting the use of compressed air and afterwards discarding it.

There are, in fact, comparatively few shops now which have not an air compressor as part of the equipment, and where any such shops are found, they are not railroad shops, because in these the handy airbrake pumps, which are far from ideal for general shop use, have provided an opportunity for "sampling" the compressed air service. The railroad shops are, therefore, now among the best customers of the builders of air compressors. Many machine-tool builders assume that there is always a supply of compressed air in the machine shop and design tools with air-actuated movements, thus increasing the efficiency and speed of operation. The shop without compressed air, and the manager who does not believe in compressed air, are shut off from the use of these improved tools. Compressors are now on the market with unlimited range of capacities, adapted to any mode of driving, entirely automatic, and working with all possible economy of power. In urging their wider employment, the writer aims to promote the interest of the machine-shop proprietor more than that of the compressor builder.

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LAYING OUT PROPELLERS*

By OLAF MALVIG†

In the following article is explained a method of laying out propellers which the writer has used at the works of the Trondhjems mekaniske Vaerksted for the last six years. The method has been found very satisfactory, both in the drawing office and in the foundry. Of course any method for developing a screw-thread surface on a plane surface is inexact, but the method explained has been found sufficiently accurate for all practical requirements. Figs. 1 to 3 show the method of laying out the propeller in the drafting-room; Fig. 4 shows an adjustable guide-curve device used for molding propellers; while Fig. 5 shows the details of this device. The guide-curve device has been in use at the works mentioned for the last two years, and has proved very satisfactory as a saver of both time and material. The halftone shows a model guide-curve device, 9 inches long, placed beside a wooden model which represents the propeller mold, and which is marked off from the propeller drawing. Fig. 5 gives the main dimensions for a full-sized device in use in the works. The guide-curve can be adjusted, ready for use, in from 10 to 15 minutes.

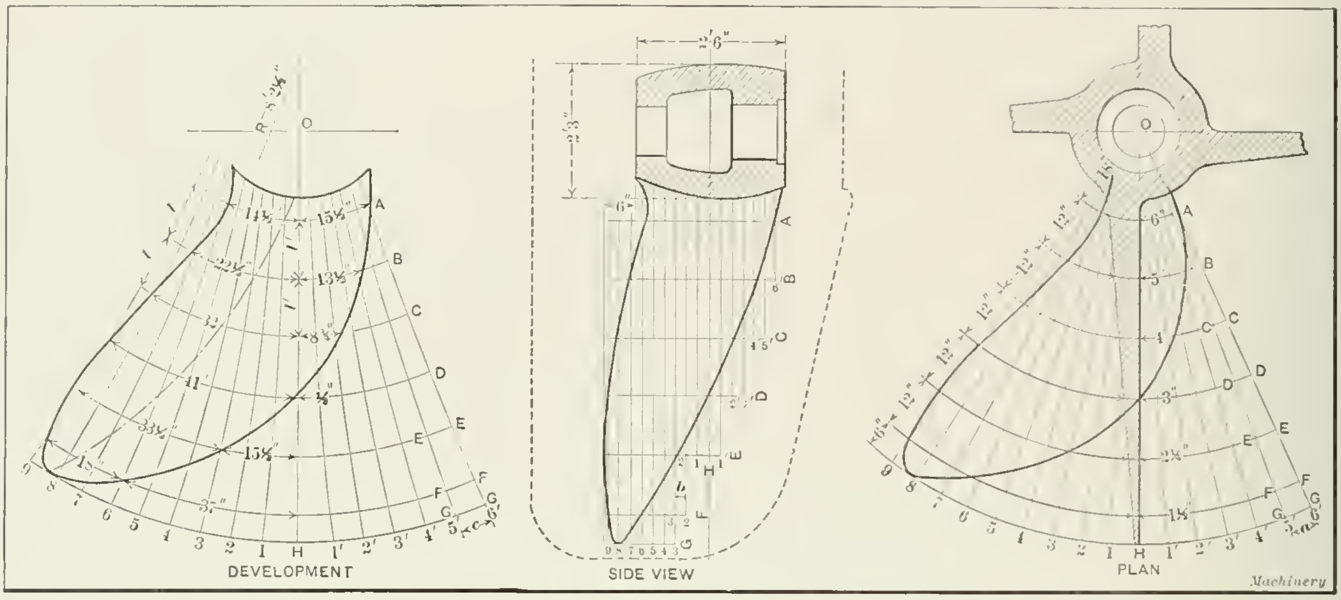
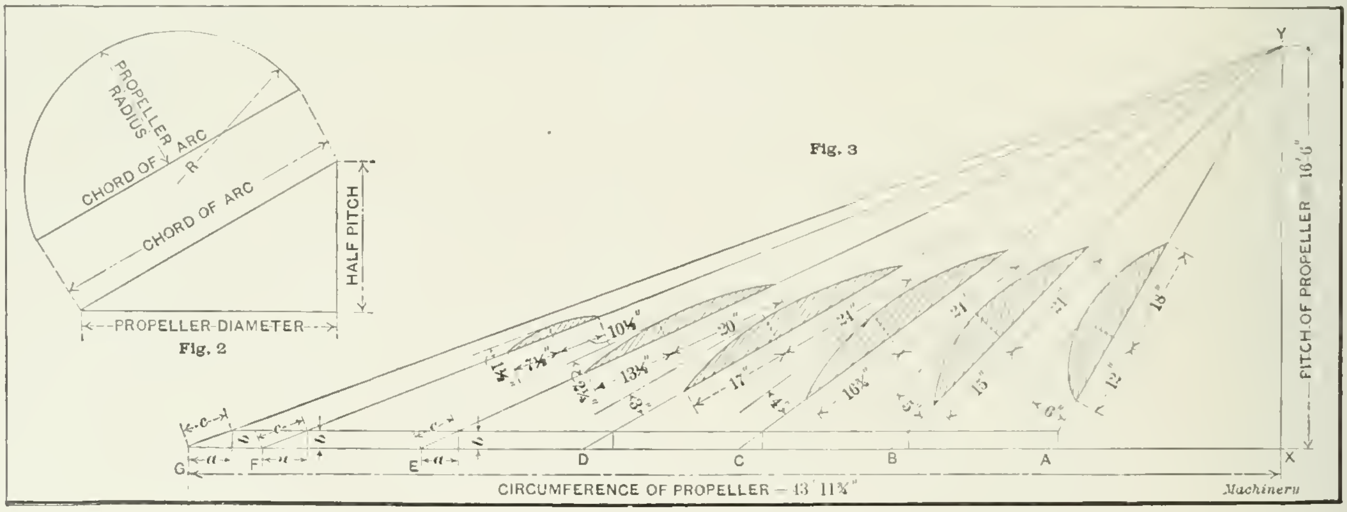


Fig. 1. Development, Side View and Plan of Propeller



Figs. 2 and 3. Method of Laying Out Propellers

The method of laying out the propellers and the use of the guide-curve device can be best explained by reference to a specific example. The dimensions of the propeller to be laid out are supposed to be known. In this case, the diameter is 14 feet, the pitch is 16 feet 6 inches, and the area of the developed surface of the blade 61 square feet. The back-throw abaft the propeller hub is 6 inches.

In the plan, as shown in Fig. 1, first draw a section of the blade and the hub; then draw an arc of a circle *G*, passing through the tip of the blade. Mark off on the radius *OG* any number of points *A*, *B*, *C*, etc., and draw arcs through these points with *O* as a center. On arc *G* set off any number of equal distances 1, 2, 3, etc., and 1′, 2′, 3′, etc., on each side of the center line *OH*, and draw radial lines from the points thus set off. In the present case each of the divisions on arc *G* is 6 inches.

Lay off to any convenient scale the horizontal line *GX*, Fig. 3, which represents the circumference of the propeller at the tips of the blades, and let the distances *AX*, *BX*, *CX*, etc., represent the circumference at points *A*, *B*, *C*, etc., in the plan, Fig. 1. The vertical line *XY*, Fig. 3, represents the pitch of the propeller. Join the points *A*, *B*, *C*, etc., with the point *Y* as shown. These lines show the angle of the propeller blade sections. In the side view, Fig. 1, draw the longitudinal section of the propeller hub and the propeller aperture. The hub must be placed in its proper position in the aperture so that the exact clearance of the propeller can be seen. The aperture is indicated by dotted lines. Also divide the space for the side view of the blade, by vertical lines, into a number of equal spaces corresponding in number to the divisions in the plan.

Set off on the base line at *G*, Fig. 3, any one of the distances on arc *G*, Fig. 1. In the present case, assume that the distance *a* in the plan is transferred as indicated. Distances *b*, Fig. 3, are equal to any of the distances *H*–1, 1–2, 2–3, etc., in the side view. As the propeller has a uniform pitch, the height b will be the same for all the small triangles shown at the base in Fig. 3. The base a of the seven small triangles, however, is equal to the distances *FF*, *EE*, *DD*, etc., on the arcs *F*, *E*, *D*, etc., in the plan view. The hypotenuse c in each of the small triangles is now equal to the distances *GG*, *FF*, *EE*, etc., in the development in Fig. 1.

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* For further information on this and kindred subjects, see MACHINERY, November, 1908, "A Propeller Planing Machine;" November, 1907, "Obtaining the Pitch of a Propeller;" September, 1907, "Laying Out a Propeller;" November, 1903, engineering edition, "Bauer Propeller Blade Shaping Machine;" October, 1903, "A Screw Propeller Planing Machine."

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Next calculate the radius of arc *G* in the development. As is well known, the radius in the development view will not be the same for two propellers of equal diameters if they do not have the same pitch. The easiest way to determine this radius is as follows: Draw a triangle, as shown in Fig. 2, where the base equals the diameter of the propeller, and the height equals one-half the pitch. The hypotenuse of this triangle will then be equal to the chord of an arc, the versed sine of which equals the radius of the propeller, and the radius of which equals the radius of arc *G* in the development.

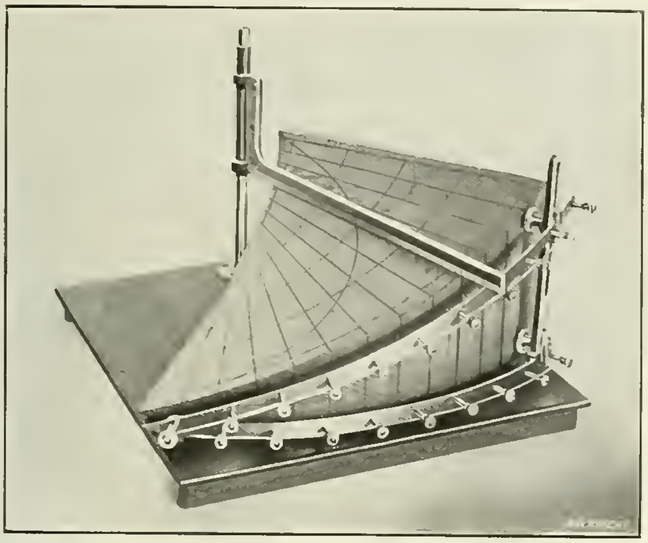


Fig. 4. Model of Guide-curve Device for Molding Propellers

The formulas for the calculation of the radius *G* of the development are as follows (see Fig. 2):

Let C = chord of arc,

D = diameter of propeller,

P = pitch of propeller,

R = radius of development of propeller blade surface.

Then

$$C = \sqrt{D^2 + (\tfrac{1}{2}P)^2}$$

$$R = \frac{(\tfrac{1}{2}C)^2 + (\tfrac{1}{2}D)^2}{D}$$

The radii for arcs *A*, *B*, *C*, etc., in the development, Fig. 1, are determined in a similar manner. In the development, the same center can be used for all seven arcs if the pitch is small, but for large pitches, it is necessary to move the center upwards for the smaller arcs, otherwise the distances 1 will be somewhat longer than distances 1′, as the lines in the development are not radial. Set off a sufficient number of distances 1, 2, 3, etc., and 1′, 2′, 3′, etc., on both sides of the center line *OH* in the development. Set off on the arcs *A*, *B*, *C*, etc., the distances c as found from Fig. 3, c being the hypotenuse of the seven small triangles, as already explained. Through the points thus determined draw slightly curved lines which represent the radial lines in the plan and the vertical lines in the side view. Then, in the development sketch in, by free hand, the propeller blade to about the required shape, and measure the area by a planimeter. Small alterations may have to be made in order to get the right area.

On the radial lines in the plan and the vertical lines in the side view, mark off the points where the contour of the blade crosses the radial lines in the development, and then, by free hand, sketch in the contour of the blade through these points, so as to get the shape of the blade in the plan and side view. It must be remembered that the shape of the blade in the side view is not what it would appear to the eye, but is the exact opening required for the blade when revolving. The curve of the propeller hub in the development is found by taking the vertical distances between the horizontal line *A* and the propeller hub in the side view.

The use of the guide-curve for laying out propeller blades in the foundry from the drawings will be apparent from the illustration of the device itself.

* * *

RECORD OF AUTOMATIC SPRINKLERS

The development of concrete and hollow tile building construction, with the attendant development of means of limiting fires to restricted areas, such as fire walls, automatic self-closing doors and windows, etc., have made it possible to construct buildings which can be relied upon to resist fire to a very great extent. In the ordinary case, however, the same measure of protection has not been afforded the contents of the building, and we occasionally see a structure which is considered absolutely fireproof, but which has been completely gutted, and left with simply bare walls. The development of automatic sprinklers has reached such a point, however, as to make it possible to give the contents of a fireproof building the very highest degree of protection, and to insure that whatever fire may start from spontaneous combustion, or any other source, will be confined to a very limited area, and in most cases entirely extinguished without human aid. The record of the automatic sprinkler is already absolutely clear so far as preventing the spread of fires is concerned. In 1911, 96.6 per cent of all fires under sprinklers were absolutely prevented from spreading, and most of the failures were due to the fact that the apparatus had been tampered with.

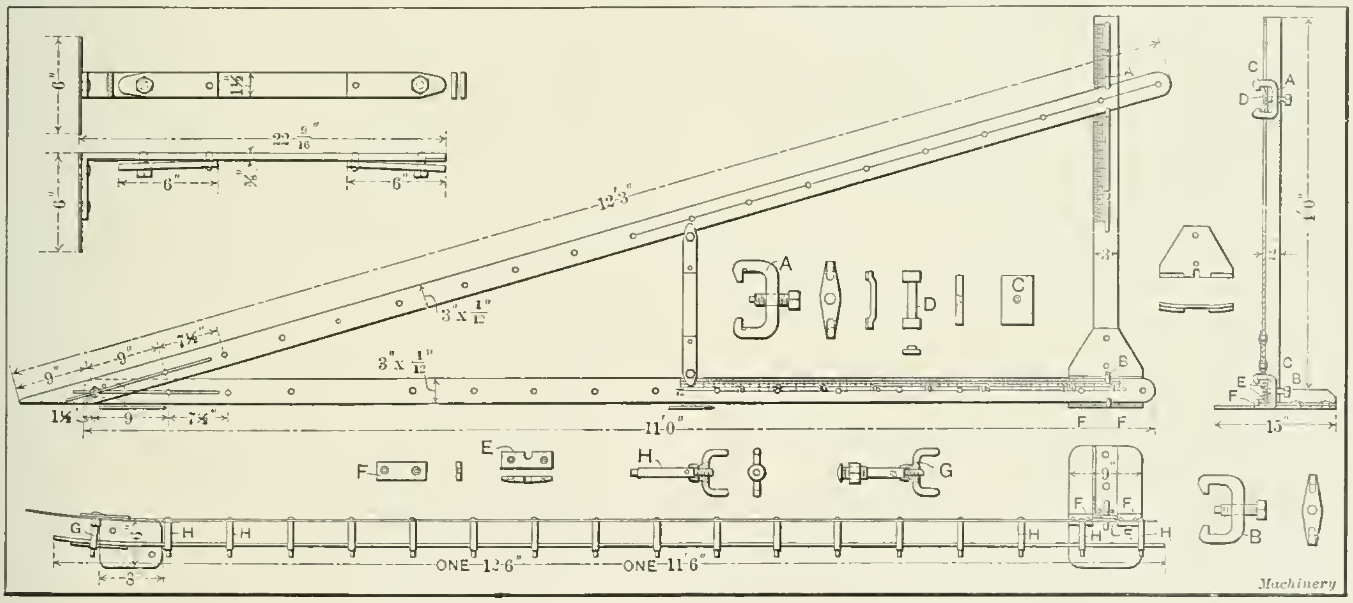
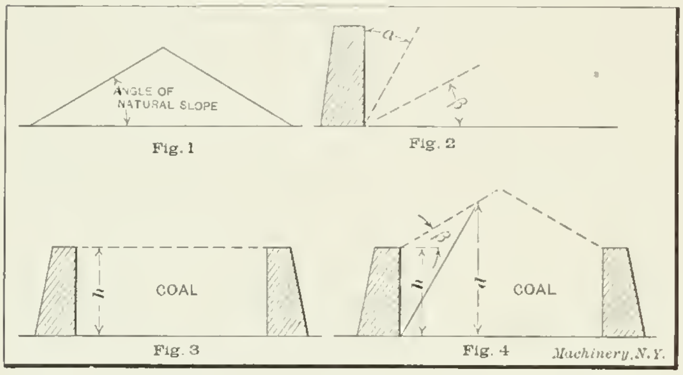


Fig. 5. Details of Full-size Device made on Same Principle as that illustrated in Fig. 4

PRESSURE OF COAL ON STORAGE BIN WALLS*

When designing storage bins for coal or other material of similar nature, the first factor to be determined is the pressure of the coal against the retaining walls. Owing to the fact that there is a certain amount of friction between the individual pieces of coal, this pressure cannot be considered or calculated the same as would the pressure of water or any other fluid contained in a bin or reservoir.

If coal is stored on a floor or other horizontal surface in a pile not constrained at the sides, it will assume a cone shape as indicated in Fig. 1. The angle which the sides of the cone form with a horizontal plane depends upon the kind of coal stored and, to some extent, upon the size of the coal. "The angle of repose" is then the angle which a pile of coal will assume when not constrained by retaining walls. For anthracite coal it may be assumed to have an average value of 27 degrees and for bituminous coal an average value of 35 degrees.



Figs. 1 to 4. Angles used in Formulae for Calculating Pressure on Storage Bin Walls, and Different Methods of Storing Coal

This angle is the basis of the calculation of the horizontal pressure upon the walls exerted by coal contained in a storage bin.

In the formula for calculating the horizontal pressure on the retaining wall per foot of length, the angle α, Fig. 2, is used. This angle is one-half of the angle which the line of repose or natural slope line makes with the vertical, hence:

$$\alpha = \frac{90^\circ - \beta}{2}$$

β being the angle of repose. In the case of anthracite coal we then have:

$$\alpha = \frac{90^\circ - 27^\circ}{2} = 31 \text{ degrees } 30 \text{ minutes,}$$

and in the case of bituminous coal:

$$\alpha = \frac{90^\circ - 35^\circ}{2} = 27 \text{ degrees } 30 \text{ minutes.}$$

Coal can be stored in a bin either with the top surface horizontal, as shown in Fig. 3, or with the top surface cone-shaped, as shown in Fig. 4. The pressure upon the retaining wall evidently is greater in the cases shown in Fig. 4 than in that shown in Fig. 3. The formula for the total pressure on the retaining wall per foot of length for a bin containing coal with the surface horizontal, as shown in Fig. 3, is:

$$P = \frac{wh^2}{2} \tan^2 \alpha$$

in which

P = total pressure per foot of length on retaining wall, in pounds,

w = weight of coal per cubic foot, in pounds,

h = height of retaining wall, in feet,

α = angle as shown in Fig. 2 = 31 degrees 30 minutes for anthracite coal, and 27 degrees 30 minutes for bituminous coal.

The weight w per cubic foot may be assumed as 52 pounds for anthracite coal and 47 pounds for bituminous coal.

The pressure upon the retaining wall when the coal is stored as indicated in Fig. 4, is obtained by the same formula as that used for bins with the coal surface horizontal except that instead of the factor h^2 in the formula, a value equal to 1.454 h^2 for anthracite coal, and a value equal to 1.574 h^2 for bituminous coal is used. The formula then is:

$$P = \frac{w \times 1.454\, h^2}{2} \tan 31^\circ\ 30' \text{ for anthracite coal, and}$$

$$P = \frac{w \times 1.574\, h^2}{2} \tan 27^\circ\ 30' \text{ for bituminous coal.}$$

The constants 1.454 and 1.574 express the ratios between d and h in Fig. 4 for anthracite and bituminous coal, respectively. These ratios can be applied directly only when the angles of slope remain 27 and 35 degrees, respectively.

The tables in the accompanying Data Sheet Supplement have been calculated by means of the formulas given. The column giving the pressure on the lowest foot is obtained by subtracting the total pressure for a wall one foot lower in height, from the total pressure for the wall under consideration. For example, if the pressure on the lowest foot of a wall 10 feet high is to be calculated, subtract the total pressure for a 9-foot wall from the total pressure for a 10-foot wall. Hence, for anthracite coal with the surface horizontal:

$$978 - 792 = 186 \text{ pounds,}$$

which value, it will be found, agrees with that given in the accompanying Data Sheet Supplement.

* * *

MULTIPLICATION TABLE FOR RIVET SPACING*

It is well known that the most tedious and difficult mathematical operation is simple addition. Hardly anyone but a trained accountant can add a column of figures and be sure the result is correct with the first trial. When the numbers include fractions the difficulty of accurately adding them is greatly increased. It follows, then, that in laying out a series of rivet holes for chain riveting, great care must be taken to avoid serious mistakes, especially when the spacing is expressed in fractions of an inch and there are several holes. Considerable time is required to accurately determine a series of spacings, and it is, therefore, highly important to have convenient means for facilitating the work of the draftsman and checkers of the drawings. It is customary to provide multiplication tables of rivet spaces for the use of designers of bridges, structural steel work, and other classes of fabricated shapes. The tables given in the Data Sheet Supplement, are examples of rivet multiplication tables calculated for spaces ranging from 1⅛ inch to 5¾ inches, varying by eighths up to and including 2½ inches, and by fourths from 2½ inches up to and including 5¾ inches. The number of spaces runs from 1 to 30.

The use of the table is practically self-evident. For example, suppose that eight rivet holes, 1⅜ inch pitch, are to be laid out. In the table under 1⅜ we find the total distance 9⅝ inches opposite 7. The overall distance, center to center, of the first and eighth hole is, therefore, 9⅝ inches. Again find the overall distance, center to center, of 12 rivets, 1⅝ inch spacing. Under 1⅝ and opposite 11 we find the overall space to be 1 foot, 5⅞ inches.

* * *

An interesting departure intended to aid in equalizing the demand on the electric power station during most of the hours of the day, has been put in force in the town of Sköfde, Sweden, which receives its current from the Trollhättan hydro-electric power station. During the hours of daylight a rate of only 1.35 cent per K. W. hour is charged, while during the night hours the rate is 9.4 cents per K. W. hour. This duplex rate has been adopted in order to stimulate the use of electricity for power purposes and for household use, other than lighting, the electric current being used in that case during the hours of daylight when the cheaper rate is in force. The consular report from which this information is obtained does not state what provisions are made for metering the current used at the various hours of the day.

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* With Data Sheet Supplement.

* With Data Sheet Supplement.

SHARPENING MILLING CUTTERS

By F. B. JACOBS[*]

Who has not read of the marvelous results attained by the manufacturers of milling machines, as set forth in their advertisements in the leading trade papers? These test records are, of course, made under the most favorable conditions, on new machines with new cutters and arbors, and under the supervision of men skilled in the art of teaching others how to cut down the cost of production. In everyday practice, where the conditions are not so favorable, it is impossible to duplicate the production records thus set forth. However, the average shop superintendent can come closer than he does at present by looking more carefully after the milling cutters, arbors, etc.

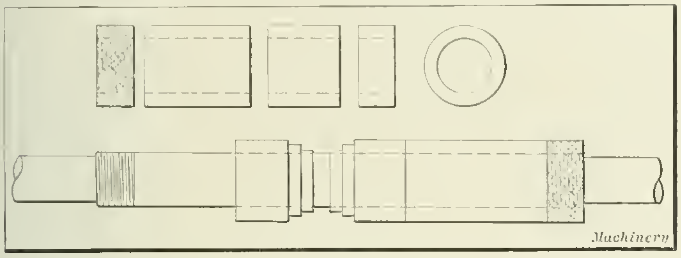

Fig. 1. Arbor and Sleeves used for Holding Cutter in Cutter Grinder

Care of the Milling Machine

The spindle boxes should always be adjusted fairly close—so close, in fact, that they will warm up while using the machine on the highest speed with the back-gears out. A loose spindle causes chattering, inaccurate work, and various other troubles. Be sure that the taper hole in the spindle is free from scores and burrs. To insure this, take an ordinary milling machine arbor, place it between the centers of the lathe, and test it with an indicator to see that both the body and shank run true. Then place it in the milling machine and test again. If it does not run true, remove any scores or burrs that are in the taper hole with a scraper and test again. The chances are that the arbor will now run true; if not, the spindle is either sprung or worn out of round. In this case the machine should be given a thorough overhauling or consigned to the scrap heap, as it is the poorest kind of economy to try to attain accurate results with worn-out tools.

Short, stubby arbors should be used in preference to long ones when it is practical to do so, as a short arbor is not as easily sprung. If an arbor runs out more than 0.002 inch, the machine cannot be depended on to produce its maximum output. Before driving the arbor home, the operator should clean the hole in the spindle with a piece of waste and take the precaution to see that there are no burrs on the shank of the arbor; if there are, they should be removed by draw-filing with a medium fine file.

Milling Cutters

Milling cutters, for some reason, seem to receive very little care. Go into any machine shop and listen to the milling cutters at work; four or five teeth will be heard to take a very heavy cut, and then there will be an interval of silence until the spindle has made a revolution and brings the high teeth into the work again. This condition is caused by dirt in the taper of the spindle, burrs on the shank of the arbor, arbor out of true, cutter out of round, or a combination of all these evils. It causes a few teeth to do all the work, whereas if all of the teeth did their share of the work, this would mean longer life for the cutter and a better quality of the work turned out. End mills generally run out of true because they invariably are sprung in taking heavy cuts, and in re-sharpening they are nearly always located from the centers instead of from the shank, as they should be.

Cutter Sharpening

While the sharpening of milling cutters does not call for special skill or the services of a toolmaker, great care should be exercised in the selection of the wheels for this purpose. Wheels for cutter sharpening should be of a medium soft grade and not too fine—never finer than 60 grit. Fine wheels cut slowly and will burn the teeth unless the operator is very careful. Wheels for sharpening cutters made of high-speed steel can be a little coarser than those used on carbon steel. It is well to have two sets of wheels and use each for the purpose intended.

It should be remembered that the softer a wheel is, the faster it will cut; but if the wheel is too soft, it will wear away rapidly, which makes it difficult to keep the cutter round while sharpening it. This difficulty can be overcome by using a wider wheel, above ¾ inch, instead of the ⅜- or ½-inch wheels commonly used. A wide soft wheel will last as long as a narrow one in a harder grade, and being of a softer

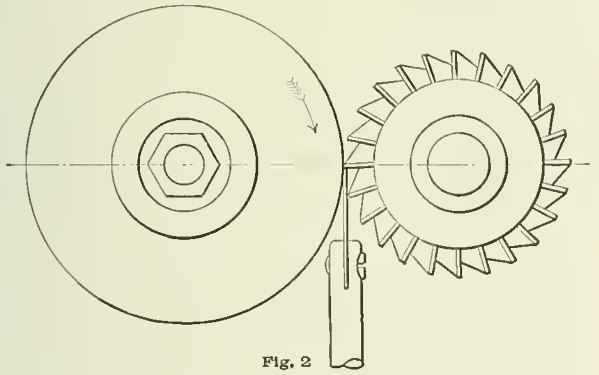

Fig. 2

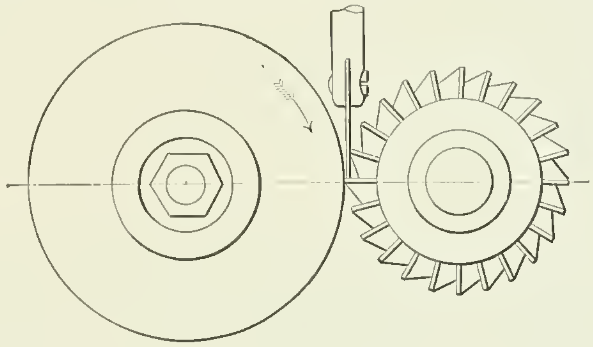

Fig. 3

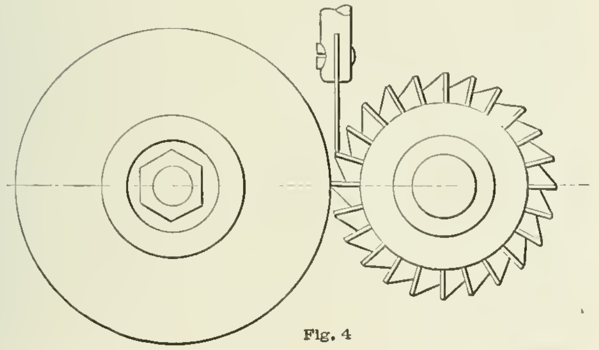

Fig. 4

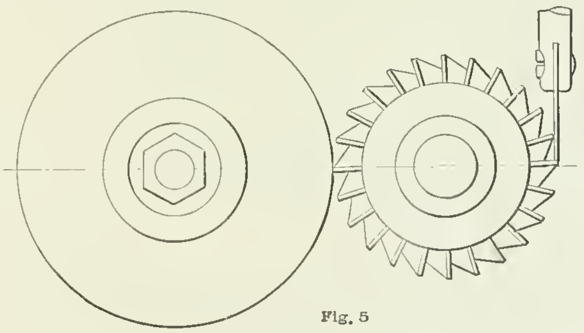

Fig. 5

Figs. 2 and 3. Correct Position of Guide Finger.

Figs. 4 and 5. Incorrect Position of Guide Finger grade, it tends to eliminate the danger of burning. For the sharpening of ordinary milling cutters a wide wheel will not be as inconvenient as it may seem, as there is generally plenty of room on each side of the wheel to pass the cutter.

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The best way to hold ordinary milling cutters for sharpening is to mount them on a sleeve made for this purpose. (See Fig. 1.) These sleeves are used in many machine shops. They slide on a round bar held in the cutter grinder, and if the bar is straight, it is evident that the teeth of the cutter will be ground parallel. Cutters can, of course, be placed on an ordinary mandrel or arbor held between the centers of the cutter grinder. If this method is used it is well to be certain that the mandrel runs true and that the centers are in line with the ways of the machine, otherwise the teeth of the cutter will not be parallel. Since it takes a great deal of cutting and trying to determine this, it is best to use the other method when possible, as it is more rapid and reliable.

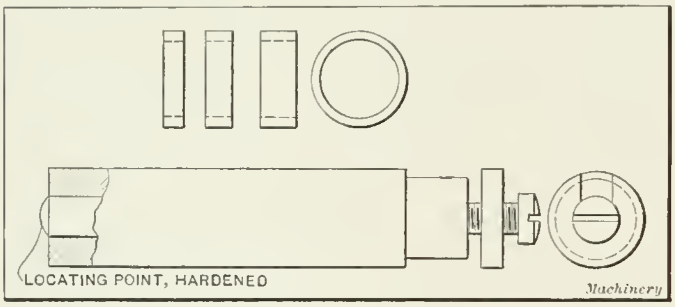


Fig. 6. Arbor used when Sharpening Side Teeth of Milling Cutters

Cutters can be sharpened on the periphery of a disk wheel, as in Fig. 2, or on the side of a cup wheel. Some operators prefer to use a cup wheel for this purpose, because the periphery of a regular wheel leaves the teeth concave, thereby causing them to become dull sooner than they would if they were ground on the side of a cup wheel. However, if the wheel is not under three inches in diameter, it will not grind the teeth enough concave to cause trouble, and the disk wheel will do the work quicker.

The wheel may be run with relation to the tooth as shown in Fig. 2, or in the opposite direction, as shown in Fig. 3. It is considered more convenient to run the wheel as in Fig. 2, as the pull of the wheel helps to hold the tooth firmly onto the guiding finger. Running the wheel in this direction throws up a burr on the edge of the tooth which should be removed by stoning. If the wheel is run as shown in Fig. 3, it will grind smoother and a heavier cut can be taken without so much danger of burning, but it must be remembered that the direction of rotation of the wheel has a tendency to pull the tooth away from the guiding finger. Therefore, care has to be exercised in holding the cutter in position, as any carelessness will result in a spoiled tooth and, sometimes, in a broken wheel. If the operator is inexperienced it is safer to run the wheel as in Fig. 2. With an experienced operator, however, more and better work can be produced by running the wheel the other way.

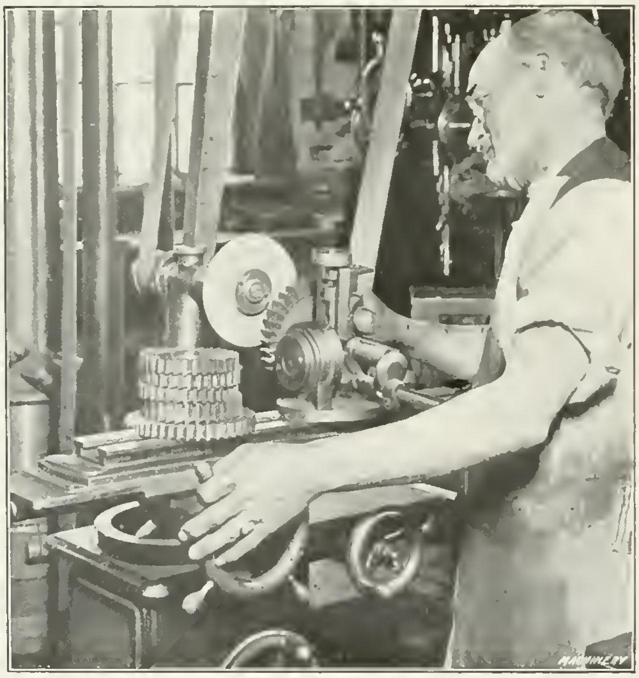


Fig. 7. Sharpening Side Milling Cutters

In sharpening, the teeth should be guided by a steel finger clamped close to the face, and enough off center to give the proper clearance. (See Fig. 3). Milling cutters need very little clearance; too much clearance invariably causes them to chatter and to soon become dull. It is hard to give any set rule for determining the amount of clearance, owing to varying shop conditions, but a clearance of five degrees is generally considered satisfactory. The guiding finger should always bear on the tooth that is being sharpened (see Figs. 2 and 3) instead of on one tooth below or on the other side of the cutter. While it is sometimes more convenient to locate the guiding finger one tooth below or on the other side of the cutter, this practice is often the cause of cutters having some of their teeth under the true cutting circle. Incorrect positions are shown in Figs. 4 and 5.

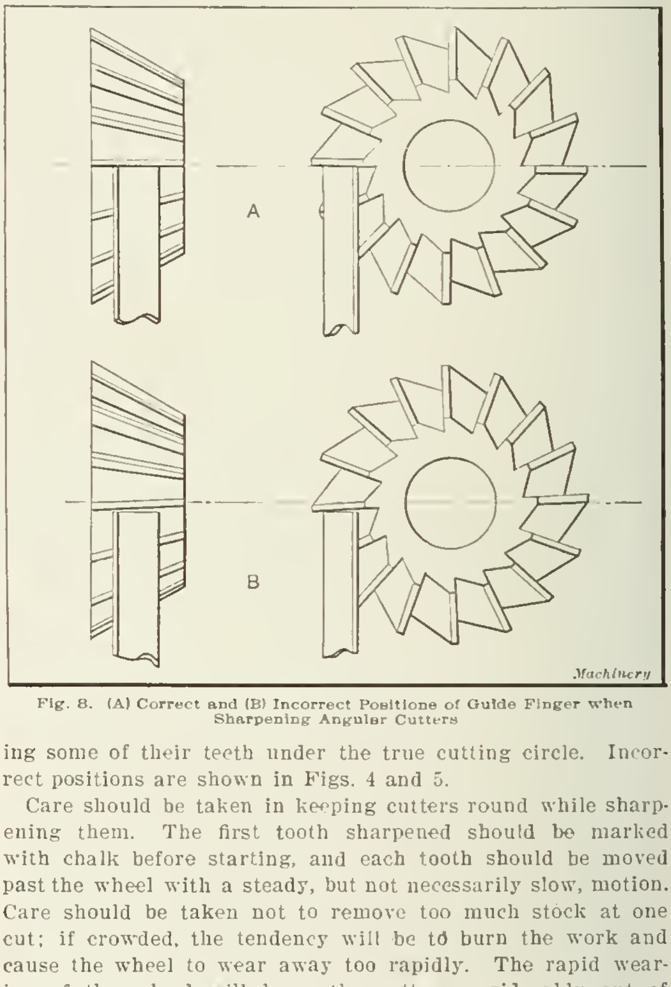


Fig. 8. (A) Correct and (B) Incorrect Positions of Guide Finger when Sharpening Angular Cutters

Care should be taken in keeping cutters round while sharpening them. The first tooth sharpened should be marked with chalk before starting, and each tooth should be moved past the wheel with a steady, but not necessarily slow, motion. Care should be taken not to remove too much stock at one cut; if crowded, the tendency will be to burn the work and cause the wheel to wear away too rapidly. The rapid wearing of the wheel will leave the cutter considerably out of round. Under favorable conditions a cut of 0.003 inch can be taken without burning the teeth or wearing the wheel away enough to cause the cutter to be out of round more than 0.001 inch. A slight error of this kind is corrected in the finishing cut. The operator should finish up with a light cut, say 0.001 inch deep, and before removing the cutter, he should make sure that it is round. This is easily determined by the manner in which the teeth "spark" on the wheel.

Sharpening End Mills

When re-sharpening, end mills should never be held between centers, even if it appears to be the easier way. They should always be located from the shank, because end mills are almost always out of true after having been used a few times, and for this reason the teeth cannot be brought concentric with the shank if the mill is held between centers. All makers of cutter grinders should provide suitable collets for this purpose to fit the swivel head of the machine.

The swivel head must be in line with the ways of the machine, otherwise the teeth will not be parallel with each other. The work should be calipered at both ends with a micrometer to make sure that it is straight. The same wheels can be used for this work that are used for sharpening ordinary milling cutters, and the process is much the same. In sharpening spiral mills or cutters, the operator should see that the guiding finger bears evenly on the tooth as otherwise it will be difficult to keep the teeth parallel.

Sharpening the Side Teeth

The side teeth of milling cutters require very little attention after they have been backed off when the cutter is new. They are generally sharpened by being held on a straight arbor with one end turned down so as to bring the cutter up to a shoulder. A screw and washer hold the cutter in position. (See Fig. 6.) In Fig. 7 the arbor for holding the cutter rests in a V in the cutter sharpening head which is set over to an angle of five degrees to give the proper clearance to the teeth.

The teeth are sharpened by feeding them past the face of a disk or cup wheel. A wheel for this purpose should be very free cutting; otherwise the teeth will be burned and thus ruined. As a general rule the side of a wheel is never as free cutting as the periphery, and for this reason the depth of cut should seldom be over 0.002 inch deep. It is best to run the wheel towards the edge of the tooth as this helps to overcome the danger of burning.

Angular Cutters

Angular cutters should be sharpened by placing them on a mandrel or arbor which will fit the swivel head of the cutter grinder. The head should be set by its graduations to give the proper angle. In sharpening cutters of this kind, the guiding finger must be set exactly on the center, otherwise the proper angle cannot be maintained. The angle for clearance, in this case, is obtained by raising the wheel or lowering the swivel head, according to the design of the machine. In no case should the guiding finger be set below the center. Many machinists overlook this important point which is the cause of many angular cutters being inaccurate and unfit for close work. (See Fig. 8.)

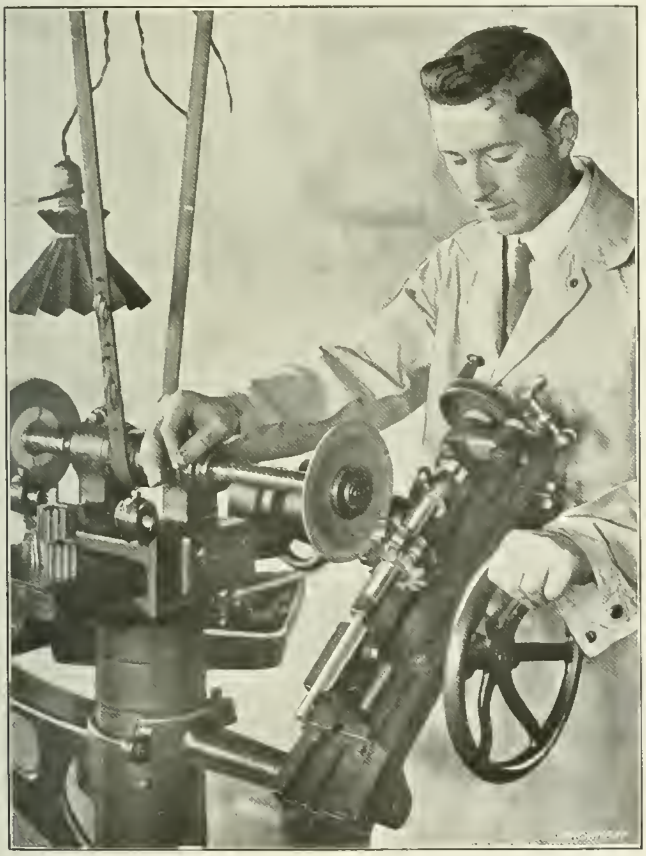


Fig. 9. Grinding Form Cutters, by means of a Form Cutter Grinding Attachment

Form Cutters

Form cutters are without doubt the most difficult cutters to sharpen properly, as all of the grinding has to be done on the side of a disk wheel. One way to sharpen form cutters is on a surface grinding machine, using for this purpose the dividing centers with which it is generally equipped. Another, and perhaps a more convenient way, is with a form cutter grinding attachment as shown in Fig. 9. The accurate spacing of the teeth must be maintained under all conditions, or else all of the teeth will not cut; and as form cutters have comparatively few teeth, it is best to have all of them in working condition. This makes it necessary to remove the same amount from each tooth (providing the spacing is accurate) every time the cutter is ground, regardless of whether all of the teeth are dull or not. If some of the teeth are dull and some sharp it may be caused by the teeth having been inaccurately spaced in a previous grinding operation, or it may be that the cutter has been used on an arbor that did not run true.

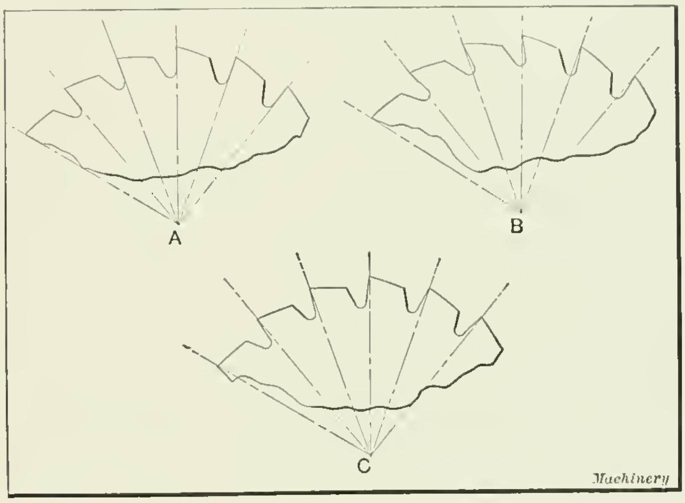


Fig. 10. Correct and Incorrect Methods of Grinding Form Cutters

In setting up the grinder for this operation, the cutting side of the wheel should run true and should be directly in line with the centers. If the wheel is set off center, the cutter will not mill the shape that it was designed for. This is one of the first principles as regards form tools, and one that should be rigidly adhered to. A form cutter that has been sharpened off center will not mill the shape for which it was designed for the same reason that an ordinary thread tool will not cut a sixty degree thread if set above or below center.

After the wheel has been set, its position relative to the centers should not be disturbed. For this reason the work should be brought to the wheel by slightly adjusting the arm that carries the index pin. If the wheel has to be dressed during the grinding operation it should be set central again before proceeding with the work.

Each tooth should be ground evenly and carefully with a comparatively light cut, as a heavy cut will burn the teeth. The operator should bear in mind the fact that it takes time and patience to properly sharpen form cutters. Never under any circumstances should it be attempted to do the work by hand, as is sometimes done with gear cutters.

In Fig. 10 are shown some form-cutter teeth. The correct form of tooth, as shown at *A*, has its cutting face parallel with a line drawn from the center to the periphery of the cutter. Illustrations *B* and *C* show the so-called "hook" and "drag" teeth. As will be seen, the faces of these teeth are at an angle with a line drawn from the center to the periphery of the cutter. These teeth will not mill the shape for which the cutter was designed.

Truing Wheels

Wheels for cutter sharpening operations should run true to produce the best results, and should be dressed at the first sign of glazing; otherwise burned teeth will be the result. A diamond tool is generally used for this process, although a carborundum brick, 20 grit, H grade, which costs as many cents as a diamond does dollars, will be found to answer the purpose in a very satisfactory manner.

Wheels for Cutter Sharpening

Wheels for cutter sharpening should be properly taken care of and not thrown about at random to collect oil and dirt.

When not in use, they should be kept in a place by themselves with their grading tags tacked over them for reference. Following is a list of "Aloxite" wheels that the writer has used for cutter sharpening operations with excellent results. To give the best results the wheels should be run at a surface speed of 5000 feet per minute.

For carbon steel mills and cutters, 50 grit, O grade, D496 bond.
For high-speed steel mills and cutters, 40 grit, O grade, D496 bond.
For carbon steel form cutters, 50 grit, P grade, D495 bond.
For high-speed steel form cutters, 40 grit, P grade, D495 bond.

These grits, grades and bonds will be found satisfactory in nearly every case. If the operator meets with any difficulties that he cannot overcome, he should not hesitate to take up the matter with the wheel manufacturers.

* * *

DESIGNING ENGINEERS ON STRIKE

In the September, 1910, number of MACHINERY reference was made to the unfavorable conditions under which technically trained men in Germany work. These conditions have caused German engineers, designers and others with technical training to combine into societies similar to trade unions, one of which now has 17,500 members and another 29,500 members. One of these societies has now begun to take active steps to improve the conditions of the members, following closely the methods of the trade unions. Since October 1, about 250 engineers and designers, including nearly ninety per cent of all those employed in the structural steel branch in Berlin are on strike. The main requirements of the striking engineers are as follows: An eight-hour day with one-half hour's allowance for lunch, and six hours Saturday; over-time to be paid at the rate of 1/200 of the monthly salary plus thirty per cent; vacations with pay to be allowed—ten days after six months' service, two weeks after one year's service, and two days additional for each year until the vacation period amounts to three weeks; wages to be paid in case of performance of military duty not exceeding eight weeks; inventions to be the property of the inventor. The employers, not willing to accept these conditions, have made the following propositions: A straight eight-hour day, exclusive of lunch hour; eight hours over-time per month without compensation; over-time above this limit to be paid at the hourly rate plus twenty per cent; vacations to be given only after one year's full service; length of vacation to be one week during the first three years and later two weeks; in case of military service full pay for two weeks if the employe has been employed a full year; employes who have been in the firm's employ a considerable time (exact time not stated) are, in addition, entitled to half pay for a period not exceeding a total of eight weeks; all invention to be the property of the employer; any paid employment after hours, or any public office of trust, can be engaged in or held only after written permission has been obtained from the firm. The engineers consider these conditions impossible of acceptance. In other parts of Germany the employers have already begun to break up the organizations of the engineers and designers by aggressive methods.

* * *

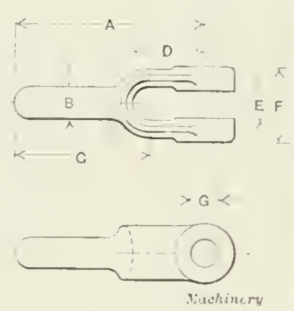
VANALIUM

Aluminum alloys, alleged to have the strength, ductility and other characteristics of steel are becoming very numerous. The *Railway Engineer* (London) tells of a new and remarkable alloy which has been brought out in Great Britain and which is supplied at a price of from thirty-two to thirty-six cents a pound. It has the lightness of aluminum, the ease in working of gun metal, and a stiffness and tensile strength approaching that of wrought iron and mild steel. It can easily be cast, forged, rolled into sheets, spun and drawn into tubes, rods and wire. When cast, it is not brittle like cast iron. The tensile strength is over 22,000 pounds per square inch, with six per cent elongation. Drawn vanalium will withstand a tensile stress of up to 66,000 pounds per square inch. The color of the metal is white and it takes a high polish. Its melting point is about 1200 degrees F.

STANDARD YOKE AND EYE-ROD ENDS FOR AUTOMOBILES

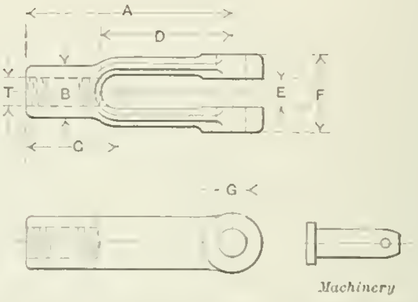
In the Data Sheet Supplement of the October, 1909, number of MACHINERY, were given tables of standard yoke and eye-rod ends, as adopted by the Association of Licensed Automobile Manufacturers, known as the A. L. A. M. standards. The Society of Automobile Engineers is now issuing leaflets giving the mechanical standards recommended by its professional committees and accepted by the society. This body of engineers is the custodian of the standards formerly established by the Association of Licensed Automobile Manufacturers. One of the standards formerly established, which has proved less successful, was that for the yoke and eye-rod ends, and the new society has therefore adopted a new set of standards to supersede those previously agreed upon. The scope of the standards has been somewhat increased, the general design has been improved, and the dimensions of the various parts have been changed to better meet the results of the experience during the last years. The accompanying tables give the dimensions as now definitely adopted. All the considerations involved have received adequate study.

TABLE I. PLAIN YOKE ENDS



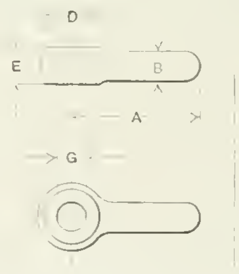
A	B	C	D	E	F	G
1¼	3/16	7/8	7/16	3/16	7/16	3/16
1¾	¼	1 ¼	5/8	9/32	5/8	¼
2	5/16	1 3/8	¾	11/32	¾	5/16
2⅛	3/8	1 7/16	27/32	7/16	7/8	3/8
2¼	7/16	1 ½	1	½	1	7/16
2½	½	1 5/8	1 ⅛	9/16	1 ⅛	½

TABLE II. ADJUSTABLE YOKE ENDS



A	B	C	D	E	F	G	T
1 9/16	5/16	11/16	1	3/16	7/16	3/16	3/16 32 U. S.
2	7/16	7/8	1 ¼	9/32	5/8	¼	¼ 28 A.L.A.M.
2 ¼	½	1	1 7/16	11/32	¾	5/16	5/16 24 A.L.A.M.
2 ½	5/8	1 ⅛	1 5/8	7/16	7/8	3/8	3/8 24 A.L.A.M.
2 7/8	23/32	1 ¼	1 7/8	½	1	7/16	7/16 20 A.L.A.M.
3	13/16	1 7/16	1 7/8	9/16	1 ⅛	½	½ 20 A.L.A.M.

TABLE III. ROD ENDS



A	B	D	E	G
1¼	3/16	3/8	3/16	3/16
1¼	¼	½	9/32	¼
1⅜	5/16	19/32	11/32	5/16
1½	3/8	11/16	7/16	3/8
1½	7/16	13/16	½	7/16
1¾	½	15/16	9/16	½

POINTS IN THE DESIGN OF TWO-STROKE CYCLE ENGINES*

By S. M. HOWELL†

The fact that a large proportion of the gas engines patented within the past decade provide a power impulse at each revolution of the shaft would seem to indicate that the general effort is in the direction of the two-stroke cycle principle; but it is plainly evident that very few of these proposed improvements have found favor with practical designers, and that the two-stroke cycle engine of today is almost the same as originally invented by L. H. Nash some twenty-three years ago, and improved by Shonlein, who took out his Swiss patent in 1891.

Nash was probably the originator of the closed crank-case, since universally adopted, by which the shaft end of the cylinder is used as a pump to force in the air charge. His engine, however, was deficient on account of its tendency to back-fire, and Shonlein to a great extent remedied this defect of the Nash engine by so locating the ports that the exhaust opened in advance of the admission, thus allowing the former free exit, reducing the heat, and relieving the back pressure against the incoming charge. He also discarded the crank-case check valve formerly used, and substituted a third port, operated by the piston, thus completing the so-called three-port engine. Nash was not oblivious of the defect of his engine, and must have recognized the cause, but strangely enough failed to devise the simple expedient by which Shonlein afterward so easily remedied the trouble.

Many of the attempts which have later been made to effect further improvements by the use of additional parts, have fallen short of commercial success for the reason that one of the chief merits of the two-stroke cycle engine is its mechanical simplicity. With good design, and attention to certain details, a satisfactory engine may be secured without such additions, and with only slight modifications of some of the usual accessories.

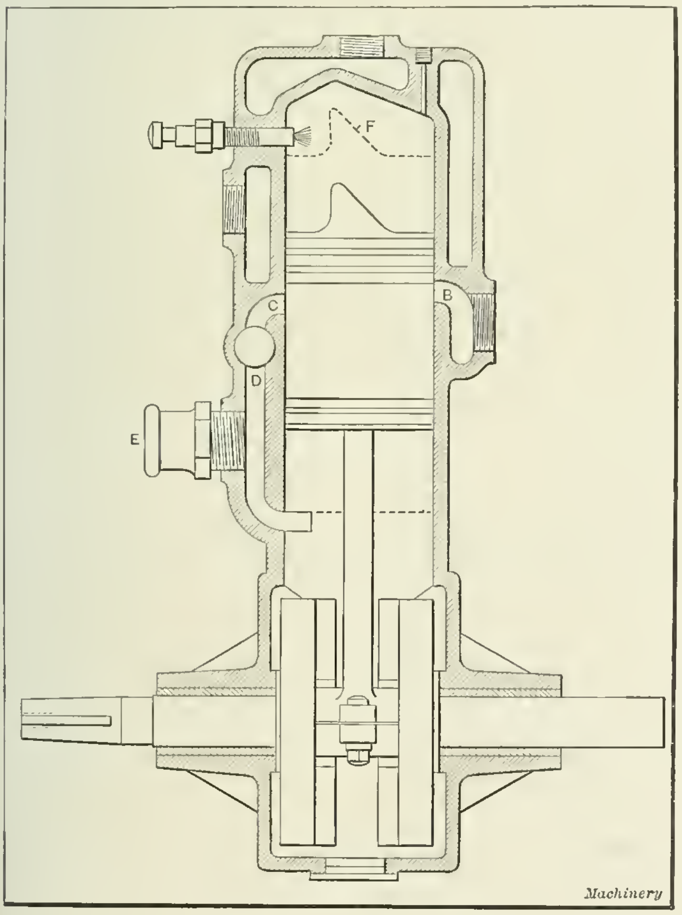
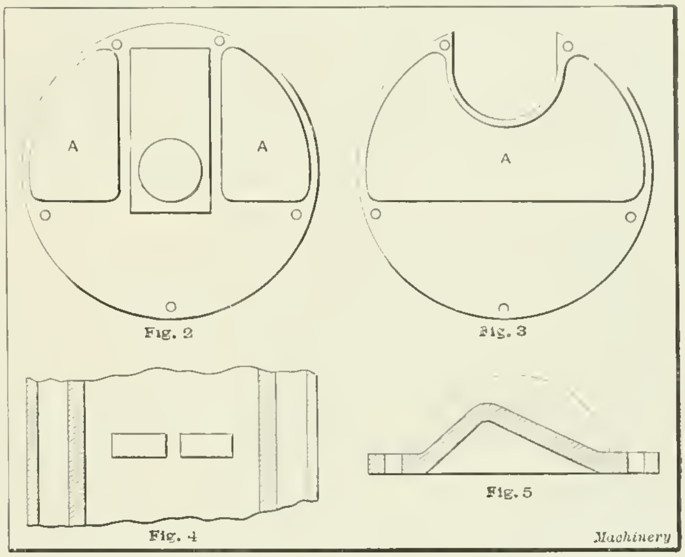


Fig. 1. Section of Two-stroke Cycle Gas Engine

Principles of Satisfactory Design

The reciprocating parts should be counterbalanced as nearly as possible, and the crank-case pressure should be as high as can be readily secured. Both of these important objects may be attained by the use of crank disks of suitable design. The piston deflector should be rather high, with the cylinder head shaped to accommodate it. With this construction the engine will run without undue vibration, and the cylinder will receive a strong charge before which the burnt gases will be driven out without mixing to any great extent with the fresh gas, so that there will be no serious loss of fuel at the exhaust port.



Figs. 2 and 3. The Two Parts of the Disks enclosing the Crankshaft Arms. Fig. 4. View showing Bridge across Inlet and Exhaust Ports. Fig. 5. Cylinder Head for Oil Engines

The igniter should be located on the inlet side of the combustion chamber, in such a position that it will be within the enclosure formed by the deflector and the cylinder wall, when the piston is at the beginning of the power stroke. This space is always filled at the moment of the spark with fresh mixture, which will promptly ignite, no matter how small the charge may be; and this will enable the engine to run regularly, without missing impulses, even at slow speeds with light charges.

The throttle may be placed in the transfer passage, or it should in all events be so situated that the speed or power output may be regulated within wide limits of variation, without disturbing the relative adjustment of air and fuel at the initial intake. The quality of the mixture will then remain practically uniform at all times, while the quantity of fuel used will be proportionate to the development of power. The transfer passage should also contain a screen of wire cloth, or a perforated metal plate, to further provide against back-firing.

The initial intake or crank-case admission may be either the third port, as used by Shonlein, or a check valve. Many recent designers have shown a preference for the latter, and to this extent have reverted to the original practice of Nash. The fact is that in some cases the third port comes in an inconvenient place, and cuts up the cylinder in an undesirable manner. A valve, if used, must be of sufficient size and of light construction, made preferably of aluminum, and operating as nearly as possible without friction. These conditions are easily secured, as the valve works only in cold air, and the pressure will not exceed 10 pounds per square inch at the most. When using gasoline fuel, this valve conjoined to a float chamber with a delivery nozzle constitutes the carbureter.

Examples of Two-stroke Cycle Engine Design

In order to illustrate these principles of design, the accompanying engravings of a vertical two-stroke cycle engine of the valveless type, constructed upon the above lines, are shown. Fig. 1 is an assembled sectional view. This view shows the spark plug and the angular form of the interior head to accommodate the deflector. The dotted line *F* indicates the position of the piston at the beginning of the power stroke. The angular shape of the head also forms a deflecting surface which in conjunction with that of the piston materially aids in the expulsion of the burnt gases, by directing the fresh charge in a body to the top of the cylinder and then downward. This action largely prevents the mixing of the old and new charges. In Fig. 1, *B* is the exhaust port; *C*, the inlet port; *D*, the transfer passage; and *E*, the crank-case air valve or initial inlet.

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* For additional information on this and kindred subjects, see the following articles previously published in MACHINERY: "Flywheels for Internal Combustion Engines," November, 1910, engineering edition; "Cooling Gas Engines," October, 1910, engineering edition; "Clearance Space of Gas Engine Cylinders," July, 1910; "Commercial Ratings for Internal Combustion Engines," "The Calculation of Crankshafts for Internal Combustion Engines," "Light and Reliable Gas Engines," "Carbureters and Vaporizers," and "Suggestions in the Design of Aeronautic Motors," all in April, 1910, engineering edition. See also the articles referred to in foot-notes in connection with the articles in the April, 1910, number, and MACHINERY'S Reference Book No. 65, "Formulas and Constants for Gas Engine Design."

† Address: Oroville, Cal.

The crankshaft is of the usual pattern, but the arms are enclosed in cast-iron disks made to fit over them, and including the necessary counterweights. For convenience in assembling, these disks are made in two parts as shown in Figs. 2 and 3. The hollow spaces *A* are tightly packed with asbestos board. When placed upon the crank arms, the two parts of each disk must be riveted together. These disks, in addition to furnishing the required counterbalance, greatly reduce the clearance of the crank-case, and thereby insure a high degree of initial pressure.

In designing small engines, the speed is usually assumed to be the highest of which the general design is capable in continuous service. Fixing this limit at 750 feet piston speed a minute, the exhaust port area should be one-eighth, and that of the inlet port three-thirty-seconds, of the piston area. These ports should be bridged by a narrow span of solid metal, as shown in Fig. 4. This makes two short openings in the cylinder wall in place of one, and permits the rings to pass smoothly over the ports. The ports should be so located that the exhaust will begin to open when the piston has completed four-fifths of its out-stroke, and should be about two-thirds open when the piston begins to uncover the inlet port, the latter being wide open when the piston has reached the extremity of its outward movement. This gives 80 per cent of the out-stroke to the direct production of power, and more than 30 per cent of the entire revolution for the exchange of the charges, with a lead of two-thirds the width of the exhaust port to clear the cylinder. This rule for port area may be modified somewhat to suit individual conditions, but it is about the usual practice, and the writer found it to be satisfactory in his own experience.

The piston clearance should be so proportioned that the compression will be about 80 pounds gage, or 95 pounds absolute, figured adiabatically. In four-stroke cycle designs the total displacement of the piston is used as the basis of this calculation, but in a two-stroke cycle engine, since compression can not begin before the closure of the exhaust, we must regard the displacement as the contents of the cylinder from the top of the exhaust port to the top line of the piston's travel. Then one-third of this amount will equal the required clearance, and the charge will be reduced to one-fourth of its atmospheric volume at a gage pressure of at least 80 pounds per square inch. Assuming the bore and stroke to be 4½ inches, the piston displacement above the exhaust port would be 57.3 and the clearance 19.1 cubic inches.

A single-cylinder engine thus designed, having a 16-inch flywheel with a 60-pound rim, should run steadily at a piston speed as low as 200 feet a minute, and is capable of a speed as high as 700 feet per minute, or even higher. The average power output should be as much as 0.00012 horsepower per cubic inch of total piston displacement per revolution per minute; or, in a 4½ by 4½ engine, 7 horsepower at a speed of a little over 800 feet per minute.

Changes Required for Oil Engines

The engine as shown in Fig. 1, and so far described, is designed to run on gasoline, drawn into the crank-case through the initial intake with the air; but, by a modification of the cylinder head, the addition of a special injecting device, and a change in the location of the throttle, kerosene distillate or any similar cheap product may be used as fuel. The oil fuel injector is a very ingenious device which has recently come into use, and has been successfully applied to several well-known makes of two-stroke cycle engines.

The principle of this device is as follows: Attached to the outside of the cylinder, adjacent to the inlet port, is a small float-feed cup, closed to the outer air, but connected at its upper part with the crank-case or transfer passage. The oil from the fuel tank is piped to this cup, into which it may flow by gravity, but is prevented from returning by a check or non-return valve, and from overflowing the cup by the action of the float upon a small valve in the usual well-known manner. A tube of small bore leads from the bottom of the feed cup through the cylinder wall, or the wall of the transfer passage, to a nozzle extending into the inlet port, almost into the bore of the cylinder. The area of discharging capacity of this fuel nozzle is controlled by a needle valve, the stem of which terminates in the usual handwheel, accessible from the outside. The adjustment of this valve, however, does not require frequent change. The crank-case handles air only, and the throttle is in the initial intake.

When the inlet port has been uncovered by the piston at the termination of the out-stroke and the beginning of the in-stroke, the pressure within the feed cup (received from the crank-case) forces a charge of the liquid fuel through the nozzle into the cylinder. The oil strikes the deflector and is caught by the entering air from the crank-case and carried upward to the top of the combustion chamber, where it comes in contact with a hot plate, or the heated surface of the cylinder head, and is thereby completely gasified. An interesting feature in the operation of this injector is the fact that it can deliver the fuel only in the interval of admission, that is, when the inlet port is open to receive the air charge. The reason for this is that while the inlet port is covered by the piston, the mouth of the oil nozzle is also in the zone of same pressure as that which is acting within the feed cup, and there is consequently no force to move the oil; but the instant the port opens, the tension at that point is relieved, and as the movement of the oil is parallel with that of the air current, it meets with no resistance.

The throttle consists merely of some means of controlling the lift of the initial intake valve. This, in stationary engines, is accomplished by the action of the governor. In boat engines, a small screw of coarse pitch, having a lever handle, may be arranged to bear upon the valve or its stem, and thus regulate the admission of air to the crank-case. The regulation of speed is effected solely by the manipulation of this throttle to reduce or increase the crank-case pressure; and since the quantity of oil ejected from the nozzle depends directly upon the pressure in the feed cup (and this is always equal to that of the crank-case), it follows that a change of air pressure by a movement of the throttle will be accompanied by a corresponding change in the amount of oil delivered, and the resulting mixture will be of same quality as before.

A modification of this device draws the oil into the feed cup by the vacuum of the crank-case when the piston rises, and this obviates the necessity of elevating the fuel tank above the engine. As an engine cannot easily be started on oil alone, the arrangement should also include a small container for a few ounces of gasoline, to be used until the parts are hot enough to vaporize the oil. The change from gasoline to oil is usually made by means of a three-way cock. Patents have been secured upon combinations covering certain specific methods of construction which embody this system of fuel oil injection, but the principle cannot be broadly claimed.

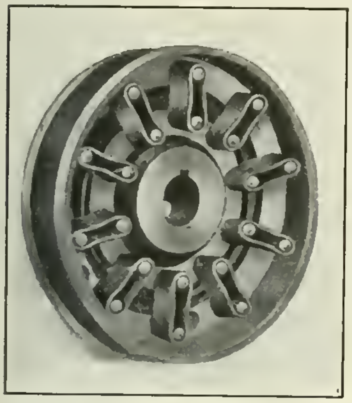
The hot plate above referred to is a piece of metal, usually of flat shape, and perhaps half as large as the cylinder bore, secured at one or more points to the inside face of the head. It should stand away from the head somewhat, and may be perforated with a number of small holes or slits, in order to permit the fresh charge to pass through and circulate more freely around it. Since it is not fully in contact with the metal of the head which is cooled by the jacket water, this plate will become quite hot and remain so. It will effectually gasify the oil, but the writer prefers to do away with the water cooled head and also the integral method of casting the cylinder, and use an unjacketed head, made separately and bolted on. This was the original practice, but was rather objectionable when gasoline came into use, as an unjacketed head is liable to preignite the charge. In the oil engine, however, the naked head carries the necessary heat for the vaporization of the fuel; it is easily removed and replaced, and when thus made, the cylinder is more readily machined. (See Fig. 5.)

The lubrication of a two-stroke cycle engine using gasoline is commonly accomplished by mixing the lubricating oil with the gasoline in the fuel tank. The air of the crank-case takes up the gasoline, but precipitates the oil very evenly upon the cylinder walls and all the internal parts of the engine. When oil is the fuel, the required lubrication must be applied by the use of oil cups.

In the operation of an engine using oil fuel in this way, there is little opportunity for loss of the exhaust, for the reason that the air entering the cylinder through the inlet port moves more rapidly than the liquid fuel, and by the time the latter has been completely gasified, the exhaust port has closed.

* * *

FLEXIBLE SHAFT COUPLING


Flexible Shaft Coupling

At a recent exposition held in Dresden, Germany, the firm of Vogel & Schlegel of that city exhibited a flexible shaft coupling of the type illustrated in the accompanying halftone. The coupling consists principally of two disks, each keyed to one end of one of the shafts to be connected. The two disks are united on their inner faces by endless leather or canvas strips running around studs in the disks as indicated in the illustration. It is evident that this provides for a flexible drive, the starting up is more easy on the connected shafts and the machinery, and there is a tendency to eliminate the heating of the journals or bearings in cases where the shafts are not well lined up.

The accompanying table gives the capacity of these flexible shaft couplings for transmitting power. The figures are converted into English measure from the tables given by the makers. The ratio $\frac{N}{n}$ is the maximum horsepower divided by the number of revolutions per minute.

CAPACITY OF FLEXIBLE SHAFT COUPLINGS

Ratio $\frac{N}{n}$	Turning Moment, Foot-pounds	External Diameter, Inches	Maximum Bore, Inches
0.00025	1.3	3.15	0.71
0.002	102.0	13.40	2.17
0.250	1288.0	26.60	4.13
1.000	5156.0	35.40	6.22
3.532	18239.0	49.20	8.66
7.610	39242.0	59.10	10.23

* * *

Superior methods for receiving and delivering freight are used in several European countries, notably in Great Britain and Belgium. As an example may be mentioned the conditions under which freight is handled in Brussels by the state-owned railroads. The railroads own and operate their own freight vans and trucks; freight rates are made directly to and from a man's place of business, and include the cost of collecting the freight and delivering it, as is the case with express rates in this country. On account of this systematic manner of handling freight, the number of trucks passing through the streets is very much decreased, as one van will collect all the freight on a given street or within a given territory. The freight is not stored in sheds or in the cars as is frequently the case in this country, but is delivered at once. The results are: an elimination of congestion of freight cars at terminals; a smaller number of idle freight cars; and decreased demand for extensive track facilities at terminals.

STANDARD AUTOMOBILE LOCK WASHERS

Lock washers have hitherto been made to a great many different dimensions. It is stated that one firm alone has made as many as 700 different sizes. For this reason the Society of Automobile Engineers has issued tables giving standard sizes for lock washers, for use on automobiles, which reduce the number to twenty-eight. These sizes have been adopted after careful consideration of the requirements. A number of engineers regarded the sections used against iron and steel as too heavy for use against soft metal, and for that reason a standard was adopted for washers having less depth, which will not mar such metals as aluminum, for example.

TABLE OF STANDARD AUTOMOBILE LOCK WASHERS

AUTOMOBILE HEAVY (A. H.)

Bolt Diameter, Inches	Lock Washer Section, Inches	Bolt Diameter, Inches	Lock Washer Section, Inches
$\frac{3}{16}$	$\frac{1}{16} \times \frac{1}{16}$	$\frac{11}{16}$	$\frac{1}{4} \times \frac{1}{4}$
$\frac{1}{4}$	$\frac{5}{64} \times \frac{5}{64}$	$\frac{3}{4}$	$\frac{1}{4} \times \frac{1}{4}$
$\frac{5}{16}$	$\frac{1}{8} \times \frac{1}{8}$	$\frac{7}{8}$	$\frac{17}{64} \times \frac{17}{64}$
$\frac{3}{8}$	$\frac{1}{8} \times \frac{1}{8}$	1	$\frac{5}{16} \times \frac{5}{16}$
$\frac{7}{16}$	$\frac{11}{64} \times \frac{11}{64}$	$1\frac{1}{8}$	$\frac{5}{16} \times \frac{5}{16}$
$\frac{1}{2}$	$\frac{11}{64} \times \frac{11}{64}$	$1\frac{1}{4}$	$\frac{3}{8} \times \frac{3}{8}$
$\frac{9}{16}$	$\frac{13}{64} \times \frac{13}{64}$	$1\frac{3}{8}$	$\frac{3}{8} \times \frac{3}{8}$
$\frac{5}{8}$	$\frac{13}{64} \times \frac{13}{64}$	$1\frac{1}{2}$	$\frac{7}{16} \times \frac{7}{16}$

AUTOMOBILE LARGE (A. L.)
For Optional Use against Soft Metal

Bolt Diameter, Inches	Lock Washer Section, Inches	Bolt Diameter, Inches	Lock Washer Section, Inches
$\frac{3}{16}$	$\frac{1}{16} \times \frac{3}{64}$	$\frac{9}{16}$	$\frac{13}{64} \times \frac{5}{32}$
$\frac{1}{4}$	$\frac{5}{64} \times \frac{1}{16}$	$\frac{5}{8}$	$\frac{13}{64} \times \frac{5}{32}$
$\frac{5}{16}$	$\frac{1}{8} \times \frac{3}{32}$	$\frac{11}{16}$	$\frac{1}{4} \times \frac{3}{16}$
$\frac{3}{8}$	$\frac{1}{8} \times \frac{3}{32}$	$\frac{3}{4}$	$\frac{1}{4} \times \frac{9}{16}$
$\frac{7}{16}$	$\frac{11}{64} \times \frac{1}{8}$	$\frac{7}{8}$	$\frac{17}{64} \times \frac{3}{16}$
$\frac{1}{2}$	$\frac{11}{64} \times \frac{1}{8}$	1	$\frac{5}{16} \times \frac{1}{4}$

The specifications given are as follows: The outside diameters of lock washers shall coincide practically with the "long diameters" of the S. A. E. standard nuts, which are approximately equal to the "short diameters" of the U. S. standard nuts. The inside diameters of the lock washers shall be from 1/64 inch to 1/32 inch larger than the bolt diameter. All lock washers shall be of parallel-faced sections; bulging and malformed ends must be avoided. They are to be submitted to the following tests as to temper: After being compressed to a flat, the reaction shall be sufficient to indicate necessary spring power, and on a subsequent compression to flat, the lock washer shall manifest no appreciable loss in reaction. The test for toughness shall be made as follows: Forty-five per cent of the lock washer, including one end, shall be firmly secured in a vise, and forty-five per cent, including the other end, shall be secured firmly between the parallel jaws of a wrench. Movement of the wrench at right angles to the helical curve shall twist the lock washer through forty-five degrees without sign of fracture; and shall twist the lock washer entirely apart within one hundred and thirty-five degrees. The accompanying tables give the standard dimensions adopted.

* * *

According to *La Fonderie Moderne*, a French metallurgist has discovered a new copper alloy having the hardness of steel combined with great tensile strength. The alloy is made in the proportion of one pound of chromium melted for one hour with one pound of aluminum, after which twenty-two pounds of copper are added, the entire charge being kept at a fusing temperature for one-half hour. Five pounds of nickel are next added and the mixture is heated for another hour, after which four pounds of zinc are added. The proportion of copper and chromium may be varied somewhat in accordance with the use to which the alloy is to be put, but the quantities and directions given above must not be changed in any other respect.

NEW CASEHARDENING METHODS*

By E. F. LAKE†

During the past decade there has been a great deal of investigation relating to the conditions under which the various carbonaceous gases may be used in place of the familiar solid carburizing materials. Everybody using or making steel knows that the old method of carburizing, or casehardening, is to pack the pieces, with some such carbonaceous material as bone and charcoal, in an iron box, sealing on the cover to exclude the air, and then baking for several hours in a furnace. The furnace is kept at a temperature high enough to cause the steel to absorb the required amount of carbon from the bone and charcoal, or other carbonaceous material that may be used.

This process was the only one known for many centuries. It was used without a question of its superiority until the manufacture of armor plate became such a large industry that efforts were made to find a better, or cheaper, way of causing the carbon to penetrate this plate. The first method employed was to place an armor plate in a pit and cover it with a layer of charcoal, and then lower another plate onto it. The cover was then put on the pit and the plates heated to (or baked in) a temperature that was sufficient to cause them to absorb the carbon from the charcoal. Gas was generally used for the fuel, owing to the ease of controlling the heat. The next method tried was to send a current of carbonaceous gas between the two plates, in place of the charcoal. This caused the carbon to "soak in" in less time and was found more economical. Later, electricity was used for heating the plates, and with the carbonaceous gas and electricity, the carbon penetration was found to be more uniform over the entire surface of the plate.

TABLE I. RESULTS OF CARBURIZING STEEL WITH CARBON MONOXIDE FOR TEN HOURS AT 2000 DEG. F.

Depth from Surface at which Sample was Analyzed	Percentage of Carbon			
	Carbon Steel		Nickel-chrome Steel	
	CO Gas alone	CO_2 and Charcoal	CO Gas alone	CO_2 and Charcoal
$\frac{1}{64}$ inch	0.70	1.17	0.86	1.16
$\frac{3}{32}$ inch	0.67	0.81	0.87	0.81
$\frac{3}{16}$ inch	0.53	0.34	0.75	0.50
$\frac{5}{16}$ inch	0.39	....	0.59	....

The results obtained from the action of carbonaceous gas on armor plate have been such that a muffle carburizing furnace has been built and placed upon the market. This holds the work in a revolving retort, through which is sent a current of carbonaceous gas. This retort serves as a muffle that is surrounded with the flames of the heating gases. With this furnace, small pieces can be carburized in much less time than formerly, and at about one-half the cost as compared with packing in iron boxes and then baking in an oven furnace. All of the labor of packing materials is done away with; carbon will penetrate the metal in less time and more evenly; its depth and percentage can be controlled more easily; and the work can be heated to the carburizing temperature more quickly and maintained there more easily. A steady flow of carbonaceous gas can be kept passing through the retort, and thus any depth of carbon can be obtained without repacking the work.

When considerable depth of carbon is required, this is impossible with the old method of packing with bone and charcoal in an iron box and sealing on the cover. This is due to the fact that only a certain amount of carbon is present, and the longer the work is baked, the more there will be in the steel and the less in the charcoal. When an equilibrium is established, no more carbon will penetrate the metal, and to obtain a greater depth, the work must be packed in fresh carbonaceous material and the heating repeated.

With the gas process, however, the percentage of carbon in the gas surrounding the work can be maintained at a permanent figure until the carbon has penetrated to the center of the metal, the percentage of carbon possible to impart to the steel being far above that which is used for any kind of commercial work. Some of the gases that have been experimented with are methane, ethylene, illuminating gas, carbon monoxide, carbon dioxide, and gases that are made from liquids like petroleum, naphtha and gasoline. Most of these gases have been used in combination with ammonia, in order to ascertain to what extent this would aid in the penetration of the carbon.

From the numerous experiments that have been conducted it has been found that carbon monoxide is far superior to any of the solid carbonaceous materials in the specific, direct carburizing effect it has upon steel. It is also better than all other gaseous materials in this respect. Carburizing materials that do not contain nitrogen cost only from one-tenth to one-twentieth of the nitrogeneous materials. It has been found, however, that nitrogen acts as a carrier for the carbon, and when it is not present, carbonaceous materials have a very weak carburizing effect; some investigations have shown that the effect is absolutely nil without the intervention of gaseous carbon compounds. When solid carbonaceous materials are used, the specific effect of the nitrogen is very weak, and it is only when these contain a high percentage of the cyanogen compounds that they have any marked carburizing effect.

While carbon monoxide is capable of rapid penetration, it has an oxidizing effect on steel, and is liable to form a scale that will spoil small work which cannot afterwards be ground. This oxidizing effect is more pronounced in chromium and manganese steels. When carbon monoxide alone is used for the carburizing medium, there is a distinct demarkation between the carburized zone and the core of the metal. This is also a detrimental feature, in that when the piece is hardened, it has a tendency to crack at this demarkation, causing the outer shell to peel off.

To overcome these bad effects of carbon monoxide, a new process has been developed by Dr. F. Giolitti, Genoa, Italy. In this process the work is packed with wood charcoal in a cylinder, and when heated to the carburizing temperature, a current of carbon dioxide is injected into the cylinder. It was demonstrated that when a slow current of carbon dioxide traversed a mass of wood charcoal, the carburizing gas was supplied with great rapidity and without any excess of carbon monoxide. Thus, an equilibrium with free carbon was established at the carburizing temperature. The exhaust gas contained less than three per cent of carbon dioxide, it being almost entirely carbon monoxide, and its volume being about double that of the carbon dioxide which was introduced into the apparatus. Some results that were obtained with carbon monoxide alone, and in combination with charcoal, are shown in Table I.

TABLE II. RESULTS OF CARBURIZING STEEL WITH COMPRESSED GAS FOR THREE HOURS

Kind of Steel	Carburizing Temperature, Degrees F.	Pounds Pressure of Carburizing Gas	Percentage of Carbon at a Depth of	
			$\frac{1}{64}$ Inch	$\frac{1}{32}$ Inch
	1600	235	0.71	0.12
Nickel Steel*	1775	235	0.99	0.29
	1650	400	0.73	0.36
	1750	235	2.22	1.03
Chromium Steel†	1925	235	3.10	1.39
	1875	400	2.37	1.40
	1525	235	0.45	0.54
Chrome-nickel Steel‡.	1650	235	0.76	0.49
	1525	400	0.54	0.56

* Composition in per cent: Nickel, 5.02; carbon, 0.118; silicon, 0.20; manganese, 1.53.

† Composition in per cent: Chromium, 2.33; carbon, 0.41; silicon, 0.15; manganese, 1.02.

‡ Composition in per cent: Nickel, 3.17; chromium, 1.5; carbon, 0.33; silicon, 0.06; manganese, 1.15.

With the use of this new process, a more rapid penetration can be obtained than with any of the solid or gaseous materials, except pure carbon monoxide. The carbon is evenly distributed in the carburized zone, and the peeling of the outer shell, when hardened or tempered, is reduced to a minimum. Any desired depth of penetration can be obtained without renewing the carburizing material, and there is absolute security against the introduction of any foreign substance. Variations in the percentage and depth of the carbon can be obtained by diluting the carbon monoxide in nitrogen; by limiting the contact of the solids with the metal; and by varying the temperature during the carburizing operations. Expansion or contraction and warping of the pieces being carburized has also been reduced to a minimum. In fact, there are so many features that make it superior to the old method of packing and sealing the work to be carburized in iron boxes, that it is safe to say that the new process is incomparably better.

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* See also papers read before The Iron and Steel Institute (Great Britain) at the October, 1911, meeting, by F. Giolitti, and by F. Giolitti and F. Carnevali.

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After much experimenting, Dr. Giolitti decided that the double muffle furnace, shown in Fig. 1, was the most efficient and economical for carburizing small or medium size pieces of varying shapes. By providing two muffles, one could be filled with work and kept at the carburizing temperature, while the other was being emptied and refilled. If the amount of work would warrant, many more muffles could be used in the same furnace. The scale to which the illustration is made, as indicated in the lower left-hand corner, will give an idea of the size of this furnace, but the size would, of course, have to be figured from the size and class of work that is to be carburized. The muffle to the right is shown by a sectional view through the center of the furnace, but the retort that holds the work is not sectioned, while the muffle to the left is shown by a sectional view on the center line, thus revealing the interior.

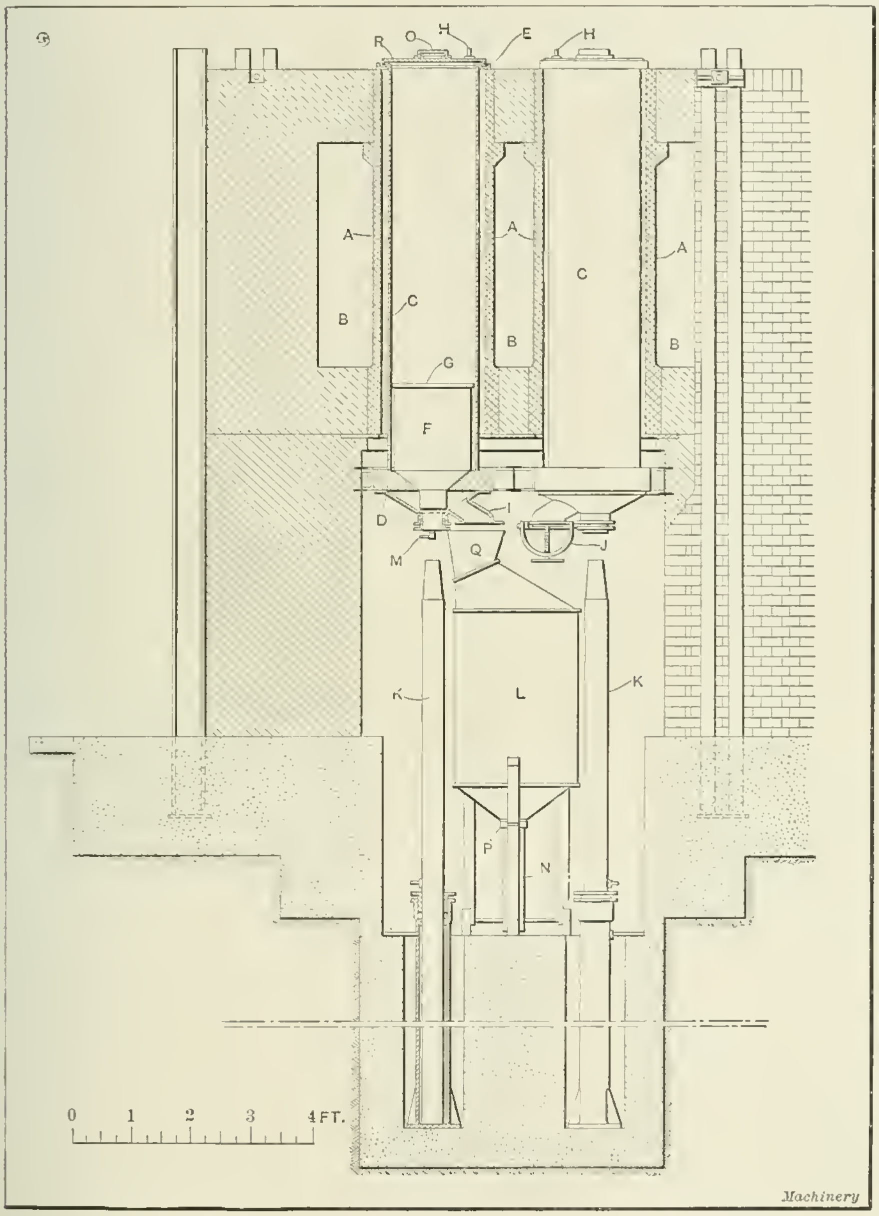

Fig. 1. Muffle Furnace for Carburizing Steel with Charcoal and Carbonaceous Gas

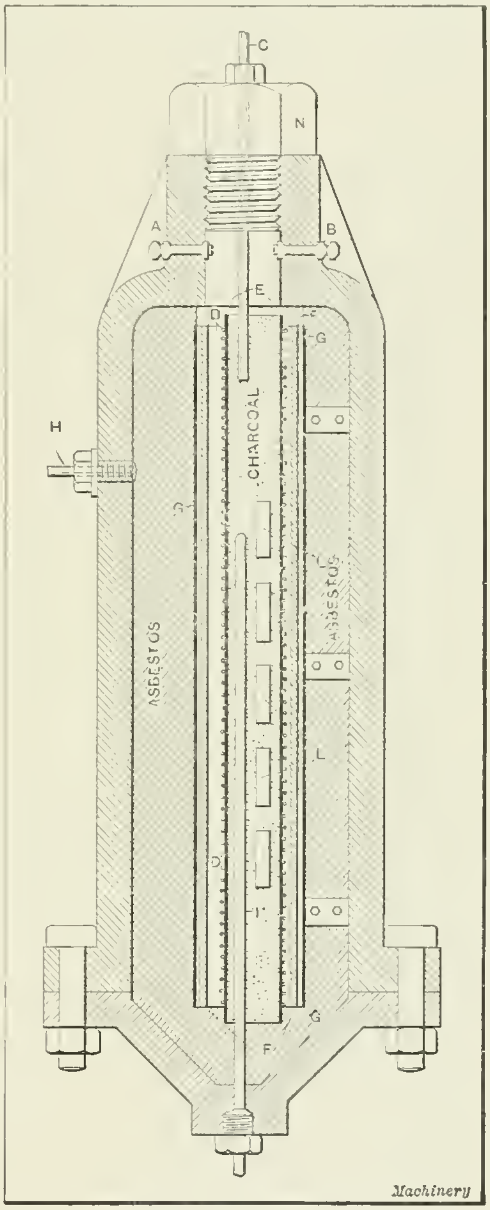

Fig. 2. Carburizing with Compressed Carbonaceous Gas and Electric Heating

Cylindrical muffles *A* are made of some refractory material and are built into the brick-work of the furnace. Surrounding them are passages *B*, in which the combustion of the heating gases takes place. These passages are lined with fire-brick or fire-clay and the furnace is provided with regenerators, so that the fuel gas, which is furnished by producers, can be used in the most economical manner. By this arrangement and the valves that are supplied, it is possible to maintain the work at a uniform pre-determined temperature. The work-holding retort *C* is made of seamless steel tubing and sets into flange *D*, which latter is attached to a frame that fits into the brick-work underneath the heating chamber. Flange *E*, which is made U-shaped to hold cover *R*, supports retort *C*, at the top of the furnace. Thus, it is only the work of a few minutes to take out retort *C* and replace it with a new one, when it has become warped out of shape or burnt through.

Inside of retort *C* is located a hollow cast-steel cylinder *F*, and inside of this is located a device that evenly distributes the carburizing gas around the work in the retort, by sending it through cover plate *G*, which is filled with holes. When all of the carbon is taken from the gas, it is allowed to escape through vent *H*. The work to be carburized is stacked up on cover plate *G*, which rests on casting *F*, and this in turn rests on the same flange *D* that supports the retort. To the bottom of this flange is attached the cast-iron nozzle *I*, which is closed at the bottom by the non-return valve *J*. Underneath the muffles are located two hydraulic rams *K* and a cylindrical iron tank *L*, mounted on wheels, for handling the solid carburizing material, which is in a granular condition.

Tank *L* may be turned on its wheels so that spout *Q* will come under the nozzle *I* of either muffle.

In operating this furnace, a continuous method can be employed. When a batch of work has been carburized, the granular carbon is drawn off through nozzle *I* into tank *L*. After that, pipe *M*, through which the carburizing gas enters the retort, is unscrewed, and ram *K* raises steel pot *F* towards the top of retort *C*, thus pushing the work that rests on plate *G* up with it, so that it can be removed as the ram proceeds upwards. When casting *F* has reached the top of its stroke, which is a little below the top of the furnace, and the old work has been taken out, new work is placed on disk *G*, which is lowered by ram *K* as fast as the work is located. When the retort is filled with work, tank *L* is wheeled out from under the muffles and raised over the top of the furnace with a hoist on a swinging arm. When over the top of the furnace, pipe *N* at the bottom of tank *L* is lowered into opening *O* in the center of cover *R*. Valve *P* is then opened to allow the hot granular carbon to flow out of tank *L* and fill the interstices surrounding the work.

If granular carbon is held at or near the carburizing temperature, it acts very much like a liquid, and readily flows into all of the crevices surrounding the articles in the retort that are to be casehardened. When it is drawn off at the bottom of the retort it is at the carburizing temperature, and the time consumed in removing the finished work and replacing it with new is so short that the granular carbon does not cool down to a temperature below 1500 degrees F. Thus, it retains its mobility and flows around the work. An operator on top of the furnace might assist this flow by using iron rods that can be inserted into the retort through holes in the cover.

When the retort is properly filled, butterfly valve *P* is closed and tank *L* is lowered and wheeled to its position underneath the muffler. The work is then allowed to stand until the carburizing temperature has been reached. In the meantime, pipe *M* has been screwed into position, and when the carburizing temperature has been reached, the carbonaceous gas is injected into the retort through this pipe. While the work in the retort to the left is being carburized, the retort to the right can be emptied and filled, without in any way disturbing the process in the other.

Another method that has been tested by the designers of this furnace is that of compressing the carbonizing gases, and some very good results have been obtained. The tests demonstrated that when carbon monoxide acts on ordinary steel in the presence of free carbon, as in the furnace shown in Fig. 1, an increase in the depth of carburization will be obtained with an increase of the pressure on the gas, and there will also be an increased concentration of carbon within the carburized zone.

In carrying out some experiments of this nature, a cylindrical retort was used, like that shown in the sectional view in Fig. 2. In this, electricity was used to heat the work to the carburizing temperature. The work was packed in charcoal in a retort into which a current of carbon dioxide was injected, in a very similar manner to the method used in the furnace in Fig. 1. In the illustration, *A* and *B* are the clamps for the terminals and these conduct the current to nickel-wire spiral *D*. This wire is wound around porcelain tube *E*, which can easily be inserted into, or taken out of, the apparatus. By taking off nut *N*, tube *E* is readily slipped into fire-clay tube *F*, which is surrounded by steel tube *G* and insulated with asbestos. The carbon dioxide gas enters the retort through tube *C* and the used gas escapes through pipe *H*. Porcelain tube *I* contains a thermo-electric couple that is inserted into the retort at the opposite end from gas tube *C*. With it the temperature of the entire length of the casehardening chamber can be measured. Blocks *L* are the experimental pieces to be carburized, and are surrounded by granular carbon. Table II shows some results obtained with various kinds of alloy steels. While this is only a crude experimental apparatus, it would seem to suggest some ideas or principles that can very profitably be used for carburizing steel parts on a commercial scale.

Definite proof was obtained that variations in the pressure of the carburizing gas were always accompanied by variations in the depth of carburization, and also in the percentage of carbon in the carburized zone. It was found, however, that when the pressure was too high it would cause an oxide to form on the steel and this was more pronounced with chromium and manganese steels than with others. It was also found that as the carburizing temperature was raised, the pressure could be increased without causing this oxide to form. Thus, the higher the carburizing temperature, the higher can be the pressure used on the carburizing gas, with an absolute assurance that no oxidation will take place.

A rod of soft steel, 2⅜ inches in length and three-eighths inch in diameter, was casehardened for about three hours by heating three-fourths of an inch of its central portion to about 1800 degrees F. and allowing this temperature to decrease towards the two ends, so that at these the temperature was about 900 degrees F. Unmistakable carburizing took place in all portions that were above 1450 degrees F. The surface was absolutely unaltered in the hottest portion in the center, which was also the most intensely carburized, while a distinct layer of oxide was seen in the cooler portions, this oxide thickening as the temperature lowered towards the ends.

Such good results were obtained by compressing the carburizing gas as it was injected into the bed of charcoal in which the work was packed in the retort, that this method promises to become a commercial success. While the mixed agent, carbon monoxide and charcoal, increased both the speed of penetration and the percentage of carbon in the carburized zone over all previous methods or materials used for carburizing steels, compressing the carbon monoxide has still further increased these factors. Like all methods and processes, however, it must be handled properly. The amount of compression, as well as the carburizing temperature, varies with different kinds of steels. Therefore, these must be discovered and properly adjusted, if work is to be turned out that is free from oxide and scale, and that has the desired penetration uniformly distributed over all portions of the exposed surfaces.

Whether work is carburized with an ordinary flow of carbon dioxide into and through the charcoal, or by compression, the advantages which vertical muffles, as shown in Fig. 1, have over horizontal muffles are in the greater speed of charging and removing the work, due to the greater simplicity of the operations, the uniformity of the treatment of all pieces forming the charge, and the more uniform distribution of the carburizing gases, due to the spaces being reduced to a minimum.

The time for the various operations with the furnace shown in Fig. 1 is as follows: Charging the pieces to be carburized from 1 to 5 minutes, according to their size and shape; completely filling the retort with granular carbon from 1½ to 4 minutes; lowering ram *K*, replacing pipe *M*, removing tank *L*, and closing down cover *R*, 1 minute; drawing the granular carbon from retort *C* into tank *L*, 4 minutes; raising ram *K* and removing the work from the retort, 2 minutes. The time consumed in all the operations, where ordinary work is being handled would, therefore, be about ten minutes, but with specially shaped pieces and unfavorable conditions, this time might be extended to 30 minutes.

By pre-heating the work to a carburizing temperature before putting it into the retort, no time will be lost in fully heating it in this furnace. The temperature of the granular carbon can then be maintained nearly up to the carburizing temperature, as it will not be chilled by cold work. The process can thus be made strictly continuous. Under these conditions, a depth of carbon penetration of 1/32 inch can be given the work in one hour, and of 1/16 inch in two hours. Thus it will be seen that from 1¼ to 2½ hours is all that is required for the complete carburizing operations in one retort.

By using gas for fuel and gas for carburizing, the work can be controlled within closer limits than with any other process, unless it should be an electric one, and the arrangements of this furnace are such that its capacity for producing work is greater than that of any furnace which has been designed with the same size of work holder. If there is not enough work to keep both muffles going on pre-heated work, one of the muffles can be used as a pre-heating furnace, while the other is doing the carburizing. By alternately using the muffles for pre-heating and carburizing, an amount of work will be turned out that will compare favorably with any other casehardening furnace. If desired, the current of carbonaceous gas can be used for a whole or any given part of the carburizing time, and thus the results obtained can be made to cover a wide range. Where localized casehardening is required, the granular carbon can be drawn off until only enough is left to insure the chemical equilibrium in the gas, and by thus isolating the carbon monoxide, it will intensify its specific action.

* * *

THE PHOROGRAPH—A CRITICISM

By GEORGE L. SULLIVAN

The writer was much interested in Mr. Moody's description of the phorograph, in the October number, but was unable to check the theory of the method or to see the utility of it. In fact, it seems that the method is simply a complication of the instant center and the resolution of motion methods, without any new results and a great deal less logic. In the examples given, the results are all correct except that, in the quick-return motion illustrated, the velocity of the oscillating arm is represented by the line $c_1d_1 - c_1e_1$, and it still remains to solve for the velocity of the ram in order to complete the solution. This is easily done by finding the horizontal component of the velocity of *ce*, but the writer does not know what the phorograph method would be. Incidentally, this is not the Whitworth quick-return. The Whitworth mechanism is shown on page 154 of the same number of MACHINERY.

In the first place, Mr. Moody says that he expects to find a point on link *a* which has the same velocity as some other point in the mechanism, but the "equivalent point" or "image" which he finds is not on link *a*. What he does do is to find a line, the length of which represents the velocity of the point *bc* to a scale in which length of *a* equals velocity of point *ab*. It is not at all necessary to confine ourselves to this scale; in fact it would be easier to assume that 1 equals the velocity of point *ab*; then the scale will be immediately known when the velocity of *ab* is known.

Fig. 1 shows how any scale may be used in finding the velocity of a point on a four-link mechanism. Let *e* represent the velocity of *ab*, and *h* be drawn parallel to *b*; then *g* will represent the velocity of *bc* to the same scale. For if we produce *c* and *a* they will meet at O_1, the instant center of *b*, or point about which *b* is rotating at this instant. Then, the velocity of *ab* is to the velocity of *bc* as O_1-*ab* is to O_1-*bc*, or as *e* is to *g*. Draw g_1 parallel to *g*; then g_1 is equal to *g*. Now if *e* is equal to *a* then g_1 is equal to c_1, which is also the c_1 of Mr. Moody's solution.

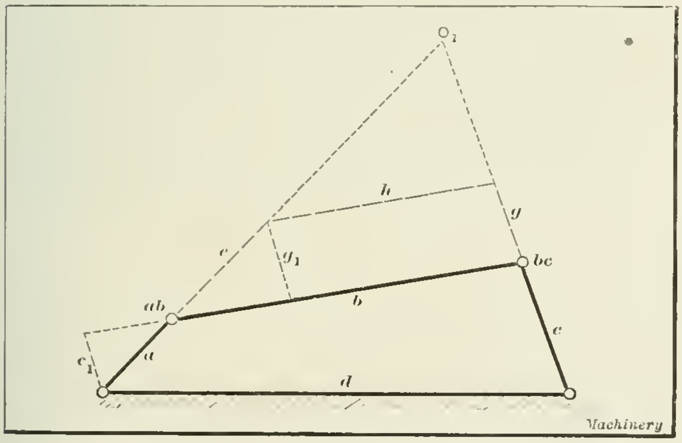

Fig. 1. Simple Four-link Mechanism analyzed by the Instant Center Method

On top of page 107, Mr. Moody says that "every point in *b*, and *b* produced, has exactly the same direction of motion relative to the point of revolution *ab*." He means that the direction of rotation is the same. The direction of motion is directly opposite if the point is on the opposite side of *ab*. At the bottom of the same page, first column, he says "these images revolving instantaneously at a uniform speed." There is no such thing as an instantaneous uniform speed, because uniform speed means that the speed does not change from instant to instant, and we must consider more than one instant to determine whether the speed remains uniform or not.

In the analysis of the quick-return motion, the writer cannot see why the same reasoning is not applied to the motion of *bc* as is used in the analysis of the slide-and-crank mechanism, Fig. 3. In speaking of Fig. 3, he says "as b_1c_1 has a horizontal motion, it must be in a vertical line through *da*, as only such points in *a* have a horizontal motion." Apply the same reasoning to Fig. 4 and we have:

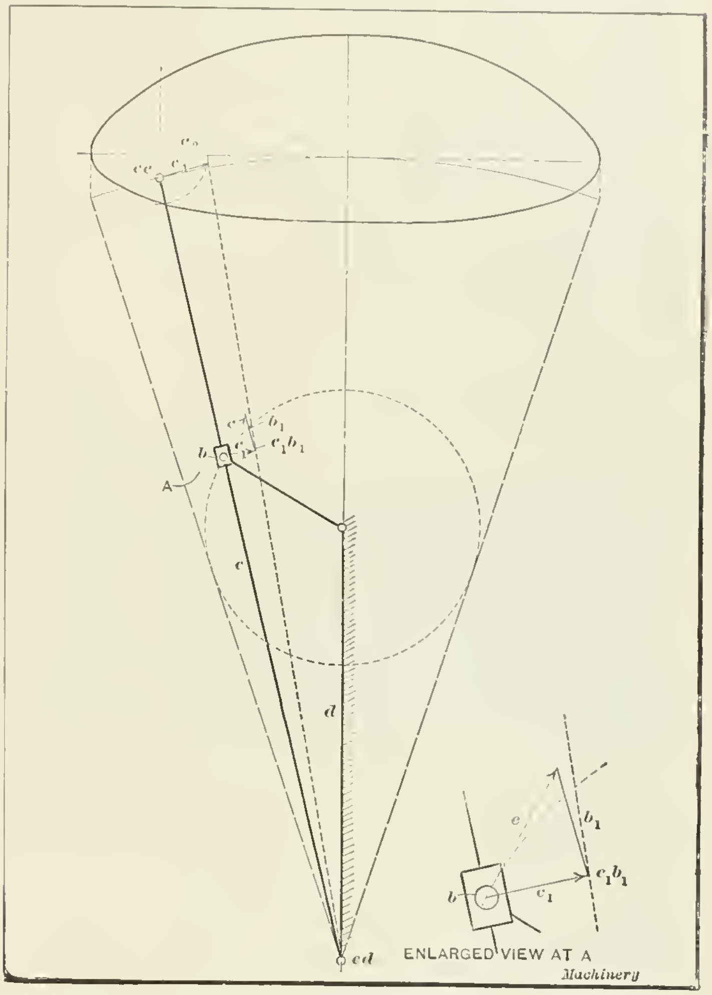

Fig. 2. Velocity Curve of Oscillating-bar Quick-return obtained by the Resolution of Motions

"The point *bc* moves in a line parallel to link *c*, and therefore must be in a line perpendicular to link *c* through *da*, as only such points in *a* have such a motion." This would throw the diagram off. What Mr. Moody really did was to let *a* represent the velocity of the block *b*. Then he resolved this velocity into the components b_1, perpendicular to *c*, and c_1, parallel to *c*; b_1 is the velocity of sliding of *b* on *c*, and c_1 is the velocity of the point *bc* in *c*. Now the velocity of *ce* is to the velocity of *bc* (in *c*) as *cd*–*bc* is to *cd*–*ce*. Fig. 2 shows the same thing done by the ordinary method. Let *e* represent the velocity of block *b*. Draw c_1 perpendicular to *c* and b_1 parallel to *c* through the extremity of *c*. Then c_1 is the velocity of *bc* (in *c*) and b_1 is the velocity of sliding of the block *b* on *c*. Extend *cd*–c_1b_1 to meet a tangent drawn from *ce*. Then e_1 is the velocity of *ce* and e_2 is the velocity of the ram. The rest of the velocity diagram is determined in the same way. In Fig. 4, of Mr. Moody's article, it will be found difficult to project b_1c_1–c_1d_1 to a tangent from *ce* accurately. This will be avoided by the construction shown in Fig. 2 of the present article.

* * *

THE SAME MIGHT BE SAID OF TOOL STEEL

"There are over a million brands of cigars", observed the loquacious traveler. "Yes, and only two kinds", said the cigar salesman sententiously. "What are they?" "The kind that sells, and the kind that doesn't."

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MAKING THE PRESS-BUTTON KNIFE

By G. P. CAMPBELL*

There is hardly a manufacturing industry in the United States today in which machinery is used to a lesser extent than in the cutlery or knife business. While the machine is an important factor in producing, forming and handling different parts of the knife, yet, owing to the vast number of styles and the peculiar shapes of knives, nothing has yet been devised to take the place of the skillful hand of the cutler. A factory which to some extent constitutes an exception to this rule is that of the Press Button Knife Co., in Walden, Orange Co., N. Y., where the press-button knife is made. Mr. George Schrade, who is the inventor of this knife, is also the designer of the special tools used in its manufacture. He has recently severed his connection with the company mentioned, and is now engaged in the business of making new and improved machinery for manufacturing cutlery.

With the exception of the blade, which is hand-forged and largely finished by hand, and the coverings, all parts are produced and finished by machinery, and are ready to be put together without any fitting. The knife shown in Fig. 2 is a large one-blade pocket-knife. It is composed of twenty-seven different parts, requiring 112 different operations, nearly all of which are performed by machinery and with the use of the tools shown in Figs. 2, 3 and 4. All of these tools are used for making this one style of knife only.

Fig. 1. Works in which Press-button Knife is made, Walden, N. Y.

Fig. 5 shows the different parts ready to be assembled. In this engraving *A* is the blade; *B* and B_1, the linings; *C*, the back; *D*, the coverings; *E* and E_1, the bolsters; *F*, the fly-spring, which opens the blade; *G*, the lock-spring, which locks the blade either in its open or closed position; *H*, a washer for the lock-spring; and *I*, washer *H* riveted over the lock-spring *G*. Further, *K* is the push button, *L* is a bushing, *M* is a lock-pin for the lock-spring *G*, and *N* is a stud by which the lock-spring and the washer are riveted onto the linings B_1. At *O* is shown one of four German silver pins which fasten bolsters *E* and E_1 to linings *B* and B_1; *P* is one of four German silver pins which fasten coverings *D* to the linings; *Q* is one of a pair of German silver pins, one of which holds the fly-spring in place, while the other holds the covering, lining and back together; and *R* is one of three steel pins for fastening the linings, back and blade together before the covering is put on.

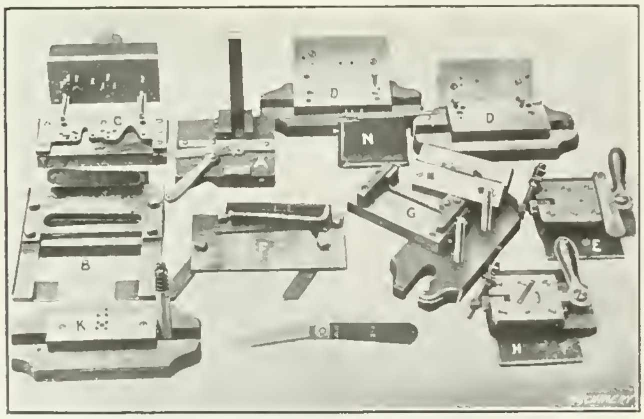

Fig. 2. Tools used in making the Press-button Knife

Tools and Operations

After the blade is forged it is drilled in jig *A*, Fig. 2, for the bushing *L*, and reamed with a spring socket reamer *K*, Fig. 4. This reamer is used in conjunction with part *L*, Fig. 4; the pressure of the spring of the reamer on the blade holds the latter down level on *L* while reaming. The two lock holes *S* and *T* in the blade, Fig. 5, are now drilled in jig *A*, Fig. 4, for lock-pin *M*, Fig. 5. This latter is riveted onto the lock-spring and protrudes through lining B_1, holding the blade either open or closed as mentioned. The tang or flat part of the blade is now milled in the milling machine in a jig, not shown, a shoulder being formed on the blade as shown at *U*, Fig. 5. The blade is now placed on a pin which holds it through hole *V*. This pin is located a certain distance from a grinding wheel and the blade is swung around against the revolving wheel which grinds the tang to the required radius or shape. The tang is now stamped, the cutting part of the blade is hardened, tempered and ground to shape, and the tang is glazed. The blade is now ready to be inserted in the knife.

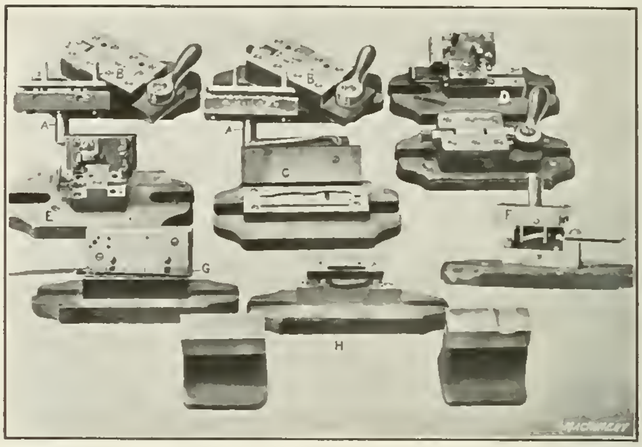

Fig. 3. Another Set of the Tools used in Press-button Knife Making

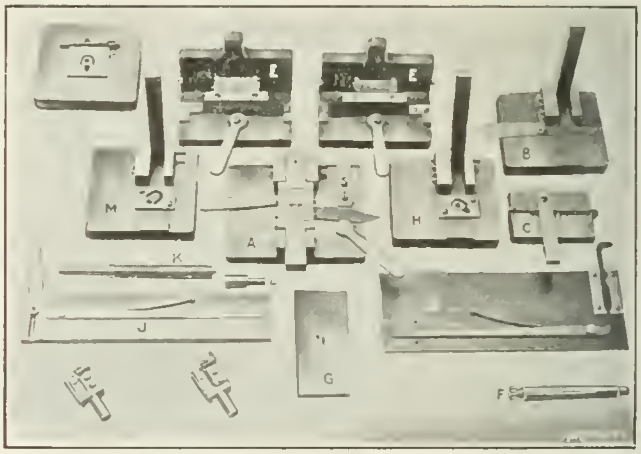

Fig. 4. Additional Knife-making Tools

In setting up the knife blade for cutting the square shoulder in the milling machine, the gage shown at *J*, Fig. 4, is used in testing for accuracy; the blade is shown in this gage in position for testing. The distance from the shoulder of the blade to the pivot of the indicator is one-tenth of that from the pivot to the extreme point of the indicator, so that all errors are shown in a scale of 10 to 1; the graduations read in thousandths of an inch. The gage *G* is used for testing the accuracy of the lock-pin holes *S* and *T*, Fig. 5.

Die *B*, Fig. 2, is used for blanking the linings *B* and B_1, Fig. 5. These linings are then perforated in die *C*, eleven holes being punched in one and twelve in the other of the two lining pieces. These holes are punched in one stroke of the press. The holes for the pins in the linings are then countersunk to allow for riveting in a foot-press with the tools shown at *D*. They are then put into tools *B*, Fig. 3, and pins

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O, *P* and *R*, and stud *N*, Fig. 5, are inserted and riveted in one operation. The upper parts of the tools *D*, Fig. 3, are shown at *A*. Bushing *L*, Fig. 5, is inserted and secured in place by the tool *E*, Fig. 2.

The lock-hole in lining B_1 is now reamed in jig *B*, Fig. 4, the lining being shown in position in the tool. The knife-backs *C* are first punched out or blanked in die *F*, Fig. 2. They are then cut off or cropped in tool *G*, after which they are "dotted" or centered for drilling in jig *C*, Fig. 3. Then they are held in jig *C*, Fig. 4, and milled to exact length. One of the backs is shown in position in this jig. They are then tested in gage *D*, this gage being constructed on the same principle as gage *J*. The four holes in the back are now drilled rapidly and accurately in one operation.

In the knife shown, the coverings *D* are of buckhorn, but they are also made in shell, ebony, aluminum or German silver. The coverings are cut to length, width and thickness on a small circular saw, after which they are cut to the shape of the lining. The ends, which join the bolsters *E* and E_1 are matched on a coarse wheel, after which they are both drilled in jigs *E*, Fig. 4, the four holes for pins *O* and *Q*, Fig. 5, being drilled in each at one operation. The coverings are now grooved with a milling tool *F*, in a jig not shown. This groove allows space for the lock-spring and washer *I*.

Bolsters *E* and E_1 are generally cast or drop-forged of German silver. In the case shown they are cast. The bolster *E* is drilled for pin fastenings and push-button in jig *H*, Fig. 4, and afterwards countersunk in jig *M*. Fly-spring *F*, Fig. 5, is made in forming and cutting-off tool *F*, Fig. 3, which forms and cuts off the spring in one operation. After this the spring is hardened, tempered and ground. The indentation shown in the spring at *V*, Fig. 5, fits a corresponding recess in the back *C*. The pin *Q* passes through holes in the linings and holds the fly-spring accurately in position.

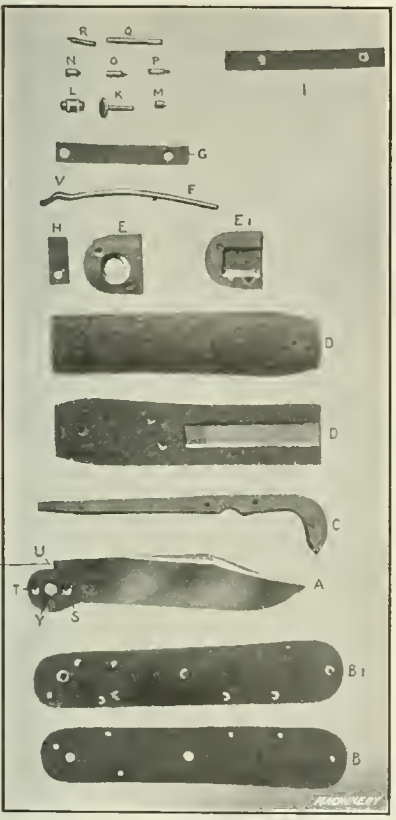

Fig. 5. Parts of the Press-button Knife

The lock-spring *G* is first punched and cut to length in tool *D*, Fig. 3; then lock-pin *M* is put in and riveted in tool *H*, Fig. 2. The spring is then bent to the correct shape in forming tool *H*, Fig. 3, after which it is hardened and tempered. The washer *H*, Fig. 5, for the lock-spring, is made in a combination punching, forming and cutting-off tool *E*, Fig. 3, the three operations being performed successively. A piece of stock is shown in position in the dies with a hole punched and the washer formed to shape and ready to be cut off to length in the next operation. The washers are then hardened and tempered.

The tool *K*, Fig. 2, is used for tightening the blade and for securing and spreading the bushing for the press-button. Tool *N* is used for riveting the push-button, and a knife is shown in position in this tool with all parts assembled except the covering. The three pins *R* which hold the linings and the back together, are put in and riveted in one operation in a jig *G*, Fig. 3. The fly-spring is dropped in place and secured by pin *Q*, and the bolsters and coverings are now put on. The blades are then set by the cutler. The operation consists in "straightening" the blades by tapping with a very hard and sharp hammer on the hollow side of the tang, which is laid on the anvil, and which is not as hard as the rest of the blade. This operation bends the blade or "straightens" it, so that it is in the proper position to keep the keen edge from striking the lining or another blade, where there is more than one. The handle of the knife is now ground smooth and finished by an operation called "hafting." The blades are next polished, etched and finally edged on an oilstone. The knives are now ready for inspection, packing and shipping.

In opening the knife the push button is simply pressed, and as the end of the button rests against the lock-spring *G*, it forces this spring back and releases lock-pin *M*, which protrudes through lining B_1. The fly-spring pressing against the tang then causes the blade to fly open, and when hole *T* in the blade is opposite the lock-hole in lining B_1, the lock-pin slips into the hole and locks the blade in the open position. To close the knife the operation is reversed.

General Features of the Press Button Knife Co.'s Shop

There are a number of features in the shop of the Press Button Knife Co. that may be of interest. At each wire rack in the shop a wire gage is conveniently attached by a chain, and a great deal of time is saved throughout the year by this arrangement. Each man has his own individual oil can with a brass tag soldered onto the button with his number. Oil cans belonging to special machines have the number of the machine on them, and the can is expected to be found full and ready for use at all times. A place is provided on each machine for holding the can in a position convenient to the operator. All pins, studs, and bushings are made on a No. 00 Brown & Sharpe automatic screw machine, and the writer understands that this machine does the work formerly done by three hand-operated machines, each having an individual operator. The automatic machine requires attention for about one hour daily, or a total of about six hours per week.

Another feature of this shop is the close attention paid to details, such as the placing of material convenient for the operator. All wire of different kinds and sizes is kept in racks close to the automatic machine, so that the operator practically can reach it without moving from the machine. This feature is observed throughout the shop wherever feasible. Where small pieces are handled by the thousands, it makes a great deal of difference in the results whether the operator moves his hand or arm six or sixteen inches for each.

Instead of ordinary waste, silk waste is used in this shop, made into pieces the size of an ordinary wash rag. These can be washed when dirty, and can thus be used many times before becoming useless. The absence of lint and the non-clogging of oil holes are alone forcible arguments in favor of using this kind of waste instead of the ordinary loose cotton waste.

* * *

LARGE-APERTURE PHOTOGRAPHIC LENS

The Emil Busch Optical Co., 35 Charles St., Hatton Garden, London, E. C., England, has placed on the market a photographic lens which can be used for taking photographs of machinery in poorly lighted shops. This lens is called the "Glaukar" anastigmat. The principal features are the very large aperture and flatness of the field, as well as great covering power and fine definition. This lens was used by Sir Benjamin Stone for taking instantaneous pictures of the coronation ceremonies in Westminster Abbey, London. It has an aperture of F 3.1, which is large enough to enable pictures to be taken instantaneously even in very unfavorable lighting conditions. It is especially valuable for cinematograph work.

* * *

China has been moving forward industrially rapidly during the last few years, and few people realize how much the Chinese are now able to do for themselves in the mechanical and engineering fields. As one example, it may be mentioned that the Hanyang Iron and Steel Works employs 20,000 men, and that at these mills all the rails used for the Great Central Railroad of China from Peking to Hankow, some 700 miles, were rolled. There is at present 6000 miles of railway in operation and about 14,000 miles in prospect or under construction. Some lines have been constructed entirely by the Chinese, no foreign engineers having been employed.

THE FORMS OF LATHE BEDS—2

By JOSEPH G. HORNER*

Lathe Beds of Circular Section

The circular bed is cheaply made for small lathes of, say, from 6- to 10-inch swing. It is used for these, not so much because it happens to be the stiffest form, but because of the advantage which it offers for swivelling the rest to different angles, thus making it a kind of universal tool for all kinds of cutting. This design is adopted in the recent lathes of that type built by Messrs. Drummond Brothers, Ltd., of Guildford, England. The bed, of cast iron, 3 inches in diameter, is of hollow form, ground on the outside to a limit of 0.0001 inch, and on it the heads and saddle fit. As seen in Fig. 26, there is a slot in the under side of the bed which receives a tongue or bush secured to the bolt that passes up to transmit the motion from the lead-screw. By tightening the nut on this bolt the swivelling portion *A* is locked. The range of swivel is indicated by the radiating center lines. Fig. 27 shows the complete tool-rest, with the upper part held in the split socket of the saddle; thus permitting of a horizontal swivel movement which enables the tool, or the top of the rest, to be moved in a universal manner.

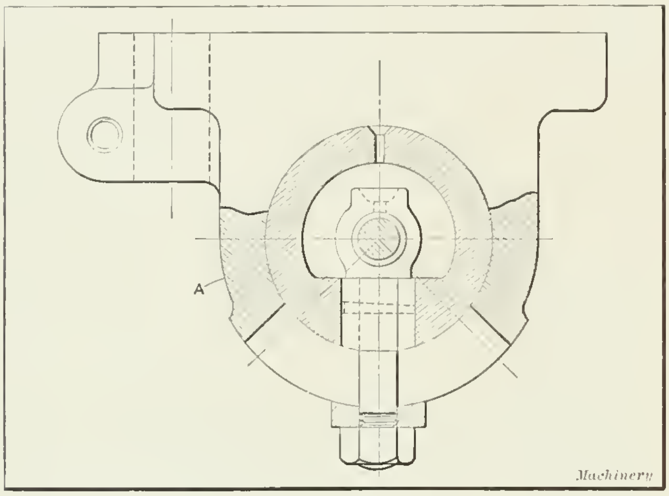

Fig. 26. Section of the Circular Bed for Lathes made by Drummond Bros., Guildford, England

This lathe, in its swivel action, resembles the Pittler lathe, although the latter is designed in a different way. In the Pittler lathe, the longitudinal guidance is provided for by a section of trapezoidal shape, within which the lead-screw passes. The form of this bed is plainly indicated in Fig. 28. The swivel motion is provided for by making the outside of the sliding carriage circular, and fitting the saddle of the slide-rest to it. In this way the sliding movement is combined with a circular movement through a complete circle. The stem of the tool-rest can be swivelled in the socket in the split saddle. The greatest swing to which lathes of this model are built is 14 inches. Pittler lathes of greater swing are built with approximately rectangular beds, having a vee and a flat guide.

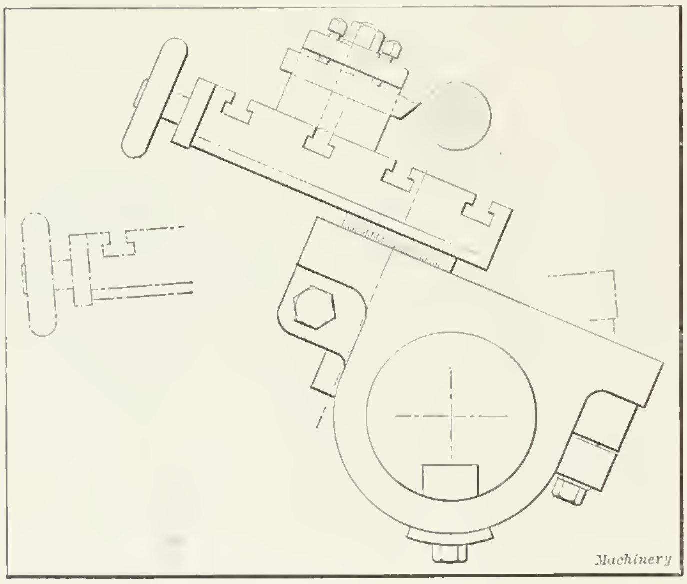

Fig. 27. The Drummond Lathe Bed and Saddle

The advantage of the circular form is also recognized in cases where it cannot be adopted absolutely. Some of the bench lathes have beds of D-section; one made by the Pratt & Whitney Co. of Hartford, Conn., is shown by Fig. 29. The headstock, tailstock and slide-rest are clamped to the flat top-face and are guided by the two sloping edges, thus preserving the alignment. The bed being small, is cast in one piece with its two feet.

The "Narrow Guide" Lathe Bed

We now come to a recent development in lathe bed practice, which has already, in the short course of some five or six years, effected a remarkable revolution in lathe construction—the application of the principle of the narrow guide. This principle, although so lately taken up in earnest, is not by any means new. To determine the period of its first application would seem impossible, but illustrations showing the idea applied to lathe carriages appeared some twenty-five or thirty years ago. The three illustrations Figs. 30, 31 and 32, are taken from Joshua Rose's "Modern Machine Shop Practice," and show how the principle was applied many years ago. All three of these illustrations are represented in recent practice, and it is noteworthy how the construction has been brought into prominence chiefly by the development of high-speed lathes. Messrs. John Lang & Sons, when they re-designed their beds in 1900, embodied the narrow guiding strip in the design, and since that date its use has spread rapidly, not only as applied to lathes, but also as adapted to many other machine slides. New examples occur from month to month.

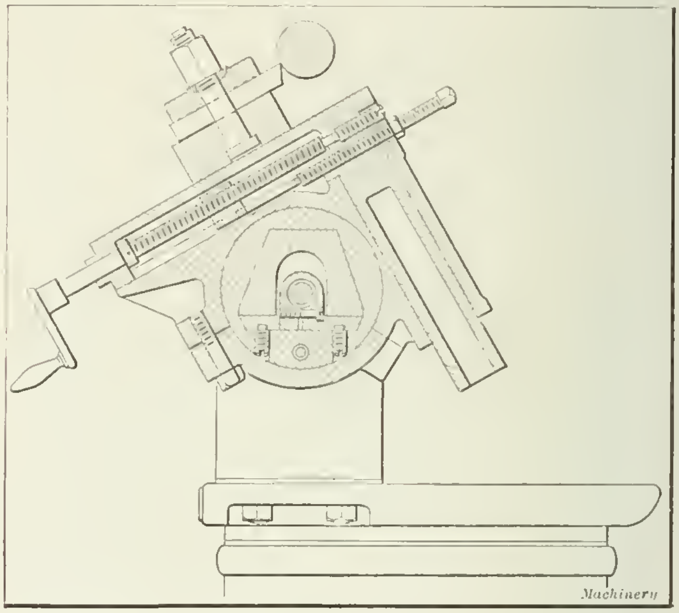

Fig. 28. The Pittler Trapezoidal Bed used by the Leipziger Werkzeugmaschinenfabrik, Leipzig-Wahren, Germany

In the narrow-guide beds, the carriage or saddle is not in sliding contact with the vertical edge of the back shear, but has a clearance there, and is gibbed against the vertical edges of the front shear only. The only gibbing on the back shear is under its lip, merely to prevent lifting. As an alternative, the saddle may be guided by a raised strip on the front shear, or by an underhanging strip, without affecting the principle. Sometimes the strip is raised above the general level of the bed surfaces, and sometimes it is formed by making a recess or channel in the front shear, although this is open to the objection that such a recess easily collects and stores the chips. The upstanding ledge, again, is more liable to become damaged.

Fig. 34 illustrates the Lang bed with its saddle. It is possible with this design to obtain a length of guide of as much as ten times the width between the guiding surfaces, which has the effect of producing a very steady movement, with a much greater amount of freedom from twisting than is the case when the saddle fits on the front and rear outer edges of the shears. The setting-up of the taper adjusting-strip can have no possible tendency to spring the sides of the bed inwards, as it might possibly have in the ordinary type of lathe bed.

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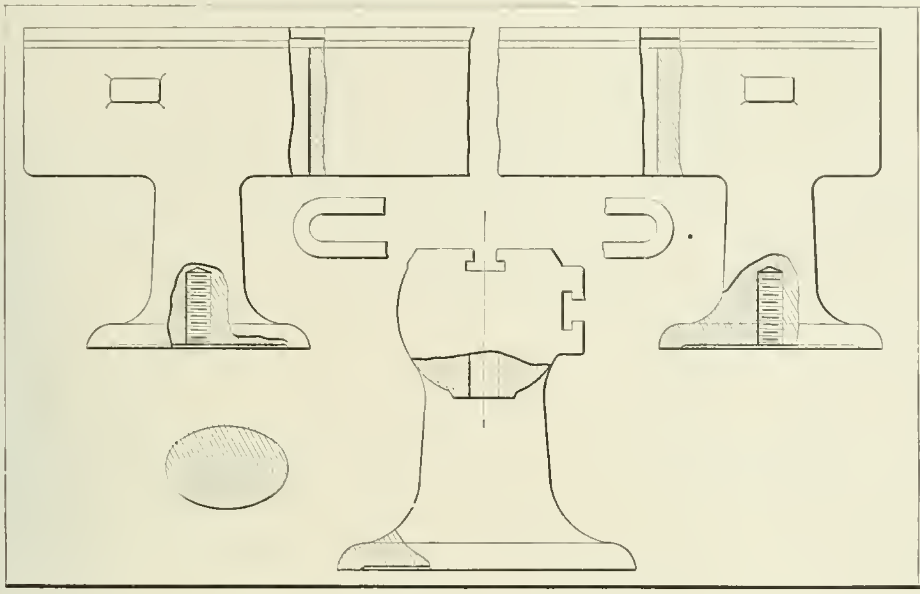


Fig. 29. Bed of the Pratt & Whitney Bench Lathe

In conjunction with the narrow guide, it is also the practice to bring the lead-screw as close as is practicable to the guide-ways, and the twisting tendency and friction caused by the old-style construction is minimized. Thus, the location of the lead-screw in Fig. 12 is just where it ought not to be with relation to the saddle slides, and this example of what was at one time standard English practice contrasts unfavorably with the location of the lead-screw in Fig. 33 and some of the succeeding illustrations, where the force is applied at the correct place—near to the guide-ways. It has been found from experience that the narrow guide principle does give far more accurate results than the usual design, and that the alignment of the saddle movement is preserved for a longer period.

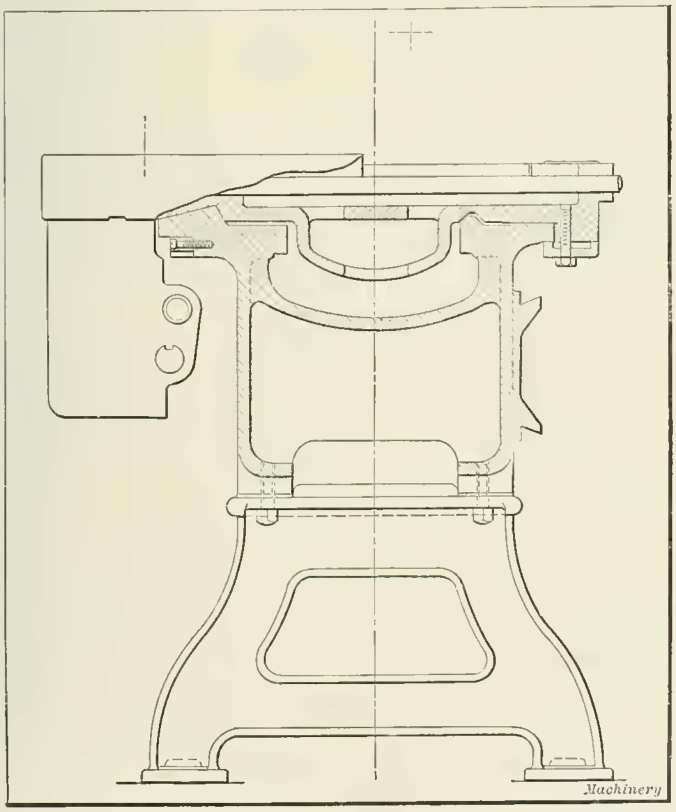
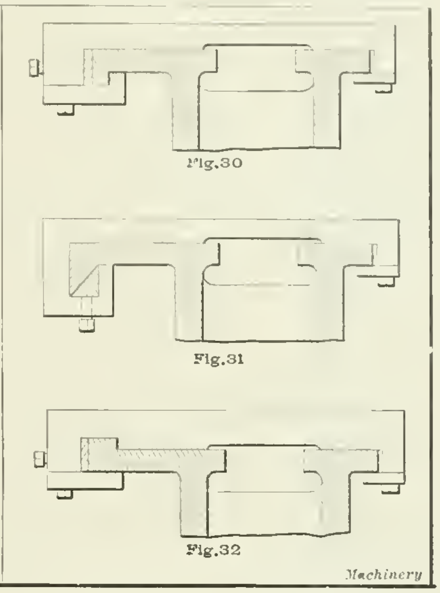


Fig. 33. The R. K. LeBlond Machine Tool Co.'s Design of Lathe Bed

American Designs Embodying the Narrow Guide Principle

Another important advantage, apart from the narrow guide itself, is that part of the pressure of the cut is resisted by a vertical face, and the forces tending to push the saddle off the bed are acting against this face, instead of against the back edge of the rear shear. This feature is also embodied in two new American designs, by the R. K. LeBlond Machine Tool Co., and the Lodge & Shipley Machine Tool Co., both of Cincinnati, Ohio. In the former company's design a nearly vertical face is employed on the front shear, and in the latter's design the vertical inner edge of the front shear comes in contact with the carriage. The LeBlond lathe, Fig. 33, is not provided with a rear vee, the carriage sliding



Figs. 30, 31 and 32. Examples of Early Lathe Beds having Narrow Guides

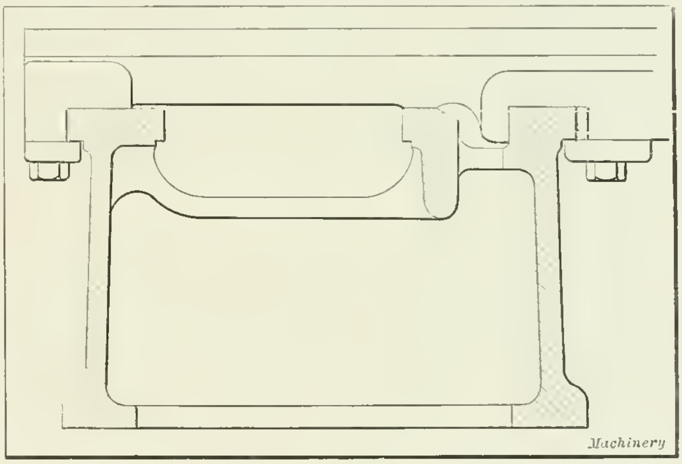


Fig. 34. The John Lang & Sons, Johnstone, Scotland, Type of Lathe Bed

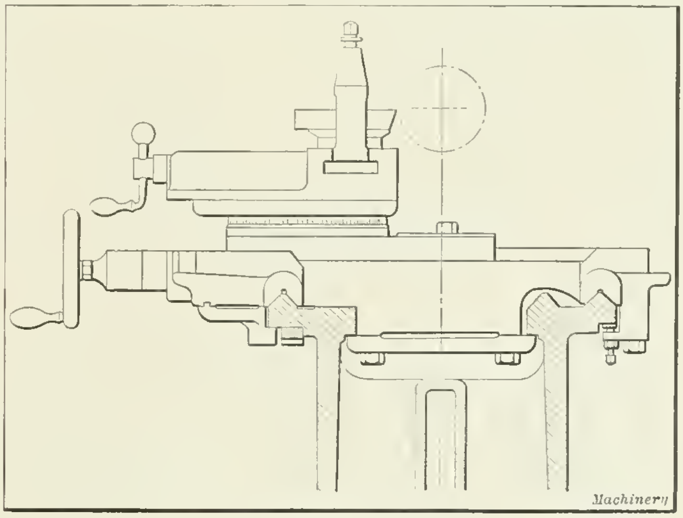


Fig. 35. The Lodge & Shipley Machine Tool Co.'s Lathe Bed with Supplementary Bearing Surface

on a flat on the back shear, but in the Lodge & Shipley lathe, Fig. 35, the carriage fits on the usual rear vee, and in addition has a horizontal bearing on the surface adjacent to the front vee, so that the solid metal of the carriage is well supported.

Belgian Type of Narrow Guide Lathe Bed

The firm of Le Progrès Industriel, Société Anonyme, of Loth, near Brussels, who has been engaged in lathe manufacture for many years, utilizes, in its present design, the narrow guiding principle, in conjunction with a single vee for the guidance of the tailstock. The carriage, as indicated in Fig. 36, does not touch this rear upstanding vee, and there is a clearance at the rear vertical edge of the rear shear. The adjustments are made by a wedge strip on the front edge of the front shear and by the two gib strips each underneath the lips. This design is a sort of compromise between American and English designs, and is used on large and small lathes alike.

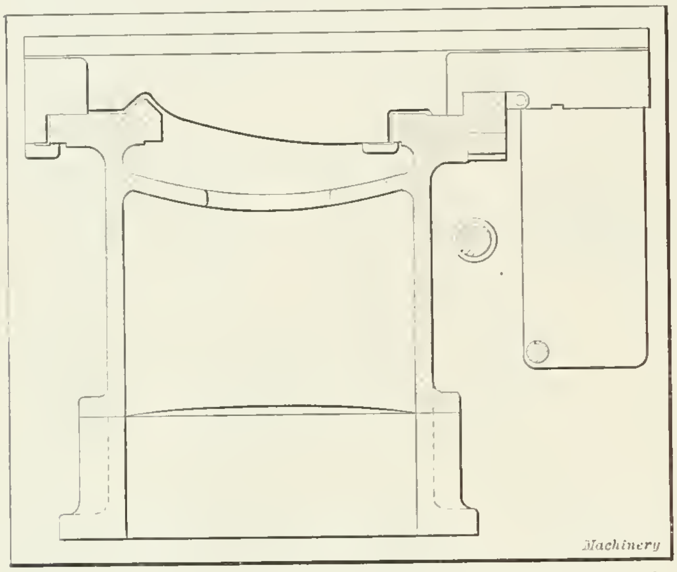


Fig. 36. Belgian Design of Lathe Bed with Raised Narrow Guide as used by Le Progres Industriel Societe Anonyme, Loth near Brussels

Modification of Design of Narrow Guide Lathe Beds

Several firms, instead of arranging a special strip for guidance, take the English bed as it is and utilize the front shear for the narrow guide, thus simplifying matters and obtaining an excellent support for the carriage just where it is most needed. Thus, Messrs. John Stirk & Sons, Ltd., of Halifax, England, have adopted the method illustrated in Fig. 37. A strip is fitted against the front vertical edge, and the solid metal of the saddle fits against the inner face of the front shear. At the edge of the back shear there is a working clearance, and two gib strips are used as shown, to prevent lifting. It will be observed that the lead-screw is brought as close as possible to the guiding way. In this design the proportion of length to width of the narrow guide is about 4 to 1, but, as mentioned previously, in some cases where a strip is employed, the proportion may be as high as 10 to 1. Some firms who retain the front shear for guidance, as in the example just referred to, lengthen the wings of the saddle to the right and left in order to increase the bearing length. The tailstock slides between these wings up to the main body of the saddle.

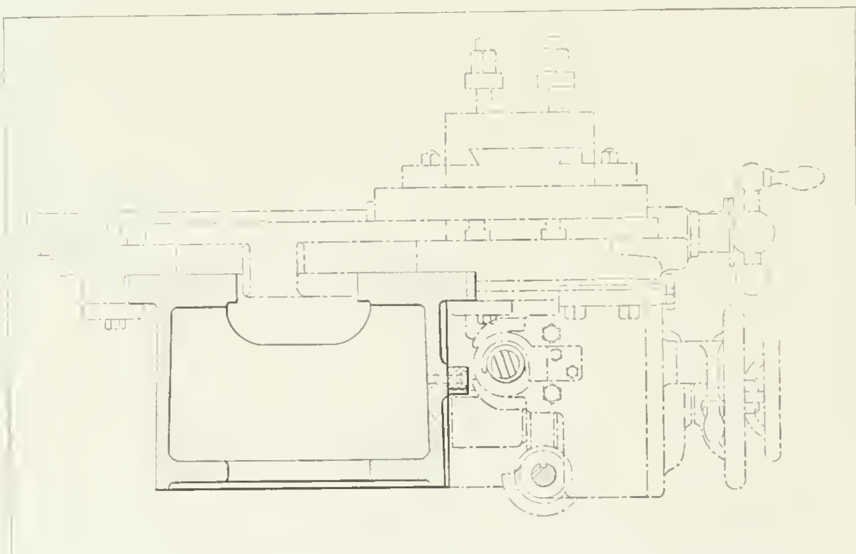


Fig. 37. Example of Narrow Guide on Front Shear of Lathe, designed by John Stirk & Sons, Ltd., Halifax, England

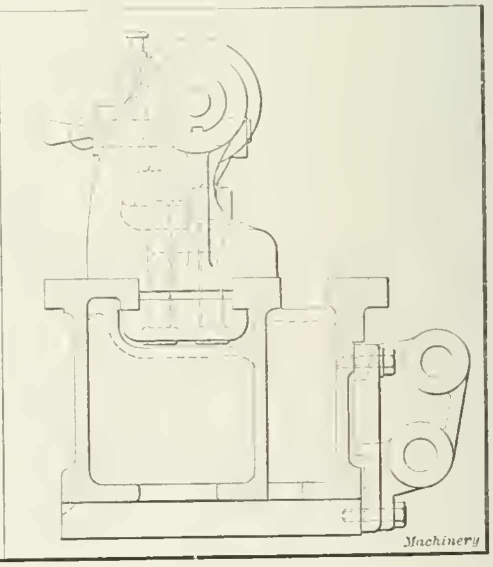


Fig. 38. Method of Fitting the Tailstock on Lathe built by Smith & Coventry, Ltd, Manchester, England

Another design of a new 20-inch high-speed lathe, made by Messrs. Smith & Coventry, Ltd., of Manchester, England, is shown in Figs. 38 and 39. The two views here given illustrate the method of fitting the saddle and the tailstock. The front shear constitutes the narrow guide, with its take-up strip on the front face. The horizontal bearing is amply provided for by three ways; on the two at the rear the tailstock slides, as shown by Fig. 38. Gib strips are located under the front and rear edges.

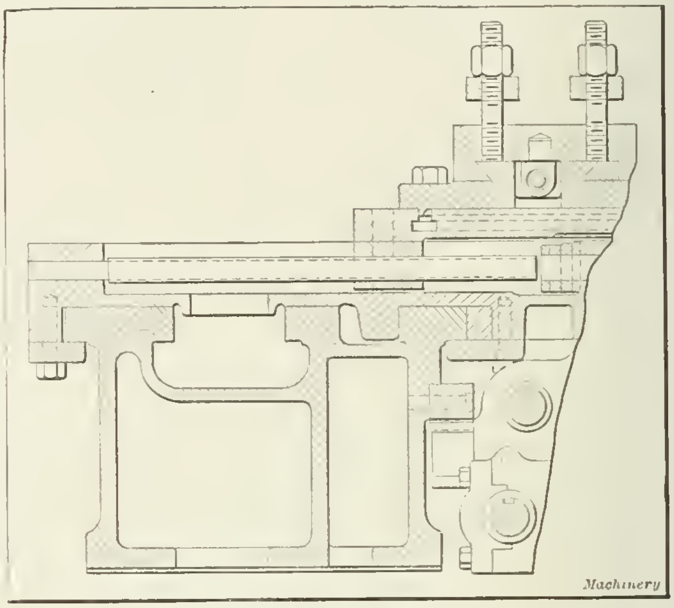


Fig. 39. Bed for 20-inch Lathe with Strip at Front, designed by Smith & Coventry, Ltd.

Messrs. Ward, Haggas & Smith, of Keighley, England, fit their lathes with a narrow guide of the type shown in Fig. 40. This design is of the inverted type, the take-up strip drawing the saddle against the inside sloping face of the hanging lip of the front shear. These surfaces are thus out of the way of the chips, and a great proportion of length to width of bearing surface is secured. The lead-screw and rack are brought very close to the guiding area. Fig. 41 illustrates the method of tightening the tailstock by a clamping plate which presses against a sloping face on the inside of the rear way, thus drawing the tailstock against the back vertical edge of the shear. As this edge is not subjected to wear from the saddle, which clears it, the alignment is preserved indefinitely. Another example of an underhanging lip employed as a guide is that of the high-speed lathes built by Messrs. George Swift & Sons, of Halifax, England, as shown in Fig. 48, which shows the saddle without its apron.

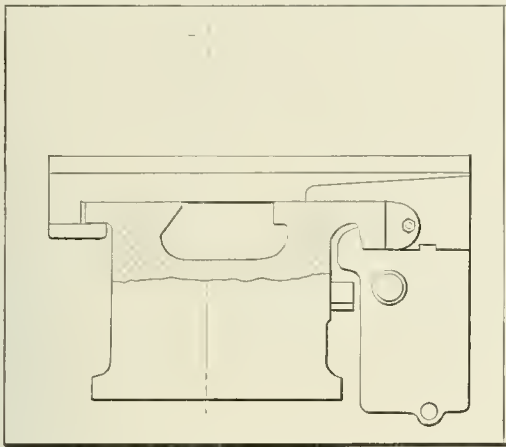


Fig. 40. Lathe Bed with Inverted Narrow Guide, designed by Ward, Haggas & Smith, Keighley, England

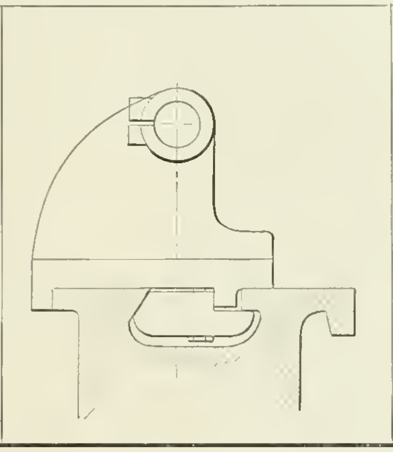


Fig. 41. Method of Clamping Tailstock to Bed shown in Fig. 40

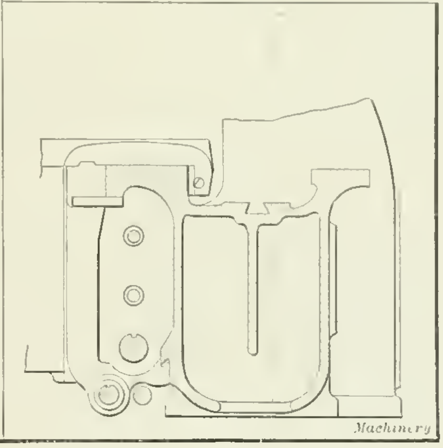


Fig. 42. Section of Bed of the Libby Turret Lathe, built by International Machine Tool Co.

In certain types of lathes one shear is employed alone to guide and support the carriage. This design is met with in a certain type of boring and turning lathe, where two duplicate carriages are run each on their own way, and are entirely independent of each other. A lower slideway or tier takes the overhang of the carriages. In another instance, that of the Libby turret lathe, made by the International Machine Tool Co., Indianapolis, Ind., the carriage fits over the front shear, as shown in Fig. 42, and a lower vee-guide opposes the tilting tendency of the carriage.

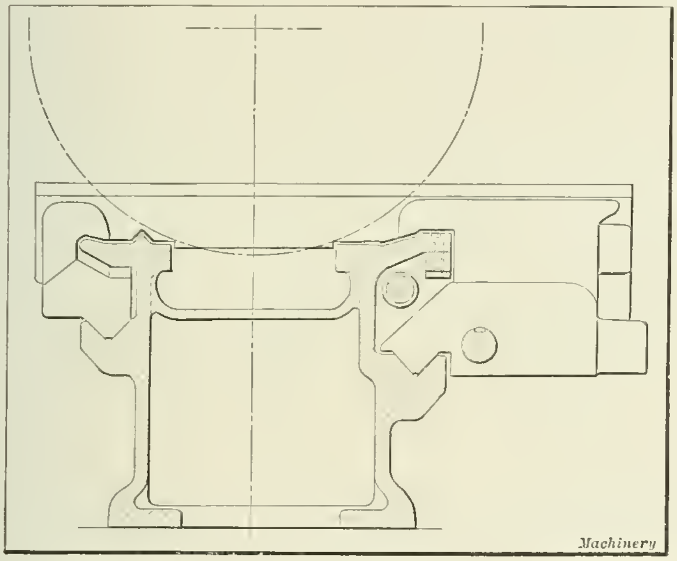


Fig. 43. Bed with Lower-tier Vee-ways as designed by Schaerer & Co., Karlsruhe, Germany

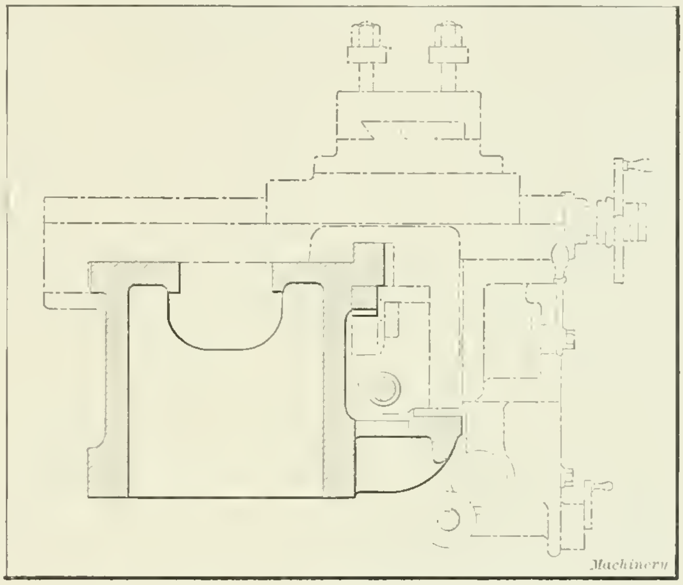


Fig. 44. Double-tier Bed with a Raised Narrow Guide on Lathe built by Darling & Sellers, Keighley, England

Lathes with Carriage Support beneath the Shears

The principle of affording support to the carriage at some point situated below the general level of the bed surfaces is met with in several designs. Perhaps the most successful example is that of Messrs. Darling & Sellers, Ltd., of Keighley, England. A bed section of one of their lathes is shown in Fig. 44. The auxiliary or "lower-tier" bed is made in the form of a strong lip, projecting out from the front of the

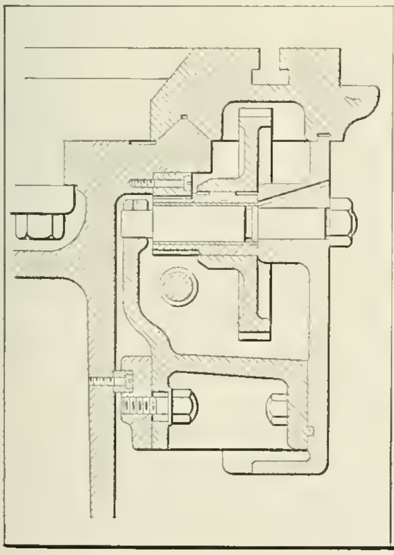


Fig. 45. Support for Apron on a Heavy Lodge & Shipley Lathe

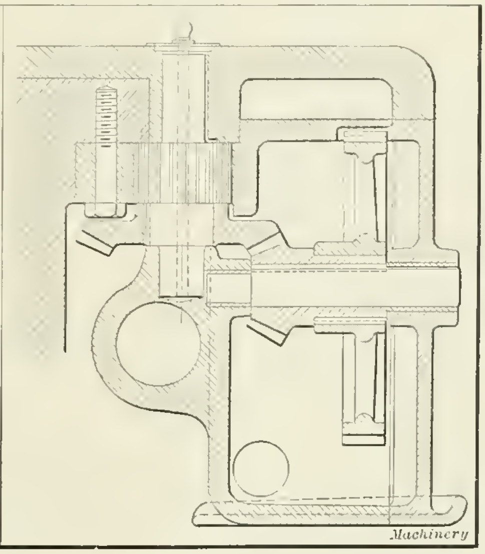


Fig. 46. Vertical Rack and Pinion on Lathe built by Joshua Buckton & Co., Ltd., Leeds, England

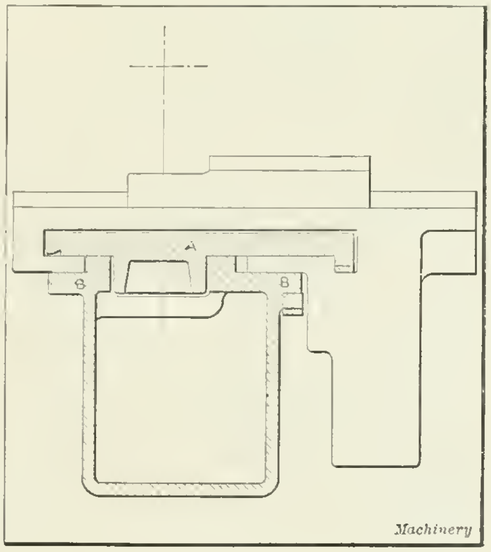


Fig. 47. The Protected Bed as made by George Richards, Ltd., London, England

bed near the bottom. The saddle has a bearing on this, as well as on the top surfaces of the bed. The overhanging weight of the saddle is thus supported in a very satisfactory manner, and it will be seen that the actual effective width of the bed is increased over that of the normal or apparent width at the top. The advantage of this construction in turning large diameters, when the pressure is applied at the extreme edge of the bed, is obvious. The position of the lead-screw and rack eliminates undesirable twisting action This bed is fitted with a narrow guide at the front edge, raised above the level of the bed as shown. A taper strip is used on the front face, and two gibs beneath the lips.

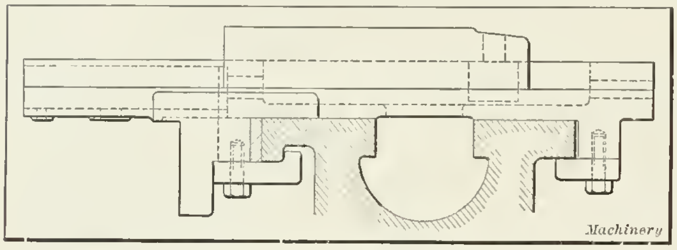


Fig. 48. Lathe Bed with Narrow Guide underneath Front Edge, built by George Swift & Sons, Halifax, England

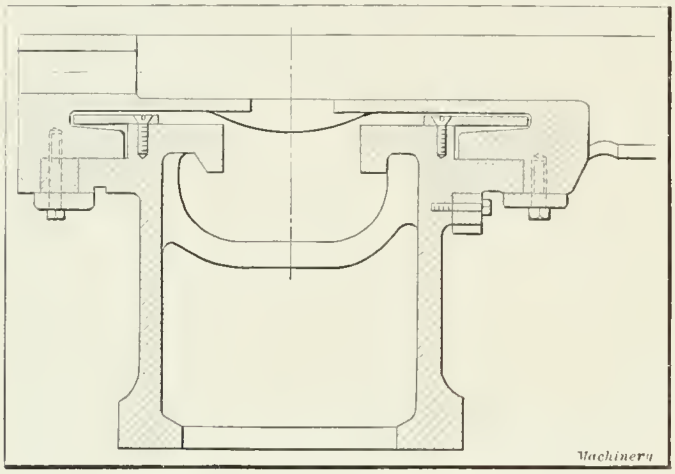


Fig. 49. A German Type of Lathe Bed with Guard Plates over the Slides

In Lodge & Shipley lathes of above 20 inches swing, a supplementary ledge is used, in the form of a steel strip let into and screwed to the front of the bed, as shown in Fig. 45. The back wall of the apron is supported by this ledge, which helps to resist the forces tending to separate the gears and rack and pinion, while under heavy duty. With a similar object in view, some makers support the rack-pinion by the metal of the saddle, in order (see Fig. 10) to prevent the springing away of the pinion. Another device is to alter the position of the rack and pinion to a vertical location, and support the pinion shaft in bearings on both sides of the pinion. A design of this kind is shown in Fig. 46, showing the construction in a lathe made by Messrs. Joshua Buckton & Co., Ltd., Leeds, England.

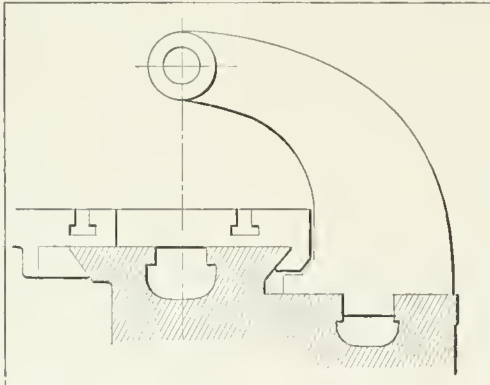


Fig. 52. Double-way Bed designed by Henry Milnes, Bradford, England

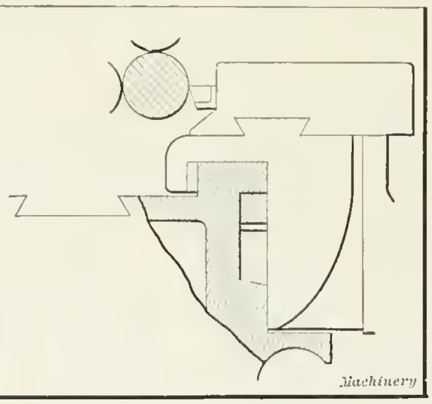


Fig. 53. The Fitchburg Design of Lathe Bed

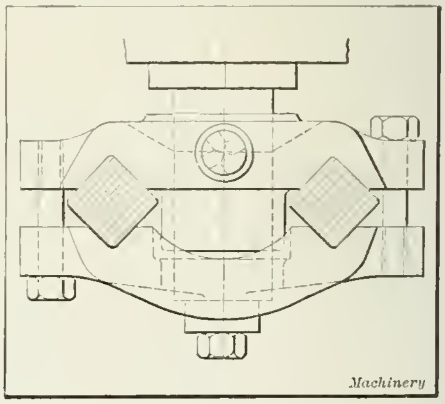


Fig. 54. The Brenot, Buronfosse & Cie Lathe Bed

A different kind of lower-tier bed is made by Messrs. Drummond Brothers, Ltd., of Guildford, England. This bed is employed for their lathes having 15- and 18-inch swing. The gap is permanently open, and the saddle is guided by two lower tiers or slide-rails, so that it can be brought along on these past the gap and close up to the largest faceplate, with a minimum of tool overhang.

Another example of a lower-tier bed is that used in a lathe built by Schaerer & Co., of Karlsruhe, Germany, in which the advantages previously mentioned regarding the support of the carriage below the top level of the bed are obtained. There are two lower-tier vee-ways, as shown in Fig. 43, set at different heights (by which it is claimed that twisting is eliminated), and directly underneath the regular ways, so that chips cannot fall into them. The top of the bed is arranged with a vee and a flat to carry the headstock. The carriage has no bearing on the top, but only in the vee-ways.

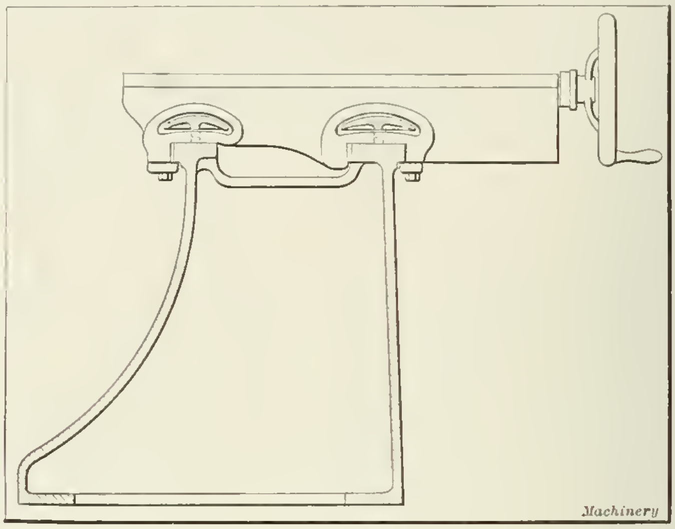


Fig. 50. John Lang & Sons' Lathe Bed with Covers over the Ways

The position of the lead-screw and rack should be noted. In the lathes which have gap beds, the carriage does not overhang its supports, but is carried along by the gap on the vee-ways.

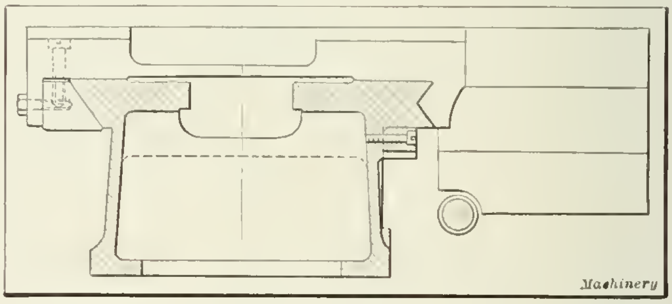


Fig. 51. Lathe Bed with Single and Double Vee-edges, built by H. Wohlenberg, Hanover, Germany

Methods for Protecting the Ways of Lathe Beds from Chips

A few instances are met with in which lathe beds are modified specifically for the purpose of protection. The bed is either cast of such a form that the slides come below the top surface, as in the example just noted, or extra covering plates or guards are fitted to keep the chips away from the bearing surfaces. A bed made by the London firm George Richards, Ltd., Fig. 47, has a top portion *A* which serves as a cover over the slides, and at the same time guides the saddle at the front, forming a narrow guide between its inner face and the outer front edge of the main bed. The surfaces *B*, on which the carriage slides are, therefore, absolutely protected from chips, and the lubricant does not become dirty. At the top of the portion *A* the saddle clears this casting.

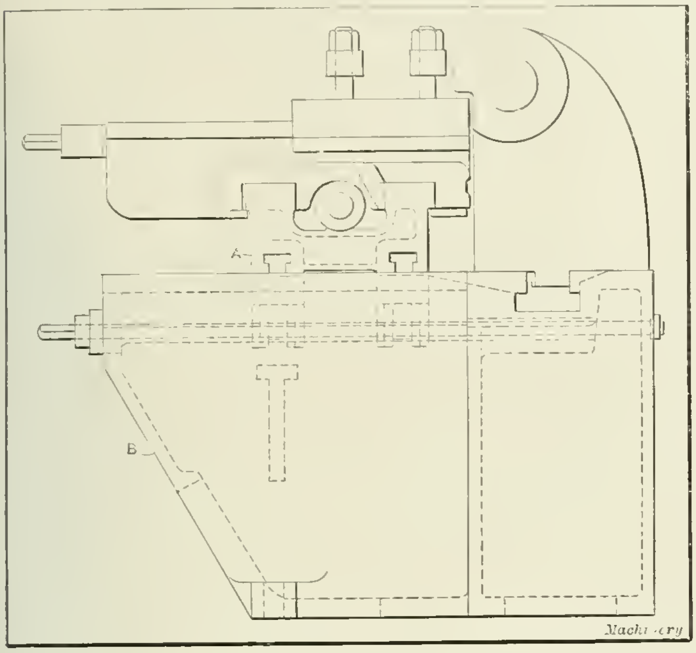


Fig. 55. The Dron & Lawson, Ltd., Glasgow, Scotland, Lathe with Extensions carrying Supplementary Bed for Carriage

Fig. 49 shows a German bed section which has the slideways arranged a little below the top surface. Steel covering plates, screwed on as guards, prevent chips from falling onto the ways. The tailstock slides on the top part of the bed, between the inner edges of the covering plates.

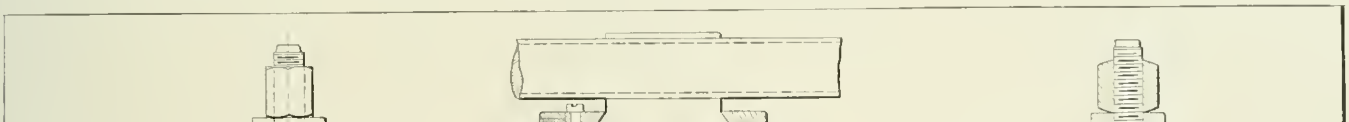


Fig. 56. An Italian Design of Lathe Bed with Gibs on Bottom Edges and Lead-screw between Shears; designed by Officine Dubosc, Turin, Italy

Messrs. John Lang & Sons build a range of surfacing and boring lathes (chucking lathes) without tailstocks, in which curved cast-iron guards, supported on short studs at each end, extend from the tail-end of the bed up to the chuck, so that chips cannot fall upon the flat ways of the bed, but are deflected by the guards and thrown off to one side. The section of a bed with its saddle cored to pass the guards, is shown in Fig. 50. It will be noticed that the saddle bears against the vertical edges of the front shear only, giving a narrow guide-way with a relation of length to width of about 7 to 1. The cross-slide (not shown) also fits on the same principle, being gibbed to the two edges of one slideway.

A rather curious type of bed is shown in Fig. 51. This type resembles an English bed at the back shear, but has a double "vertical" vee at the front edge. This lathe is made by H. Wohlenberg, of Hanover, Germany.

Double-way Type of Lathe Beds

Among the lathe beds which are made to but a limited extent are those of the double-way type, that is, beds with separate ways for the carriage and the tailstock. They are useful for work where it is required to move the carriage rapidly out of the way, and bring the tailstock up to the head without having to remove the carriage each time. The illustration Fig. 52 shows an example of this class, constructed by Henry Milnes, of Bradford, England. The tailstock slides on a back shear, below the carriage ways.

A special type of double-way bed, Fig. 55, the speciality of Messrs. Dron & Lawson, Ltd., of Glasgow, Scotland, comprises a flat-topped way carrying the tailstock, the tongue of which has a tapered adjusting strip to maintain the fit in the groove, and a loose bed *A*, resting on two extensions *B* which project from the main bed. The auxiliary bed *A* can be swivelled on the extensions for taper turning, and can be adjusted to and from the centers. The slide-rest is carried on bed *A*, and is fitted by a narrow guide at the front. The slide-rest can be moved past the tailstock, and the center of the latter need not overhang. Motion is conveyed to the screw of the slide-rest, for feeding, through a universal-joint shaft, from the gear box in front of the headstock. Graduations indicate the amount of taper when the bed is swivelled. A similar principle is employed in the Niles lathes for turning printing-press cylinders, paper-machine rolls, etc., there being carriages both at the back and front, sliding along supplementary beds or rails, which are themselves adjustable to and from the center.

Beds for Front-slide Type of Carriage

A special form of bed is adopted for the front-slide type of slide-rest. In this type of lathe, the carriage fits against the front vertical face, and is retained by vees, external or internal, or by a combination of a vee and a square edge. The advantages are that the saddle can be moved past the headstock and tailstock, that it can be provided with a vertical adjustment for milling and other purposes, and that the front faces and the lead-screw are protected from injury through chips. The construction is used chiefly for precision lathes of small size. Fig. 57 shows the section of a front-slide bed built by Messrs. G. Birch & Co., of Manchester, England. The arrangement of the saddle should be noted, as well as the mechanism for elevating, which comprises a pinion and rack, the pinion being turned by a handle or by gears through a universal-joint shaft.

The bed of the Lo-swing lathe (see Fig. 53), built by the Fitchburg Machine Works, Fitchburg, Mass., is another example of a special design evolved to avoid the built-up design of slide-rest in which the horizontal tool pressure acts at a point a considerable distance above the bed which has to resist it. This lathe, made for turning bar work between centers, has the tool-holder situated but slightly above the lip of the bed which takes the pressure.

Miscellaneous Lathe Bed Constructions

Fig. 56 is another unusual design of bed, employed in some small lathes built by the Officine Dubosc, of Turin, Italy. Here the lead-screw is located within the bed. The gibs under the edges of the top shears are dispensed with, and their place is taken by a couple of strips *A*, pressed up by set-screws underneath the bottom edges of the two shears. This construction makes possible the half-nut arrangement shown, a cam-plate device being used for opening and closing the halves of the nut. The internal ribbing of the bed should be noticed.

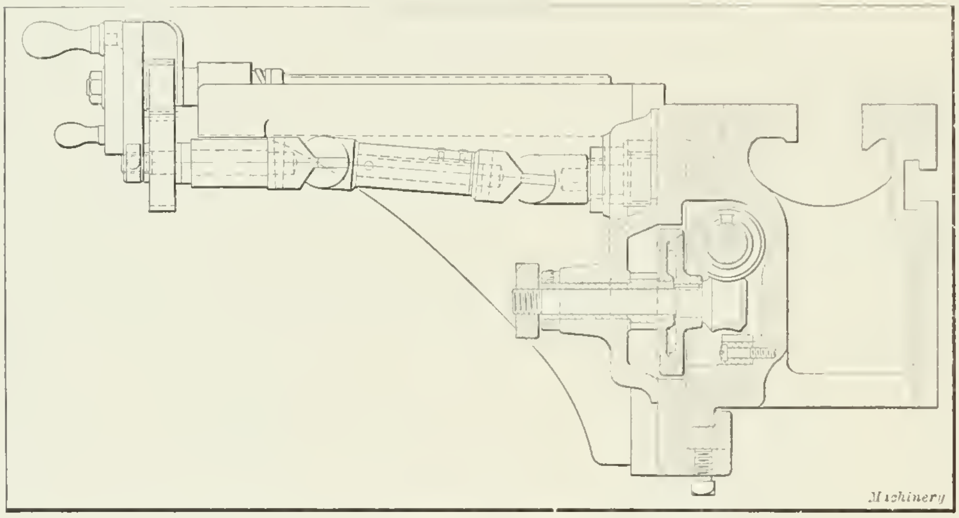


Fig. 57. Front-slide Bed of G. Birch & Co.'s Design

As a final example of a special type of bed, the double square bar design, Fig. 54, is shown. It represents a type employed in France for screw-making lathes, operated by hand, all the principal parts, including the bars, being of hardened steel and ground. The slide-rest fits on the two bars, and is slid along them by means of a lever motion. The headstock is also clamped to the bars. This lathe is made by Messrs. Brenot, Buronfosse & Cie, of Paris.

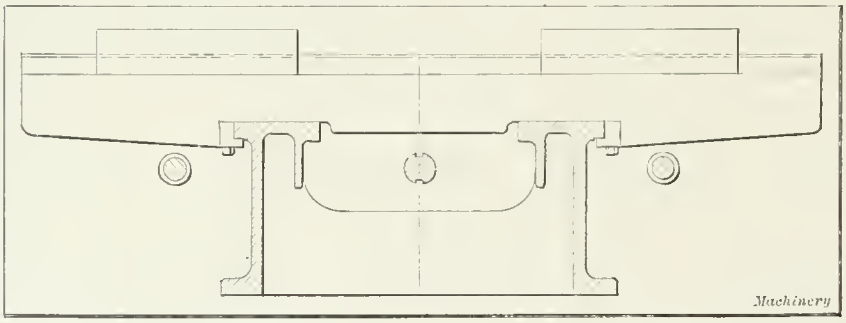


Fig. 58. Bed of Large Lathe with Internal Ribbing, as built by Hulse & Co., Manchester, England

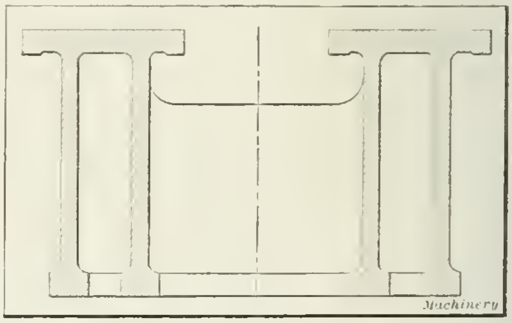


Fig. 59. Lathe Bed for Heavy Lathes with Double Webs

Beds for Heavy Lathes

When comparing the sectional forms of beds for large lathes with those of the ordinary type for the smaller and medium-sized lathes, the principal differences are found in the extra strengthening and stiffening of the large beds, in addition to differences in the form and number of their slideways, and in the building up and jointing of the sections, which for manufacturing reasons sometimes take the place of a single large casting. Extra ribbing or webbing is one of the first changes introduced as the sizes of beds increase, as shown in Fig. 58, where webs are carried down on the inside from the top, and in Fig. 59, where the inner ribs completely duplicate the outer webs. Many variations of this type exist, which it is impossible to illustrate here. It may be mentioned that the bed in Fig. 58 is from a large lathe by Messrs. Hulse & Co., Ltd., of Manchester, England, provided with the firm's non-rotating twin lead-screws. There is one screw on each side of the bed, as shown, so that the saddle is propelled in a perfectly even manner, without risk of twisting.

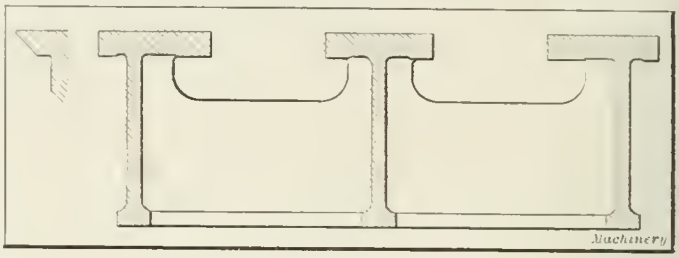


Fig. 60. Heavy Type Bed with Three Ways

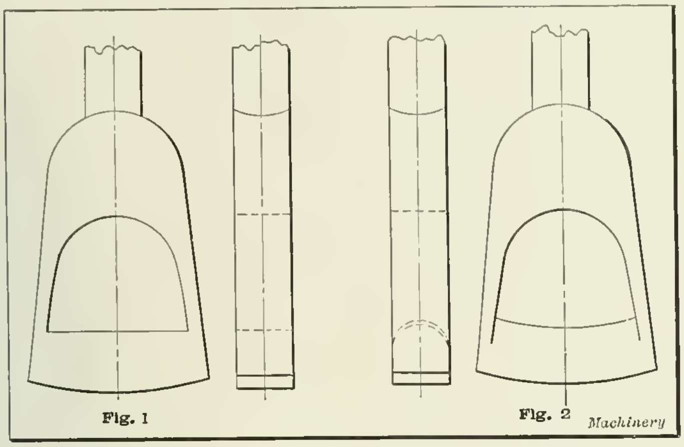
The number of ways is increased to three, four, and even more, in large beds, according to the design of saddles employed, and their number. Three ways, as shown in Fig. 60, are frequently employed when there are independent front and rear saddles, which fit on the front and back ways, respectively and rest partly on the central one so that they may pass each other. The edges may be square or of vee form as indicated in the illustration. Beds with four slide-ways for two or more independent saddles are often used in place of the type in Fig. 60, in the larger lathes. The fitting of saddles and rests for turning large diameters on faceplate work introduces the use of wing or sole-plates, extending from the side of the main bed, or in some cases cast with it and provided with a slide-way. For certain functions, as in wheel lathes, a long cross-bed passes across in front of the faceplate, and is bolted to wings extending from the sides of the main bed. In any case, for turning large diameters, it is necessary to make the effective width of the bed sufficient to bring the tool-rests out to the required radius.

In some types of lathes for facing only, there is no bed at all, but only a stand to carry the headstock, and a tee-slotted plate in front of this, which has no slide-ways, but which simply supports the tool-rest.

SPADE-HANDLE FORMING MACHINE

By FRANK W. SPENCER

Some time ago the writer had occasion to design a machine for forming or shaping the "grips" of ordinary spade handles. Figs. 1 and 2 show the handle before and after being shaped.



Figs. 1 and 2. Spade Handle before and after being formed

Formerly these handles were shaped by hand with a spokeshave, and although they were finished by this method in fairly good time, it was thought that the work could be done more cheaply and the handles be made more uniform in shape by using a properly designed machine.

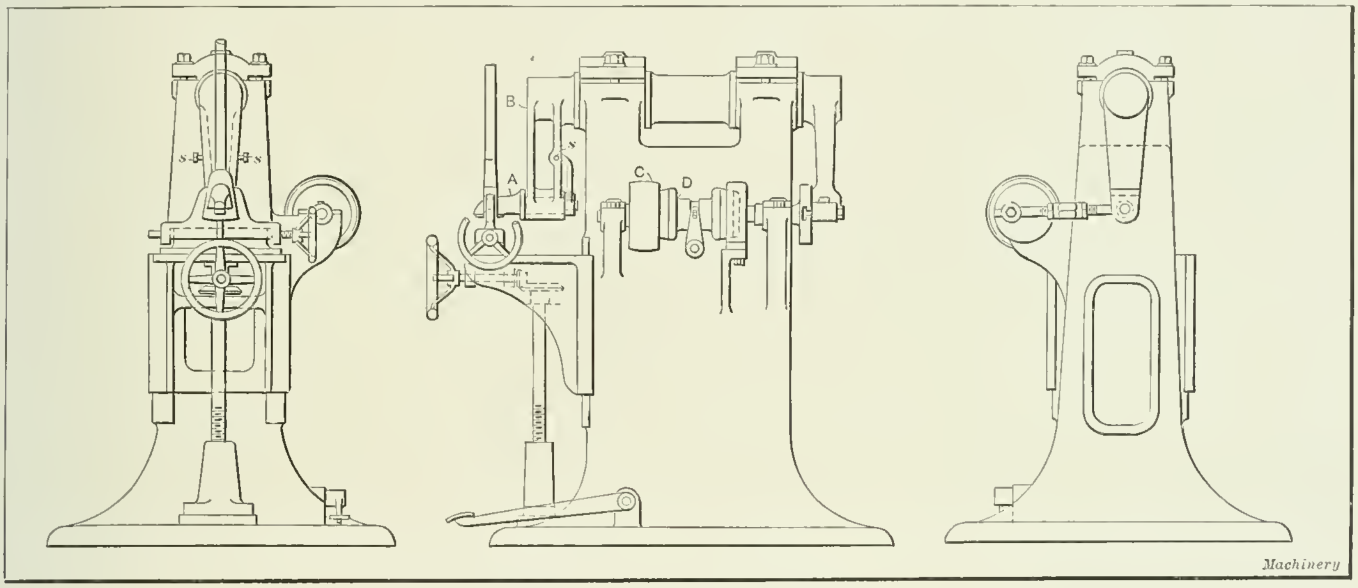


Fig. 3. Spade-handle Forming Machine

Fig. 3 shows front, side and rear elevations of the machine used for this purpose. As will be seen, it bears a rather striking resemblance to a milling machine. The inside of the handle is finished by a double-edged cutter of the proper radius, which is mounted in the holder *A*. This holder is carried by arm *B*, which is given an oscillating motion by a crank mechanism at the rear of the machine. The holder, which is shown in detail in Fig. 5, is not held rigidly in arm *B*, but is allowed a slight oscillating movement independent of the arm, which permits the cutter to tip over slightly at the end of each stroke, so as to bring the opposite cutting edge into the working position. This tipping movement is controlled by set-screws which come in contact with a dog on the rear of the holder (as shown in the front and rear detail views, Figs. 6 and 7) thus limiting the amount that the cutter is inclined in relation to the work.

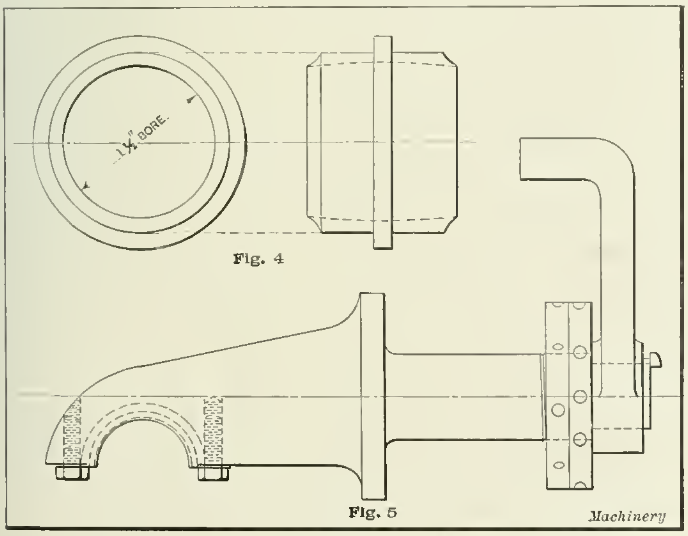
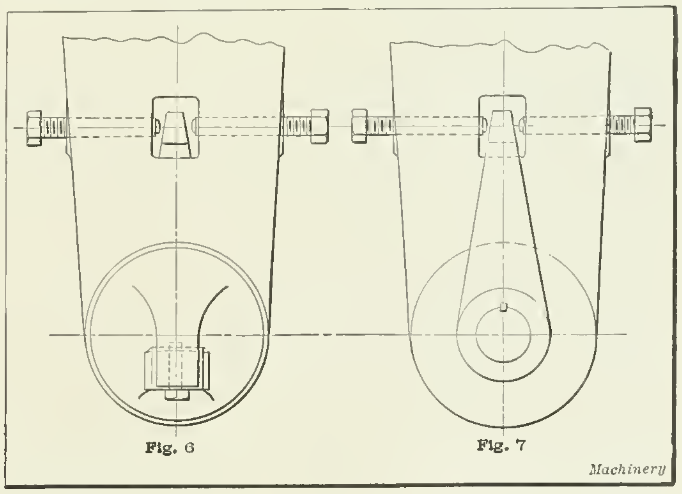


Fig. 4. Method of making Cutters. Fig. 5. Cutter Holder

In the operation of the machine, the spade handle is slipped over the cutter and clamped in a vise. The operator then engages driving pulley *C* with the crankshaft by means of a friction clutch *D* which is controlled by the foot-treadle shown. The handle is fed upward against the oscillating cutter by the handwheel seen at the front of the machine. As the cutting edge of the cutter is about one-half inch below the axis of the holder, as shown in Fig. 5, the edge on the leading side is automatically kept in the working position. For example, when the arm swings to the right, the right-hand edge is in action and when the movement is reversed, holder *A* automatically tilts and brings the left-hand edge into the working position. This simple arrangement enables a clean cut to be taken right up to the corners of the handle. The friction clutch *D* is double-ended and when the foot-treadle is released for stopping the machine, the rear end of the clutch automatically engages a stationary cone, which acts as a brake and instantly stops the oscillating movement. This feature enables the operator to remove the finished handle and insert a rough blank without loss of time owing to the machine's continued movement due to momentum. This engagement of



Figs. 6 and 7. Front and Rear Views of Cutter Holder and Mounting the clutch with the stationary cone is effected by a spring located inside the base.

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* Address: 183 Javin Hill Ave., Dorchester, Mass.

The first cutter that was made for this machine was forged and then filed and ground to the proper shape, but this required too much time and was too expensive. The method now employed is indicated in Fig. 4. A piece of tool steel is bored and turned to the cylindrical shape shown, and this shell is then sawed in half, thus forming two cutters, which are ready for the machine after being hardened and tempered. The annular projection or shoulder formed on the back of each cutter fits into a recess in the holder and takes all the cutting strain, thereby relieving the retaining set-screws.

* * *

REMARKS BY THE ONLOOKER

Nothing illustrates to my mind more clearly how gear cutting has been improved in the last few years than the construction of the high-duty lathe shown on page 395 in the January number of MACHINERY, engineering edition. Many of the readers no doubt recall the warning of the boss in past years when a specially fine job was wanted, *viz.*, "Don't use the back-gear," and there was a reason. The lathe referred to is nothing but gears in the headstock and the work from it is not complained of, which goes to show that gear cutting is now a fine art. Still the old desire for a cone drive is evinced by the fact that the American Tool Works states that it is also making this with the cone drive. I recall a story which the illustration of the lathe suggests of a somewhat "overtook" machinist who had applied for a job and had been told to take off his coat and get busy on a lathe pointed to. The man eyed the tool a moment and then said, "Say boss I said I was a machinist, not a blamed organ player. What in h— is all them handles for?"

The making of steel stamping dies as described by Mr. Lucas is interesting. I wish there were some way to teach the average machinist how to use steel stamping letters and figures on machine parts so that they would not have the appearance of having had "a night off." Very often the appearance of a fine piece of work is spoiled by slovenly marking. I suggest that the figures and letters have their sides machined with the figure or letter as the center. Then by the use of a straightedge and spacers, much better work could be done by the average machinist. The letters as now made are not always central with the body, and it is difficult for a man to estimate just how he should hold the letter to get true alignment. One of the hard things to do in a shop is to make the boss believe that a set of letters or figures ever wears out, gets broken or lost. Referring to the illustration Fig. 10, of the article, I am moved to say that perhaps times have changed. If I had filed with my forefinger, as shown, when serving my apprenticeship, it would have been unhealthy. My boss has a trick of whacking a fore-finger so placed, and I learned my lesson with the first whack, as it was a cold morning.

"Ex-toolmaker" makes some statements which I cannot accept. I know that there are many more expert machinists and toolmakers now than there were twenty years ago, and I will go farther and say that there are better men at work today than then. Fine work was done then, but it is now done more accurately and in very much less time. The fact overlooked by "Ex-toolmaker" is that there are many more people employing the skilled man now than there were twenty years ago. Just why it is not wrong to "time clock" a man who cannot read, and wrong to excuse a man who can read, is not clear to me. The statement that the average proprietor does not recognize the distinction between skilled and unskilled mechanics will not stand investigation. The proprietor is recognizing this all over the country by paying toolmakers considerably more than automatic machine tenders. I frankly admit that the distribution of wages is not fair. We now overpay the poor workman and underpay the good workman. This fact discourages the skilled man, and I think is more likely to be the reason, if there is a single reason, for his wanting to get out of the trade than what "Ex-toolmaker" suggests. The poor machinist has got into the wrong place; he might have made a very good tailor or bookkeeper, but he made a bad choice to the detriment of all concerned. The average manufacturer and all large establishments do not put their office help on honor, but use a time clock, and we read that at the Bethlehem Steel Co.'s works the president, Mr. Charles M. Schwab, is on the time clock the same as the rest of the employes. Just who is to call him down if his punching is not up to the standard, I have not found out.

The crankpin turning machine shown is very interesting to me, on account of the "full width" chip. I suppose the machine described by Mr. Perkins, and the one referred to by "Nomad" are the same. In grinding, Mr. Norton has shown the advantage of "full width" work, but I am not at all willing to accept the assertion that rapid and accurate work can be accomplished by the machine described. I will admit the rapid part, but when it comes to the accuracy, I balk. Ounces or even pounds of metal are being removed, to grains when grinding, and that is quite a different matter when accuracy is the object. I should say that a combination of the crankpin turning machine and a modern grinding machine would give very satisfactory commercial results.

I was delighted to read the "Chordals Letters" extract in your editorial. There seems to be a curious idea abroad that by the juggling of a name, great results will follow. "Scientific nonsense" would be the right term for a large amount of half-baked work now being done under the guise of scientific management. Strip it of all wordiness and put it in plain language, and Chordal's story simply tells of common sense, as useful in the machine shops as anywhere.

The gas engine industry referred to in the editorial on farm work is a great coming one, and one which has not far to come either. In fact, it is here and is only kept from a far larger development for the reason that, as yet, the cause of an internal combustion engine's doings, or rather misdoings, have to be searched for and found by elimination. When these troubles can be accounted for and found as easily as can those afflicting the steam engine, the greatest obstacle to the universal use of gas engines will be removed.

If I were to expand on automatic *vs.* hand machines, there would not be room enough in your total next year's issues to print what I would have to say. It is one of the most interesting topics of the day. "I ride with you" for a certain distance in your remarks, but jump right off when you introduce the idea that automatic machines and manufacturing are more closely allied than making or building machinery. While the saving is great in manufacturing, I believe it can be made greater in building, *i. e.*, making a single article. This perhaps will not be believed and should not be without further evidence, but let me cite a case. A Jones & Lamson flat turret lathe, will in many cases, turn out a single piece at as low a cost as any engine lathe, provided equally skilled men are employed. It will turn out half a dozen pieces at a very much lower cost than the engine lathe, but neither can do two operations at the same time, so there are a lot of possibilities loafing most of the time. If we had machine tools of one function only, cheap and substantial, they could do one operation far more efficiently and rapidly, and many operations could go on at the same time with a distinct gain. So I say, make tools of single functions only, like a thread miller, with a fair range of capacity. While the thread miller is cutting the thread, a blank is being turned in another machine, and so on. These machines should be so designed that they have one function only, which cannot be changed. I paraphrase your last paragraph in the editorial by saying: "Provide machines of single function with a reasonable range of work, and get over the idea that it is wise to buy a hay rake, a stove lifter and a milking stool all in one." I suppose this will stir up somebody who knows a lot more than I do on the subject, and who does not believe a word I say.

The heavy outlining of a machine tool as shown on page 390 seems to me a very good idea if it helps to carry the general form better in the mind and makes the tools seem alive, and thus helps the salesman. Right here can be taken up the question that "L" and Prof. Cardullo are considering: "how best to get rid of what you make." It is the burning question with all tool builders. It seems to me self-evident that the first step is to let the world know that you have something to sell and what it is. The pages of a recognized trade journal are the best medium to distribute the knowledge you want people to have, and there is where machinery people look for information in their line. The man who gets rid of the goods is the "king pin," and what he is paid must bear the same proportion to returns as in any other department.

The article on "Herringbone Gears," by Mr. Day is very instructive, and the pith of the entire article is embraced in his assertion: "Herringbone gears completely overcome all these difficulties, but only when they are accurately cut," and there is the rub. On small sizes of herringbone gears I have had little trouble, but on large sizes I have had a great deal.

The briquetting of metal borings is something to think about, but at first sight the question suggests itself, whether the result justifies the expense saved in very large works. I wonder if an inexpensive machine for small shops would not sell well? As it is now, the steel chips take up a lot of room and are often depreciated in value by being thrown out in the weather. The briquetting system would save room, but it might not show much profit.

I am a crank on small tools, and what I mean is, I believe there is no more fruitful source of loss than making small tools in the shop instead of buying them from the manufacturers who specialize on small tools. The counterbore made by the National Tool Company is an example. Here a carefully considered design is produced and made by those who are skilled in that class of work and standard sizes are provided. The cost of each is less than that of a drawing for a special counterbore. There are many other small tools which are better bought than made, and I blame the small tool people to a large extent because they do not advertise more what is available. There is a general feeling that such tools cost a lot simply because the cost is at once before the eye, while to have Bill make the counterbore covers up the cost for a time at least, and anyway it can be "run in on a job." We have it from a prominent man lately that dynamite "always acts downward." The ability to see a hole in the ground and the inability to see a hole in the air accounts for his utterance. Making small tools at home and considering it a money-saving proposition is on a par with the dynamite idea.—W. D. F.

* * *

MAKING A FERRULE IN ONE OPERATION

By THOMAS ALMA

The accompanying engravings illustrate a ferrule and the method of blanking, drawing, redrawing and finishing the hole in the bottom, in one operation. The die, which is shown in Fig. 1, is not a complicated one, nor is it difficult to construct. That it is practical is obvious from the fact that it is producing ferrules at the rate of 1080 per hour. This shows the possibility of combining several operations in one.

The punches and dies were made of 0.120 point carbon steel, and used in a No. 3½ Bliss double-acting press. This press was used because there was no smaller press available in which the dies could be used. The tools, on account of their small size, were made from bar stock, but in general, drawing punches and dies, except for small work, should be made either of cast iron or cast steel. In some cases a cast-iron die is just as efficient as one made of tool steel. It is the writer's practice to make a pattern and cast the die, punch or blank-holder as nearly to size as possible, thus dispensing with the machining and bench work. In making this die, the first thing done by the bench-hand was to make male and female sheet-metal gages, about 1/16 inch thick. These gages must be full size, not half gage, as it is very easy for a lathe-hand to misread his micrometer one turn, 0.025 inch, but there is no excuse for a workman not making a part right when he has gages to work to, and, moreover, it is quicker to work to the gages.

This set of tools, as can be seen at a glance, requires only straight lathe and grinder work; therefore, after the bench-hand had made the templets, he had no more to do with the tools until they were turned, hardened and ground and came back to be assembled. The cutting punch was only hardened on the end, leaving the shoulder soft, thus making it possible to get a perfect alignment for the two ⅝-inch sub-press pins, after the die and punch were hardened and ground. The blanking die, as well as the first and second drawing dies, had to be true with the outside diameter, as each in turn was recessed out for the other. Thus it was a simple matter to assemble the die. It was also certain to be in line with the re-punching punch, provided the cast-iron die-holder was bored out complete at one setting. Alignment is very essential on this kind of a tool. The blanking, first drawing punch, and extreme end of the second drawing punch all have to be ground true with the outside diameter.

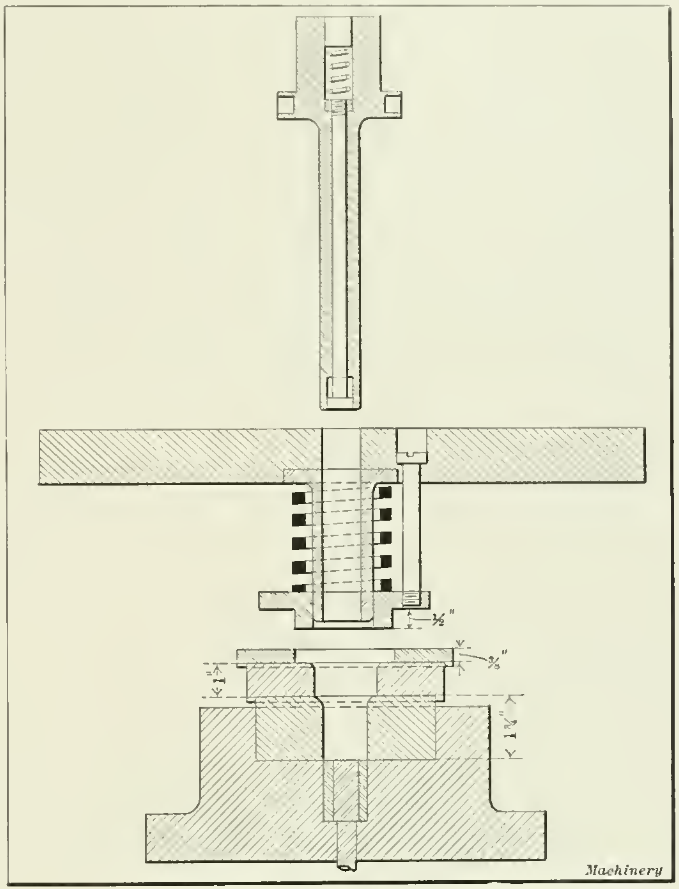

Fig. 1. Die for Blanking, Drawing, Redrawing and Punching the Hole in a Ferrule in One Operation

The second operation drawing punch, which is also the re-punching die, is provided with a spring stripper. This stripper has a rod passing through the punch, held in place by a nut. Behind the stripper is a spiral spring, held in place by a blind screw. Six 5/16-inch holes are drilled in the shoulder of this punch, for holding the punch to the ram of the press. By making the spring stripper in this manner, the scrap from the ¾-inch hole in the bottom of the ferrule is retained on the inside of the shell when it is ejected. The spring stripper which operates the blanking punch is turned down, so as to take up as little room as possible. Figs. 2 and 3 show the construction of the blanking punch and the die-holder, respectively.

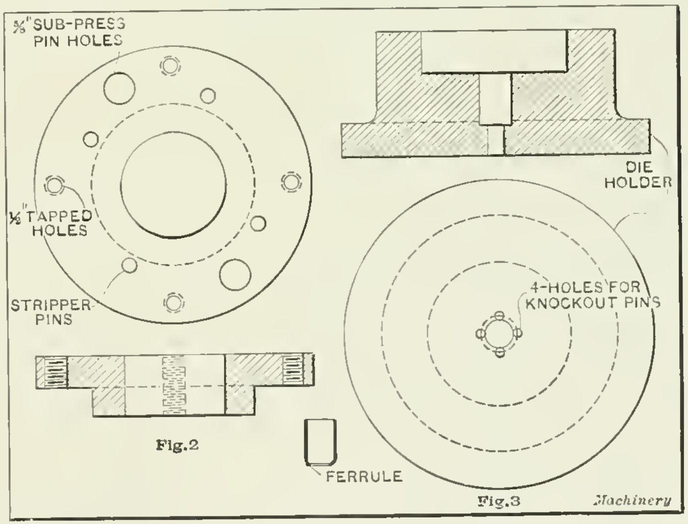

Fig. 2. Blanking Punch and Blank Holder Fig. 3. Die-holder

MAGAZINE ATTACHMENTS—1

APPLICATION TO THE BROWN & SHARPE AUTOMATIC SCREW MACHINES

By DOUGLAS T. HAMILTON*

In addition to the milling, cross-drilling and burring attachments which were described in MACHINERY from September to December, 1911, inclusive, the Brown & Sharpe Mfg. Co. has also designed a number of magazine attachments, both of special and standard nature. Most of these attachments are held on the same bracket as the milling, cross-drilling and burring attachments, etc., and are removed in a similar manner. Some of the attachments are fed by hand while others are semi-automatic in their operation. All that is necessary in the way of operating is to dump the parts on which a second operation is to be performed into the hopper, from which they are transferred to the chuck. The chief value of a magazine attachment is that it facilitates the handling of parts, such as are shown in Fig. 9, which have to be operated upon on both ends, thus necessitating re-chucking.

Magazine Attachments for Handling Plain Cylindrical Work

A magazine attachment used for handling plain cylindrical pieces on the No. 00 Brown & Sharpe automatic screw machine, which is made adjustable and fed by hand, is shown in Fig. 1. This attachment consists mainly of a movable slide *A* pivotally connected to the two sides *B* and *G* of the trough. The slide *A* is corrugated on its top face to reduce its frictional resistance to the work, and rests in a V-groove in the carrier *E*. When the cross-slide is in its "back" position it is moved back and forth (by small lobes on the cross-slide cam), so that the slide *A* is raised and lowered to prevent the work from cramping in the trough. The trough is supported by a bracket *C* fastened to the pin *D*, which acts as a stop for the cross-slide. The carrier *E*, which removes the work from the chute to the chuck, as shown by the dotted lines, is fastened to a block *F* held to the cross-slide by means of a tee-bolt and nut as shown. The plate or side *G* is adjustable on the studs *H*.

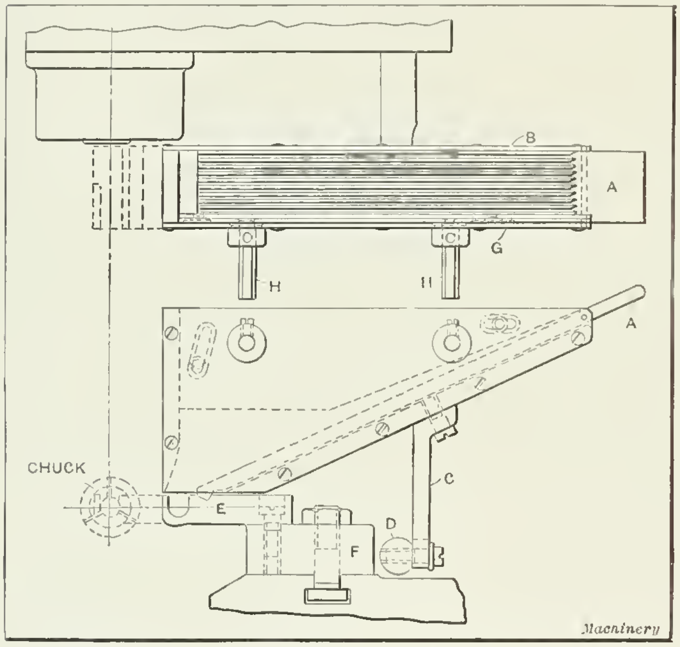

Fig. 1. Standard Adjustable Magazine Attachment for Handling Plain Cylindrical Pieces on the No. 00 B. & S. Automatic Screw Machine

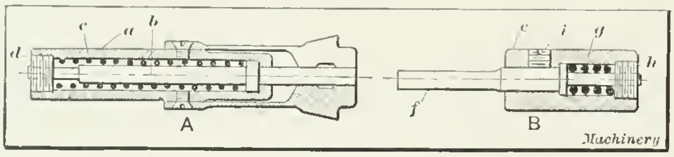

Fig. 2. Spring Collet and Work Inserter used in Connection with the Magazine Attachment shown in Fig. 1

The work is forced out of the carrier *E* into the chuck shown at *A* in Fig. 2 by the plunger, shown at *B*, which is held in the turret. The chuck is provided with a work-ejecting mechanism consisting of a sleeve *a* held in the chuck by two flat-headed screws. Inside of the sleeve is a rod *b* operated upon by a spring *c*. A hollow nut *d* is screwed into the rear end of the sleeve *a* to prevent the spring from coming out. The plunger or work-inserter shown at *B* consists of a sleeve *e*, fitting the hole in the turret and bored out to receive the plunger *f*. This plunger is operated upon by a spring *g* held in the body by a nut *h*. A set-screw *i* is provided to prevent the plunger *f* from turning when it is of flat cross-section, thus holding it in the correct relation to the hole in the chuck.

In operation, as the piece comes down the slide of the magazine attachment shown in Fig. 1, the turret is advanced, and the inserter, shown at *B* in Fig. 2, forces the work out of the carrier into the chuck, and pushes the plunger *b*, in the chuck, back against the tension of the spring until the shoulder on the plunger butts against the stop-nut *d*. The chuck is then closed and the turret drops back. When the operations on the piece are completed, the chuck is opened and the spring *c*, which has been compressed, ejects the piece from the chuck.

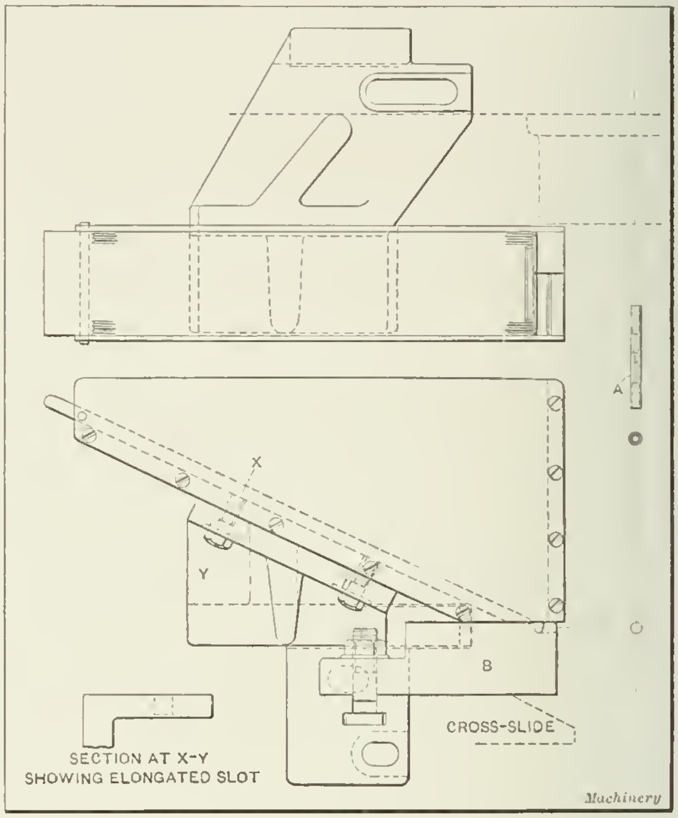

Fig. 3. Magazine Attachment for Handling a Counterbored Sleeve on the No. 2 Brown & Sharpe Automatic Screw Machine

A magazine attachment somewhat similar in construction to that shown in Fig. 1, but which is not adjustable, is shown in Fig. 3. This attachment is used on a No. 2 Brown & Sharpe automatic screw machine for handling the counterbored sleeve shown at *A*, Fig. 3, and also at *G* in Fig. 9. The work-carrier *B* is fastened to the front cross-slide and is provided with a circular groove for holding the work. The slide is corrugated and fastened to a bracket as shown. The work is held in a chuck, when being operated upon, and inserted the same as in the previous case.

In Fig. 4 is shown a magazine attachment for handling headed bushings, two of which appear on the table. The attachment proper is fastened to a bracket by cap-screws, and is built up of two strips *A*, held apart by blocks *B*. A slot fitting the head of the bushing is cut in each strip so that the work can only be placed in the slide with the head facing the turret. The chuck is provided with a spring-actuated inserter *C* held in the turret. The work-carrier *D* used on this attachment differs in construction from that previously shown, as it is necessary to open it before the work can be inserted in the chuck because of the shoulder on the work.

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* Associate Editor of MACHINERY.

The construction of this type of work-carrier is more clearly shown in Fig. 5.

Magazine Attachment for Holding a Safety Razor Handle

The safety razor handle shown at *A* and *B* in Fig. 5, and also at *A* and *B* in Fig. 9, which is used on the famous Gillette safety razor, is finished in the Brown & Sharpe automatic screw machines. The first operation consists in turning, forming, knurling, drilling and tapping one end, and cutting off, producing a piece as shown at *A* in Fig. 5. Then the handle is taken to another machine and put in the slide of the attachment shown in the illustration, fed to the chuck, and a hole is drilled clear through the handle, and one end is bell-mouthed.

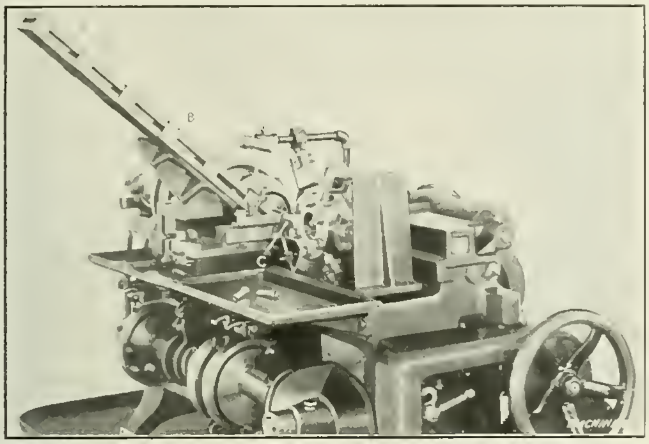


Fig. 4. Magazine Attachment for Handling a Headed Bushing

The top and bottom plates *C* of the slide are milled to suit the shape of the handle, and as it is provided with a shoulder, some means must be adopted for opening the work-carrier to eject the piece. The work-carrier consists principally of two blocks *D* and *E* and a finger *F*. Block *D* is held to the cross-slide, while block *E* is fastened to the top face of block *D*. The forward end of block *E* is cut out to fit the work, which is held in place by the finger *F*. This finger is fastened to a lever *G*, pivoted on block *D*, and prevented from swinging by a pawl *H*, acted upon by plunger *I* and pin *J*.

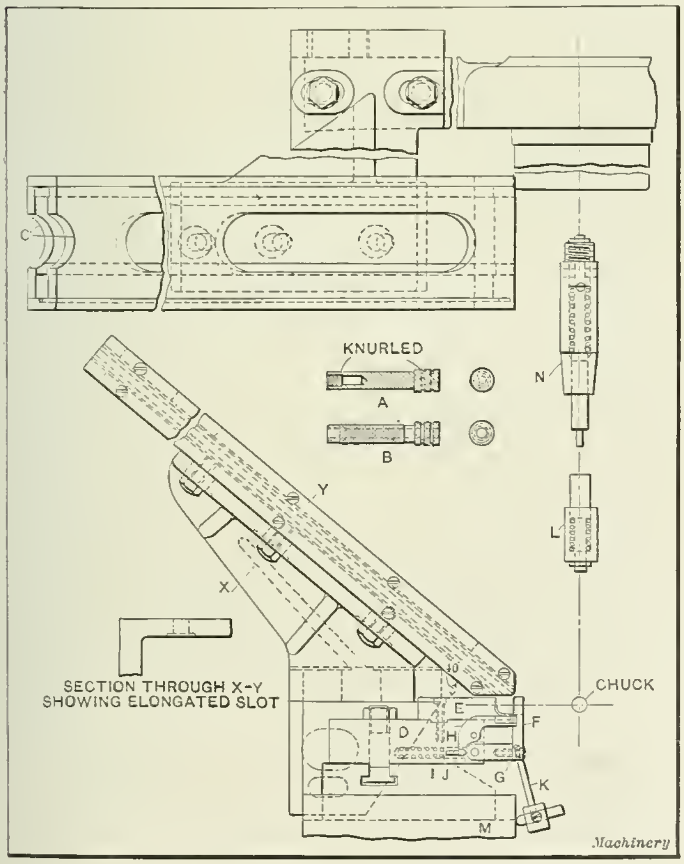


Fig. 5. Magazine Attachment for Handling a Safety Razor Handle on a No. 0 Brown & Sharpe Automatic Screw Machine

The operation of this work-carrier is as follows: When the piece drops into the pocket in the block *E* and the front cross-slide advances until the work is in line with the hole in the chuck, the large part of the inserter *L* trips the finger *F* after the work has been partly inserted. This action is accomplished by the inserter *L* coming in contact with the beveled edge of the pawl *H*, removing the V-shaped end of the pawl from the groove in the lever *G* and at the same time pushing back the spring plunger *I*, thus allowing the finger *F* to drop away from the block *E*. The pawl *H* acts as a locater for the work to keep it from sliding out of the pocket, and as it is disconnected from the lever *G*, it drops down swinging on the pivot shown, so that the work can be inserted into the chuck by the plunger *L* which is held in the turret.

After the work has been inserted in the chuck, the cross-slide, in dropping back, brings the trip *K* against the casting *M*, which through the combined action of lever *G*, pawl *H* and spring plunger *I* closes the work-carrier. The work is forced into the chuck against a spring plunger which is held in the feed finger *N*. This spring plunger ejects the work when the chuck is opened. Another piece of work, which is handled in an attachment similar to that shown in Fig. 5, appears at *H* and *I* in Fig. 9.

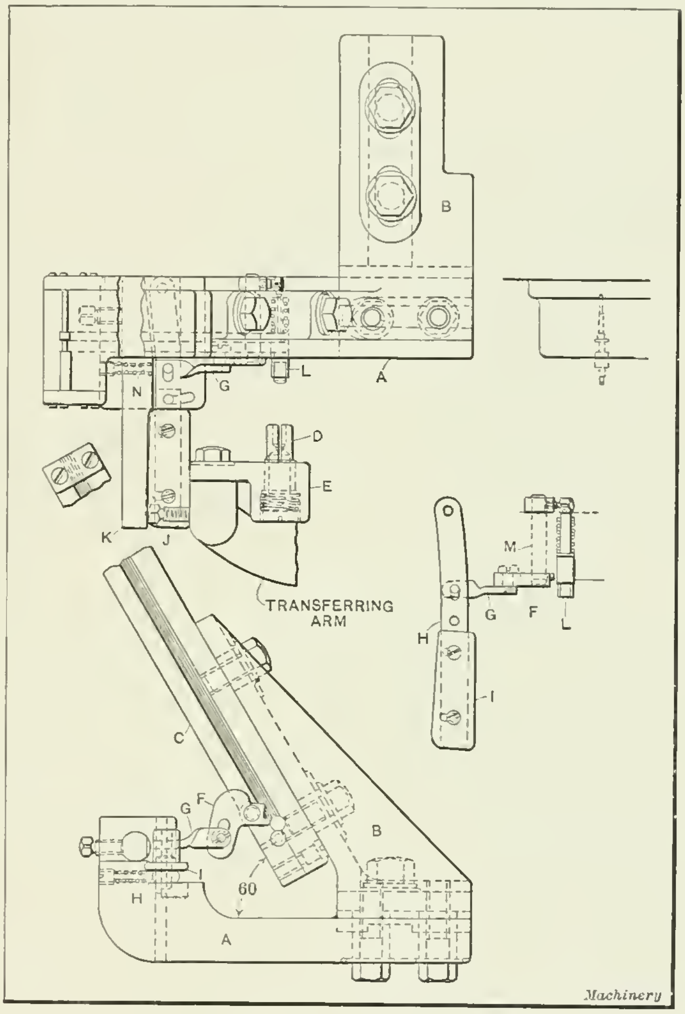


Fig. 6. Magazine Attachment for a Pinion Staff

Magazine Attachment for Handling a Pinion Staff

A magazine attachment which differs in design somewhat from those previously shown is illustrated in Fig. 6. This attachment was designed for handling the pinion staff shown by the heavy dotted lines in the illustration. The magazine attachment consists mainly of two brackets *A* and *B* and a slide or chute *C*. The bracket *A* is fastened to the bracket *B*, which is held to the boss provided on the Brown & Sharpe automatic screw machines for holding special attachments. The chute *C* is made in two parts, which are held together by blocks as shown, and is cut out to fit the blank so that it is impossible for the latter to be located except in the correct position. The blank is removed from the slide by means of a special transferring bushing *D*, split, spring-tempered, and free to slide in the transferring arm block.

The transferring block *E* is counterbored and tapped to receive a coil spring and nut for holding it.

The operation of this attachment is as follows: As the work comes down the chute *C*, it is arrested by means of the upper projection on the trip *F* which is connected to a link *G*. Link *G*, in turn, has a pin in it which works in a slot cut in the lever *H*. Lever *H* has fastened to its top face, a trip lever plate *I*, which can be set at the required angle and then held by means of the screws shown. Now when the transferring arm ascends, it is stopped in the correct position by means of a set-screw *J*, which comes against the stop *K*, the arm itself bearing against the trip lever plate *I*, and forcing it back. This action, through the lever *H* and connecting link *G*, operates the trip *F*, allowing one piece to drop into the pocket cut in it. As the arm is advanced, the bushing, in being forced over the work, pushes back the nest *L*, allowing the work to be inserted in the transferring bushing *D*. The construction of this lever arrangement for allowing only one piece to drop down at a time is more clearly shown in the part detailed view to the right of the illustration. Here it can be seen that the work-trip *F* is fulcrumed on a stud *M*, passing through the slide *C* and retained by means of a washer and set-screw.

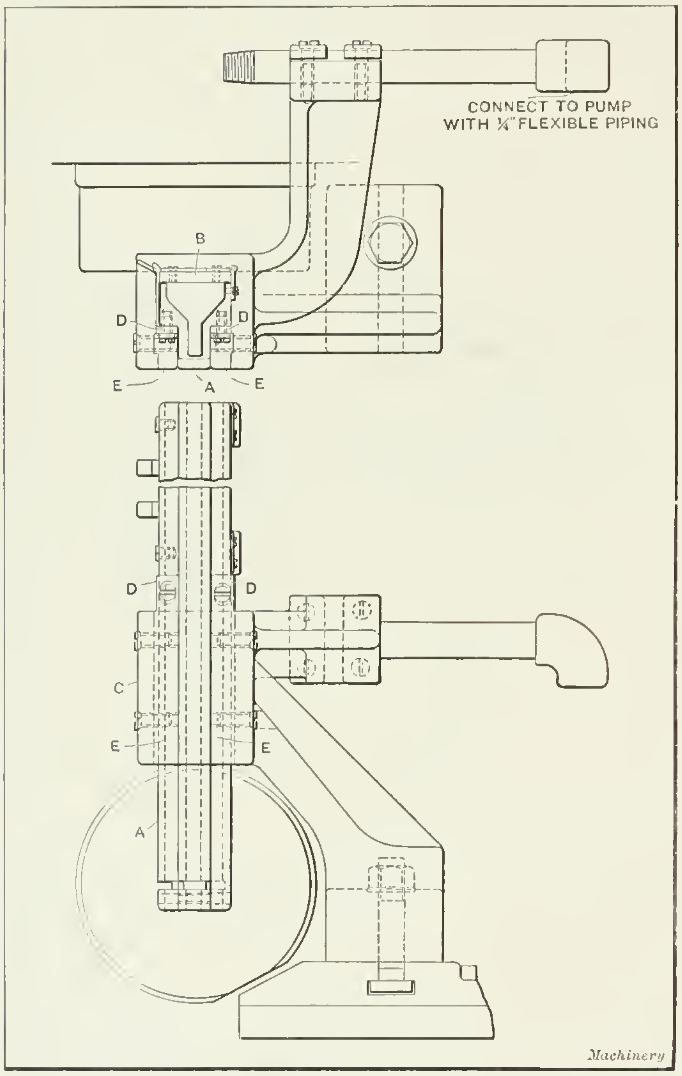


Fig. 7. Magazine for Handling a Brass Yoke blanked in the Punch Press

After the work is inserted in the bushing *D*, the arm backs away from the nest *L* and then descends to the work-chuck. Upon the descent of the transferring arm to the work-chuck, the spring *N* returns the trip lever plate *I* and lever *H* to their former position. This action, through the connecting link *G*, rotates the trip *F* back into position to catch another piece, the piece in the trip being deposited in the nest *L* ready to be transferred to the wood-chuck.

Magazine Attachment for Handling Parts Blanked in the Punch Press

Ordinarily, parts which are blanked out in the punch press and require a machining operation to complete them, are handled in a hand screw machine or turret lathe. In the majority of cases, however, where a large number of parts are required, it is advisable to use an automatic screw machine equipped with a magazine attachment. Good examples of this class of work are shown at *C*, *D*, *E*, *F* and *P* in Fig. 9. The magazine attachment for handling the piece shown at *C* is illustrated in Fig. 7. The shank of this piece is to be turned cylindrical and to an exact diameter.

Referring to Fig. 7, it will be noted that this magazine attachment consists primarily of a box-shaped slide *A*, provided with a swinging door *B*, which allows the pieces to be placed in the chute. The slide *A* is held in a vertical position, which is preferable for flat stock, in a bracket *C* provided with two arms, one of which is fastened to the rear cross-slide, and the other to the oil feed tube. The cross-slide is advanced by the cross-slide cam to bring the chute into position in front of the chuck for inserting the work.

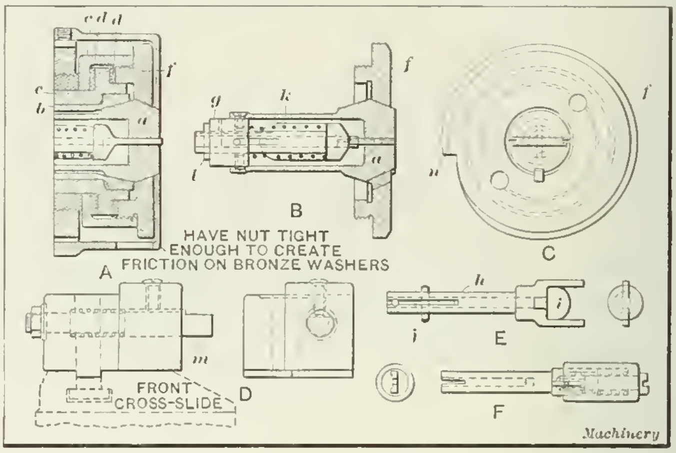


Fig. 8. Spring Collet, Cross-slide Stop for Spindle and Work Inserter used in Connection with the Attachment shown in Fig. 7

The slide *A* is milled out to suit the shape of the work and has two adjustable blocks *D* fastened to it, which rest on the top face of the bracket *C*. These blocks hold the slide so that the slot in the lower end will be in line with the chuck. Two blocks *E* are fastened to the bracket *C* by screws, as shown, acting as a locater for the slide. This slide is made long enough to hold 104 blanks and it requires approximately twenty minutes to empty it. Two slides similar to the one shown in the illustration are made, so that when one is empty, a full one can be put in place without stopping the machine. The slide is removed by simply pulling it up out of the bracket.

In turning down a piece of flat stock similar to that handled in this attachment, it is necessary that the chuck should be stopped in a certain relative position each time a piece is to be inserted. The chuck for holding the punching shown at *C*, Fig. 9, and the parts used in connection with it are shown in Fig. 8. At *A*, the chuck *a* is shown inside the special sleeve *b*, the latter being inserted in the special spindle *c*, provided with a shoulder, on each side of which are located bronze friction washers *d*. A hollow nut *e* is located in the intervening space between the rear bronze washer *d* and the bronze bearing in the front box of the machine. Screwed into the front end of this hollow nut *e* is a special nut *f*, which holds the chuck *a* in the sleeve. This nut fits the taper on the front end of

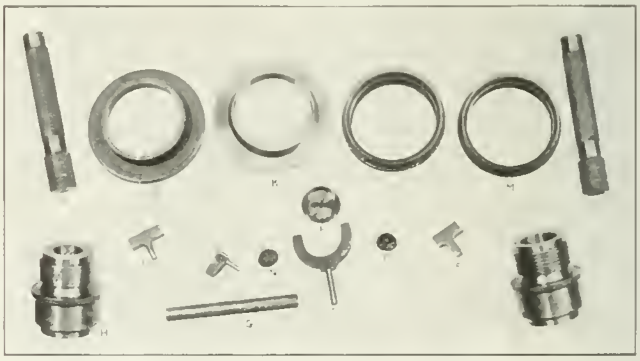


Fig. 9. Examples of Work handled in Magazine Attachments

the chuck and is keyed to the latter, as shown at *B*, the reason for which will be explained later. The manner in which the nut *f* is keyed to the chuck *a* is shown at *B*, where the construction of the ejecting plunger and stop is also shown.

The chuck *a*, as shown at *B* and *C* in Fig. 8, is broached out to suit the shape of the piece shown at *C* in Fig. 9. This chuck is also slotted and spring-tempered, the same as the ordinary spring collet. The ejecting mechanism and stop are held in a bushing *g*, which is secured in the rear end of the chuck by means of two flat-headed screws, as shown. The ejecting plunger *h*, shown in detail at *E* in Fig. 8, consists of a cylindrical body with a hole drilled through it to suit the stop *i*. The front end of the ejector *h* is milled down so that it will slide freely in the elongated hole in the chuck and is provided with a keyway in which a pin held in the bushing *g* works. The stop *i*, which is flattened on the end, is held in the correct relation to the ejector *h* by means of a pin, driven into it, sliding in an elongated hole in the ejector. This pin *j* passes completely through the stop *i*, ejector *h*, and sleeve *g*. The ejector *h* is kept out by means of a coil spring *k* and is retained by a pin *l*. The work is forced into the chuck by means of an inserter, the construction of which is clearly shown at *F* in the illustration.

In operation, the automatic screw machine is provided with one loose and one tight belt. The tight belt is used to drive the machine when turning the piece, while the loose belt is placed on the cone to which the clutch is connected when it is desired to stop the rotation of the spindle. The clutch is operated by the dogs provided on the drum on the front camshaft, when it is desired to stop the rotation of the spindle, and the front cross-slide is advanced bringing the plunger or stop *m*, shown at *D* in contact with nut *f*. This spring plunger locates beneath the ledge *n* and as the belt, which is now driving the spindle, is running loose, the rotation of the spindle is easily stopped. However, if this stop alone were depended upon, it would cause excessive jar, so that it is necessary to have the bronze frictional washers *d* interposed between the nut and the spindle. The nut *f* is tight enough to create a friction on the bronze washers sufficient to drive the work when turning.

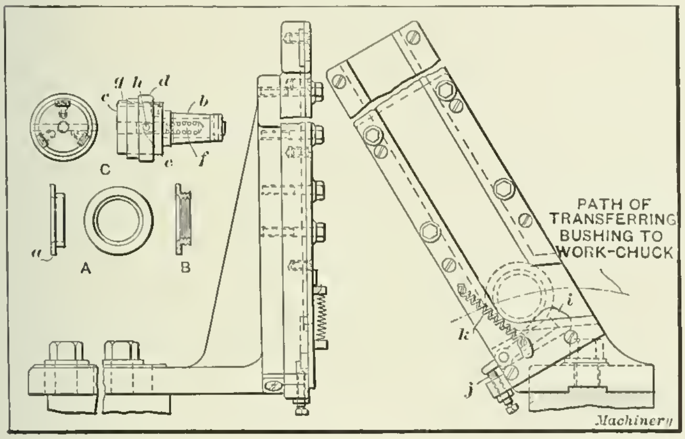


Fig. 10. Magazine Attachment for Handling a Hollow Nut, blanked and drawn-up in the Punch Press

The pieces shown at *D*, *E*, and *F* in Fig. 9 are handled in a magazine attachment similar to that shown in Fig. 7, and are held in a chuck of a similar design to that shown in Fig. 8. The ejecting mechanism, inserter, etc., used are also of the type illustrated in Fig. 8.

Magazine Attachment for Handling a Hollow Brass Nut

The hollow brass nut shown at *J* and *K* in Fig. 9 is a punch press product, as are also the parts shown at *L* and *M*. The piece shown at *J* is first blanked and then drawn up into the shape shown, in the punch press. The magazine attachment for handling this piece is shown in Fig. 10, where the work is also shown before and after completion at *A* and *B*, respectively. The same type of attachment is used for handling the pieces shown at *L* and *M*. This hollow nut requires two handlings after it leaves the punch press. In the first operation the rim *a*, shown at *A*, is turned, while in the second operation the outside and inside are turned and threaded and the rim faced. The same attachment is used for both operations.

This attachment is comparatively simple in operation and is located on the boss used in holding the milling, cross-drilling and burring attachments. The work is removed from the attachment by a holder shown at *C* which is held in the transferring arm. This holder is provided with a taper shank *b*, fitting the main body *c*. On this body *c* is held a ring *d*, through which a pin is driven. The pin *h* in this ring *d* fits in an elongated hole in the body *c* and is driven into the spring plunger *e*. The main body *c* is retained in the bushing *b* by means of a collar and pin as shown. The body is provided with a slot in which a flat spring *g* is held with a screw. This spring is furnished so that the work will be gripped securely. It also makes provision for slight changes in the diameter of the hole in the work. When the transferring arm is advanced, the work is forced onto the body *c* against the ring *d*. Now when the transferring arm descends to a position in line with the chuck and is advanced, the work is placed in the chuck. The transferring arm advances until the pin *h* comes against the rear end of the elongated slot in the body *c*, when further movement of the collar is arrested and the work is placed firmly against the shoulder in the chuck.

These hollow nuts are placed in the slide of the magazine attachment by the operator and as they drop down are retained by means of a finger *i* provided with two surfaces of different heights. The rear end of this finger *i* is held firmly against a set-screw *j* by means of a coil spring *k*, provided with a lock-nut. As the work is gripped by the work-holder, held in the transferring arm, and as the latter descends towards the chuck, the finger *i* is depressed allowing the work to slide out easily.

The chutes of magazine attachments used for handling flat pieces are generally held in a vertical position, while those used for cylindrical work are held in an inclined position. The angle of inclination of the chute or slide depends entirely on the size and shape of the work. A slide for handling small work should be inclined at a greater angle than that used for large work, the angles of inclination of the chute from the cross-slide varying from 20 to 60 degrees.

* * *

NOTES ON QUENCHING FLUIDS

It is generally held, says Mr. Shipley N. Brayshaw in the *Engineering Magazine*, that the addition of sulphuric acid (oil of vitriol) to the quenching water increases its intensity, and common salt is considered to act in the same way, but in a lesser degree. Mr. Brayshaw doubts that there is any foundation to this assumption. The heat conductivity of the water may be increased by the addition of salt, but the gain from this cause is small in proportion to the powerful intensifying action which may be produced by rapid motion of the water, for instance. It appears that the great differences obtained by quenching in salt baths and clear water have been caused either by variations in the temperature of the water or by the degree to which it was agitated. It is sometimes stated that sulphuric acid is added to prevent hardening cracks, but this statement is inconsistent with the other idea that by its use a greater degree of hardness can be obtained. If the liability to crack is reduced, it is because the acid has made the quenching bath more gentle in its action, and the hardness would be reduced.

The temperature of the hardening bath has a great deal to do with the hardness obtained. In certain experiments a bar quenched at 41 degrees F. showed a scleroscopic hardness of 101. A piece from the same bar quenched at 75 degrees F. had a hardness of 96, while, when the temperature of the water was raised to 124 degrees F., the bar was decidedly soft, having a hardness of only 83. The higher the temperature of the quenching water, the more nearly does its effect approach that of oil, and if boiling water is used for quenching, it will have an effect even more gentle than that of oil; in fact, it would leave the steel nearly soft.

* * *

Mere possession of knowledge, says one of our contemporaries, has little earning capacity; only skill in the application of knowledge to the attainment of some useful purpose has earning power, because it is from such application that useful results flow.

LETTERS ON PRACTICAL SUBJECTS

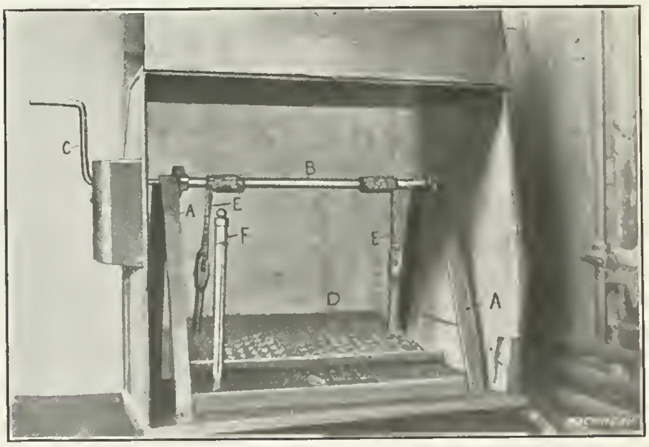
We pay only for articles published exclusively in MACHINERY.

ADVANTAGES OF THE OIL TEMPERING FURNACE

It is interesting to know that the oil tempering furnace is being adopted by leading manufacturers throughout the country because the results obtained by it are much more uniform than could be secured by the old method of drawing the temper by "color." One of the advantages of the oil tempering furnace is that the hardener can, at one heat, temper a dozen or fifty tools, and obtain uniform results. The variation in the size of the tools makes no difference. For instance, I have tempered drop-hammer dies weighing 125 pounds and at the same time reamer blades weighing less than one ounce.

The accompanying illustration shows an oil tempering furnace made by the American Gas Furnace Co., to which has been applied a device for handling the work and also agitating the oil—a point that is often overlooked by the manufacturers of oil furnaces. Two brackets *A*, one of which is fastened on each side of the furnace, hold a bar *B* provided with a crank *C*, the bar extending entirely across the furnace. The basket *D* is fastened to the bar *B* by chains *E*, so that it can be raised or lowered by means of the crank. The basket should be raised and lowered frequently during the heat to get good results. A ratchet-wheel is fastened on the bar *B*, and a pawl is attached to the bracket, so that the basket may be held in any position which is necessary when parts are only to be partially immersed in the oil.

The basket *D* consists of two plates held together by eyebolts, which are connected to the chains. The plates are separated by two $\frac{3}{4}$-inch nuts, and are provided with $\frac{7}{8}$-inch holes, so located that the holes are not in line in the top and bottom plates. This staggering of the holes assists in mixing the oil when the baskets are quickly lowered and raised. Baskets provided with handles and made from $\frac{1}{4}$-inch mesh wire screening are also used for holding chisels, hammers, punches, etc., when tempering. These baskets can be moved quickly from the furnace and immersed in a cooling medium.



American Gas Furnace equipped with Device for Handling the Work and Agitating the Oil

The temperature of the oil is determined by means of a mercury thermometer *F* graduated to register temperatures from 200 to 900 degrees F.

GEORGE T. COLES

Decatur, Ill.

A REVOLVING TAILSTOCK CENTER

When turning and polishing cylindrical shells, trouble was encountered with the castings becoming heated and expanding, due to running them upon a fixed center in the tailstock spindle. To overcome this, a revolving center was made, as shown in Fig. 1, with a parallel bearing. At first this gave satisfaction, but after being in use for a few months, the cone center became slack on its spindle, excessive wear taking place, as shown by the dotted lines. This was due to the pressure of the tool and the weight of the work not being evenly distributed on the conical center spindle. To obviate this, the revolving center shown in Fig. 2 was made. The spindle *A*, which fits in the tailstock spindle of the lathe, has two cones turned on it, and the loose center *B* is bored to suit. These two cones on the spindle *A* approach as nearly as possible Schiele's anti-friction pivot curve, which equalizes the pressure on the center spindle.

When the pattern for the center *B* was made, four triangular lugs were cast on it, as shown in Fig. 3. This enabled the casting to be gripped in an ordinary four-jawed chuck for boring and facing the cone-shaped hole. The small lugs were then removed by drilling holes in them, and the holes were drilled and tapped for the two square-headed screws *C* at the same time.

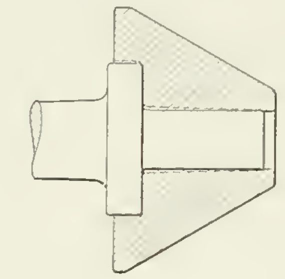


Fig. 1. Discarded Revolving Center

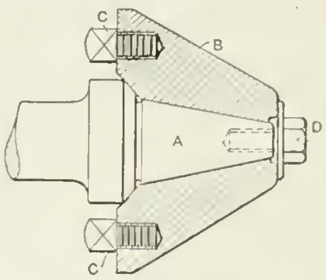


Fig. 2. The Successful Center

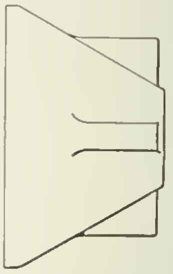


Fig. 3. Casting for the Center

To turn and grind the center *B* on its conical face, it was mounted upon the spindle *A* and held with the cap-screw *D*. Then the spindle *A* was placed in the headstock of the lathe, and the tailstock center placed in the center in the head of the cap-screw *D*, to steady it. The two set-screws *C* act as drivers, coming in contact with two projections on the faceplate.

P. H.

MAKING SURFACE PLATES BY LAPPING WITH CARBORUNDUM GRAINS

Any toolmaker who has had experience in different shops will admit that he has met with difficulties more than once in trying to find a suitable surface plate for laying out work or for scraping a piece to a bearing. Surface plates are regarded in many of the smaller shops as expensive luxuries, although it is recognized that they are a valuable asset in the production of accurate work. To make a surface plate when there is no master plate to scrape to is an expensive operation, as three plates must be made in every case. While two surfaces can be scraped to a bearing so accurately that one will lift the other by cohesion, either one of them if tested on a master plate might appear convex or concave. In the case of three plates, No. 1 and No. 2 are first scraped together, then No. 2 and No. 3, and then No. 3 and No. 1 and so on, until perfect planes are obtained.

To scrape a sixty per cent bearing on three plates, obtaining true planes, is a long and expensive operation, and it is no wonder that the average shop foreman is not very enthusiastic about attempting it, as he knows very well that not one machinist in a hundred has had the necessary experience at this class of scraping to turn out a good job in a reasonable length of time. Accurate surface plates can, however, be made in a surprisingly short time if the following method is employed:

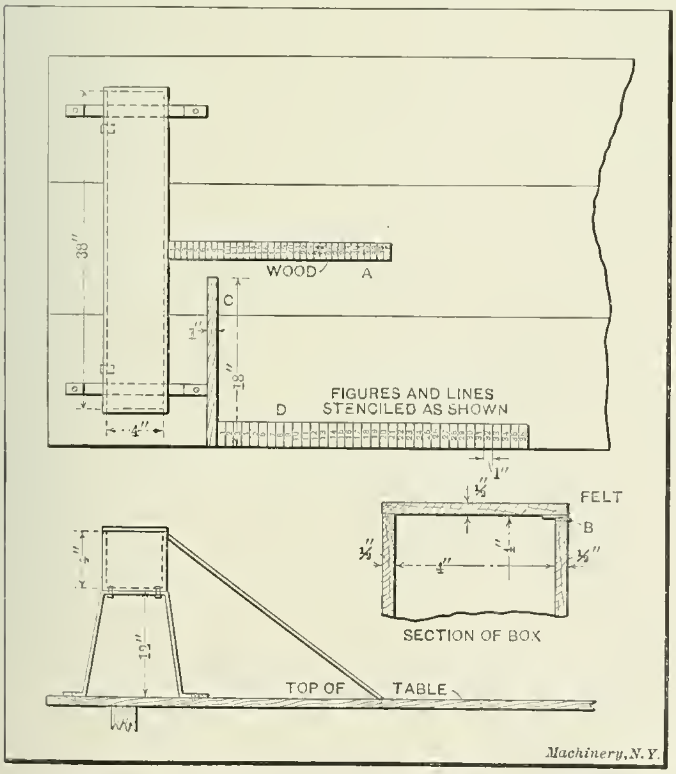
First rough off the surface and the feet, taking off at least three-eighths inch to make sure that all the surface iron is removed. This will prevent warping. Then drill and tap the holes for the handles. The plates should then be allowed to season for at least two months to allow the internal strains to permanently adjust themselves. To finish the plates, all that is necessary is a small amount of carborundum grains for lapping the plates together. Before starting to lap, stamp the plates No. 1, No. 2, and No. 3, respectively. Lay No. 2 on the bench, sprinkle some No. 36 carborundum grain over it, add a little coal oil, and lap No. 1 with it, using a circular motion, and constantly changing the relative position of the upper plate until something like a finished surface is obtained. Then lap No. 2 and No. 3 in the same manner, then No. 3 and No. 1, and then do the whole operation over again. By this time reasonably plane surfaces should have been obtained. Then repeat the procedure, using No. 60 carborundum grain. Then use No. 120, and follow this with No. 220 for the final finishing. The result will be three surface plates with perfectly true planes, a good finish, and a 100 per cent bearing. If the lapping has been carefully done, these plates will lift each other by cohesion.

Many will argue that this method of lapping plates together will so charge them with the abrasive material as to make them unfit to use with fine tools. However, when it is considered that cast-iron holes in accurate watch machinery are lapped to a bearing, and put to every-day use without wearing out the spindles or shafts that run in them any sooner than those used under the same conditions but not lapped, it is doubtful if surface plates can be loaded with abrasive material to such an extent as to make them unfit for use with fine tools. The writer has himself used this process for making plates 12 inches square, having a surface ½ inch deep, and with a base of the regular ribbed construction.

Niagara Falls, N. Y. F. B. Jacobs

BOX FOR HOLDING BLUEPRINT PAPER

In cutting and tearing up blueprint paper for making blueprints, a considerable amount of the paper is wasted; for instance, when a print is to be made from a tracing 24 by 36 inches, the paper is generally cut or torn with from one to four inches of unnecessary border, which will be waste paper when the print dries. With the device shown in the accompanying engraving, as much as four and five yards of paper can be saved on a 50-yard roll. When the necessity of measuring the paper every time a print is to be made, is thus dispensed with, the work can be done more expeditiously.



Box for Holding and Device for Saving Blueprint Paper

The box can be made of ½-inch pine or poplar boards at small cost. It is secured on the end of a table, as shown, with two ¼- by 1-inch iron legs screwed to the top of the table, the box being bolted to these legs by ¼-inch carriage bolts. It will hold a 50-yard roll of paper, and no light can penetrate into it. The iron strip shown at *B* is set into the front of the box and firmly secured with countersunk wood screws. The purpose of this strip is to provide a means of tearing the paper off along the edge. A piece of felt is fastened on the front lower edge of the lid to keep a uniform pressure on the paper when tearing it off; but, of course, if the lid is held down, the paper will tear off better.

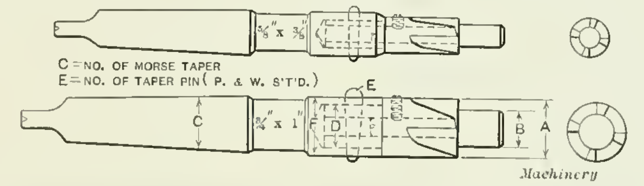
Mark on a piece of cardboard all the different sizes of tracings and hang it up where it can readily be seen. Opposite these figures allow a ¼-inch margin; for example, for a tracing 6 by 9 inches, tear to 6½ by 9½ inches. The wood strip at *A* is nailed to the table and box as shown. When making prints, take hold of one end of the paper and pull it out of the box to the desired width, and then tear off by pulling downward. Having obtained the correct width, lay the paper flat on the table, one end against the wood strip at *C* and along the scale at *D* which is divided off into inches, and with a straightedge tear the paper off to the desired length. For larger blueprints, larger scales can, of course, be made.

Toledo, Ohio. W. H. Wolfgang

COUNTERBORES WITH REMOVABLE SHANKS AND LEADERS

As high-speed steel costs about four times as much as good carbon tool steel and about thirty-five times as much as machinery steel, the tool designer who wishes to economize is always careful to design tools so as to use as little high-speed steel as possible. The engraving accompanying the table shown herewith illustrates a plan by which a considerable saving may be effected in the design of counterbores. The cutting portion of the counterbore is made from high-speed steel, the leader from ordinary carbon steel, and the shank from machinery steel. The design of counterbore not only effects a saving in the use of high-speed steel in the original manufacture of the tool, but also facilitates the replacement of broken or worn-out cutters, the same shank being used continuously. It also has an added advantage over the solid type owing to the fact that it is furnished with an inserted leader, which may be replaced when broken or when other sizes are required.

PROPORTIONS FOR COUNTERBORES WITH REMOVABLE SHANKS AND LEADERS

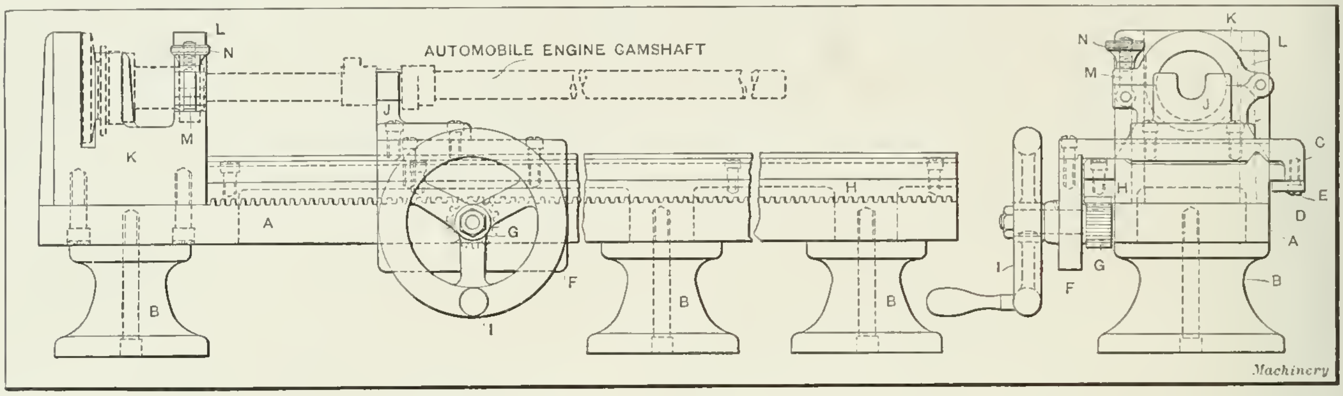


A	$\frac{1}{2}$"	$\frac{9}{16}$	$\frac{5}{8}$"	$\frac{3}{4}$"	$\frac{7}{8}$"	1"
B	$\frac{5}{16}$" to $\frac{3}{8}$"	$\frac{5}{16}$ to $\frac{7}{16}$"	$\frac{5}{16}$" to $\frac{1}{2}$	$\frac{5}{16}$" to $\frac{5}{8}$"	$\frac{5}{16}$" to $\frac{3}{4}$"	$\frac{5}{16}$" to $\frac{3}{4}$'
C	No. 2	No. 2	No 2	No. 3	No. 3	No. 3
D	$\frac{1}{2}$"	$\frac{1}{2}$"	$\frac{1}{2}$"	$\frac{5}{8}$"	$\frac{5}{8}$"	$\frac{3}{4}$"
E	No. 0	No. 0	No 1	No. 1	No. 2	No. 2
F	$\frac{3}{4}$"	$\frac{3}{4}$"	$\frac{3}{4}$'	$\frac{7}{8}$"	$\frac{7}{8}$"	1"

These counterbores can be made with two, three, four, five or six cutting edges, depending upon the class of work on which they are to be used. For clean brass castings, and where the hole extends part way into a shoulder, five or six cutting edges are preferable. For rough steel castings two, or not more than three, cutting edges are better, because the heavy strain on the cutter is liable to break the cutting edges, unless they have a good support. Straight shanks may be used if necessary. The reason that the counterbore shown in the illustration is supplied with a taper shank is that a large majority of manufacturers are now using tapered instead of straight shanks on all drill press tools above 5/16 inch in diameter.

Referring to the illustration, the dimension *D* and the taper pin *E* are fitted before the cutter is hardened. A 5/16-inch reamed hole is also provided in the cutter to fit the shank of the leader. Drilling the hole entirely through the cutter facilitates the removal of the leader when necessary. Sufficient material is left on the cutter to grind to the size required, after it has been assembled. The leader hole is slightly chamfered so that a small fillet may be left on the shank of the leader to overcome the tendency to crack when hardening. The leader is also ground on its own centers, and the shank is made a snug fit in the 5/16-inch reamed hole. The body of the leader is ground from 0.002 to 0.005 inch smaller than the hole in which it is to work. Care should be taken not to allow either the taper pin or screw for holding the leader to protrude far enough to catch the workman's clothing. Larger counterbores can also be made along the same general lines, if so desired.

Indianapolis, Ind. G. W. Linn

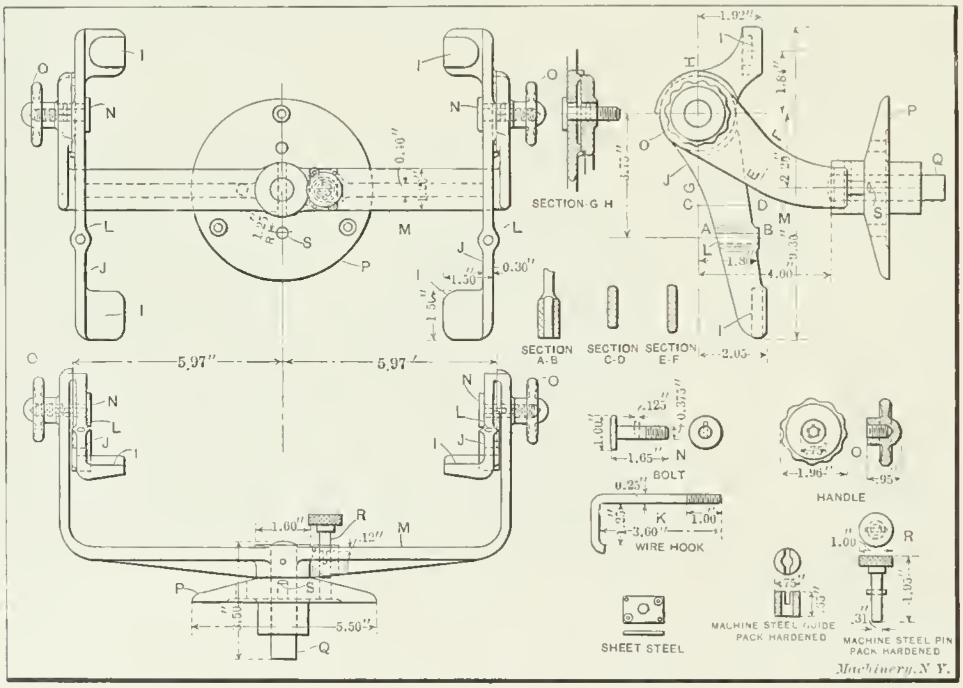


A Fixture for Pressing Cams onto an Automobile Engine Cam-shaft

A TYPEWRITER INSPECTION FIXTURE

The accompanying illustration shows an ingenious fixture designed for holding a typewriter of the general form, such as the Remington, Underwood, L. C. Smith, etc. This fixture has aptly been termed a "turntable," for it is so built that a machine, after being placed in position on it, may be turned to either side, entirely around, to any angle vertically, or upside down. In the final inspection, it is necessary to look over every part of the mechanism, and by the use of this turntable any part of the machine may be easily reached without the inspector's having to leave his seat or lift the machine.

The four feet of the machine are placed in the recesses *I* on the cradles *J*. A wire hook *K* on each side extends through the hole *L* and grips the frame of the machine, the hooks being tightened by a nut and check-nut. The cradle castings are secured to the frame casting *M* of the fixture by bolts *N* and are fastened at the desired angle by tightening handles *O*. *P* is the base casting which is screwed to the bench. The frame *M* turns about this base on the pin *Q*, which is fastened to the frame. The latter is secured in position by dropping the pin *R* into one of the holes *S* in the base. Designer



A Typewriter Inspecting Fixture, showing Details of Construction

FIXTURE FOR PRESSING CAMS ONTO AUTOMOBILE ENGINE CAM-SHAFTS

The fixture shown in the accompanying illustration was recently designed and made in our factory for pressing on and removing cams from automobile engine cam-shafts. A good deal of trouble had been experienced in assembling the cams on the shaft by means of a babbitt hammer and a piece of pipe, as it caused considerable breakage of cams and springing and scoring of the shaft, which made the latter unsatisfactory as a bearing when a cam was finally placed in position. The cams are hardened and ground in the hole, have a 3/16- by 3/32-inch keyway, and are assembled before grinding on the outside. The hole in the cam is made a press fit for the shaft, and it is necessary to have the pressure as evenly distributed as possible on the cam when forcing it on, to avoid scoring the shaft. This fixture was designed to meet future, as well as present requirements.

Referring to the illustration, the bed *A* is made much heavier and is considerably longer than was necessary for the present shaft. It is supported on three legs *B*, fastened to the bench. The carriage *C* has a V-shaped bearing on one side and a plain bearing on the other, which affords ample wearing surface, insuring long life to the fixture. Gib plate *D*, held with screws *E*, prevents the carriage from being lifted from its bearings. The apron *F* carries a pinion *G* meshing with the rack *H*.

The U-shaped block *J*, in which the cam-shaft is located, is fastened rigidly to the carriage by fillister screws, and is cut out to fit loosely over the shaft. It is made of a sufficient width at the top to go between two cams, as shown, which, of course, is necessary if the cams are to be removed from the shaft. About two-thirds of the cam surface bears against the block *J*, equalizing the strain and preventing the cam from scoring the shafts.

The large end of the cam-shaft is located in the main bearing *K* and is held in position by means of a clamp *L*, swinging-bolt *M* and thumb-nut *N*. The head of the fixture is so constructed that it prevents the shaft from moving in either direction so that cams can either be put on or removed. With the exception of pinion *G* and block *J*, all the various parts of this fixture are made of cast iron.

Lansing, Mich. E. H. Pratt

A DRILLING PROBLEM

In the following article is described a simple and economical method of machining what would be, under ordinary conditions, a very awkward piece of work. The bosses shown in Fig. 1 were to be drilled, tapped and faced, making the holes exactly in line. Owing to the length of run it was impracticable to braze a round shank drill to the end of a rod; three drills at least would be required, even if our largest horizontal drill was used. These drills would be tied up, and in addition to this, the finishing of the bosses would still have to be considered.

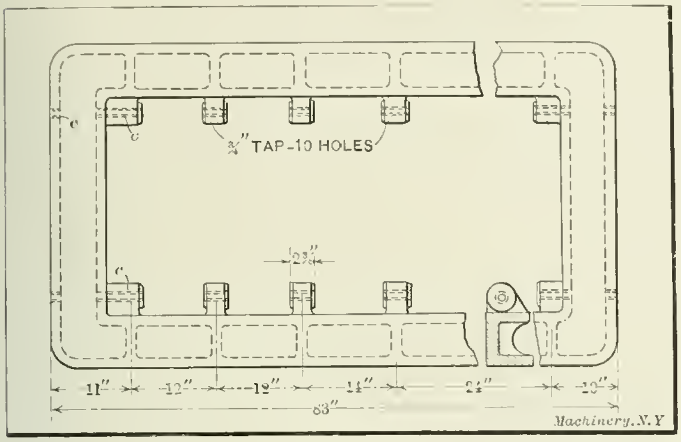


Fig. 1. The Drilling Problem—How to Drill, Tap and Face the Bosses

The job was finally done on an old-time Pond horizontal drill. Two bars were secured across the narrow way of the piece, and the whole was then bolted, by means of these two bars, to an angle-plate, previously set in position on the drill base. After leveling the job up, the holes were scribed off by means of a surface gage and a chalk line. The casting was then turned over and the lugs on the other side were marked off in a similar manner.

Fig. 2 shows the method of driving the drill, a similar method being applied to the counterbore and tap. A plain coupling was drilled and reamed to the size of the drill which it was to hold. Set-screw holes *A* and *B* were drilled and tapped, the set-screws *A* seating in flats, filed in the drill shank and driving rod, respectively. Three rods of cold-rolled steel were then turned true for a distance of about two inches from each end, to act as drive rods. The first rod was approximately 20 inches long, the second, 44 inches, and the third, 78 inches; all of ⅝-inch stock. At the outset trouble was anticipated from the use of these rods, owing to the twisting strain, but contrary to expectations, no difficulty was experienced and the drill was fed through by hand at a very good feed.

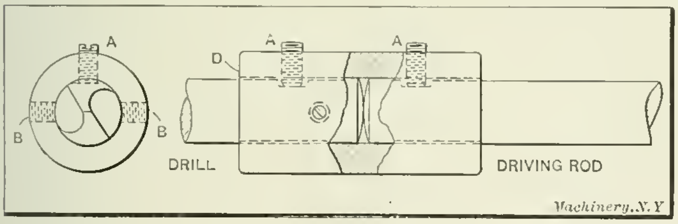


Fig. 2. Special Coupling used in Drilling, Facing and Tapping the Bosses

The holes *c* in the end of the casting are merely drilled to allow the passage of the drill, and were made with our best "extra-length" drill, which had a twist cut of about 9 inches. This drill also started the tap hole through the first long boss and prevented the round-shank drill, in the special rig, from running out. When the "extra-length" drill was used as far as possible, it was removed and a chuck put in the spindle. Then the driving rod was chucked and passed through the work, the coupling in which the drill was set was put on the end of the rod, and the hole drilled. In using the longer rods, they must be passed through the drilled holes to be chucked, to give sufficient room. The different length rods were employed to reach the different bosses all the way through. The facing of the bosses was done in a similar manner.

For tapping, the same coupling was used, but the tap was held loosely on the shank square by the set-screws *B*, which allowed it some slight play, practically forming a floating tap. When the ends of the coupling *D* came down against the boss, the tap would pull out of the coupling, eliminating the danger of a broken tap. The different length rods were used as in the drilling operation.

In changing rods, either the table or housings of the horizontal machine had to be moved. After doing this, the spindle could be again lined up by running the chuck down over the rod; when the housings were thus properly adjusted, after each new rod had been introduced, the operation was proceeded with.

This idea may be used on any drilling machine and will be found very useful; for, unlike many kinks, it is practicable.

Chips

A NOVEL DRILLING JIG

The drilling jig shown in Fig. 2 was designed to drill holes in collars, jam-nuts and cotter-pin holes in spring rods, as shown at *A*, *B*, and *C* in Fig. 1 where six holes ⅜ inch in diameter, and eight holes ¼ inch in diameter are drilled. This jig can be furnished with bushings so that pieces varying from ⅜ inch to 2 inches in diameter and holes up to ¾ inch can be drilled. Referring to Fig. 2, the jig proper is simply a V-block *A* made of cast iron, which is slotted out to receive the adjustable V-support *B* held with a cap-screw as shown. This V-support *B* is made adjustable so that it can support the work when drilling a number of holes around its circumference. The work is lined up by the plug *C*, which is inserted in the holes *D*, *E* and *F*, respectively. Where four holes are to be drilled, the plug *C* is inserted in the hole *D*, for six holes the plug is inserted in the hole *E*, and for eight holes the plug is inserted in the hole *F*.

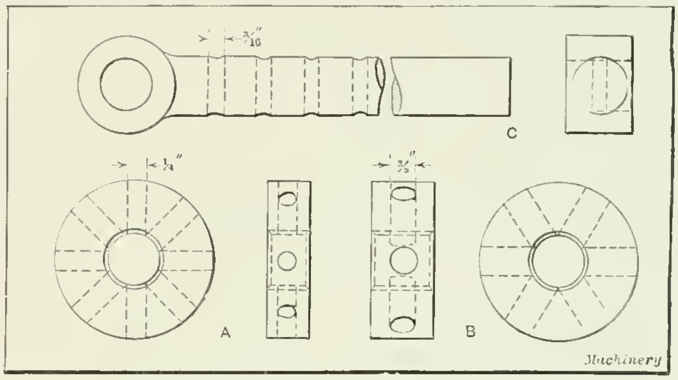


Fig. 1. Examples of Work drilled in Jig shown in Fig. 2

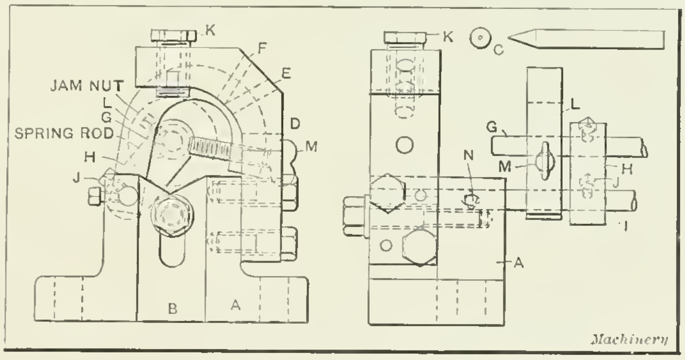


Fig. 2. A Novel Drilling Jig for Drilling Holes in Jam-nuts, etc.

Where it is necessary to drill a number of holes around the circumference from the end of a piece of work, the stop *G* is used. This is held in a block *H*, which is free to slide on the rod *I*, and is clamped in the desired position by the set-screw *J*. The work is held down at all times on the V-support *B* by the drill bushing *K*, which is threaded into the fixture.

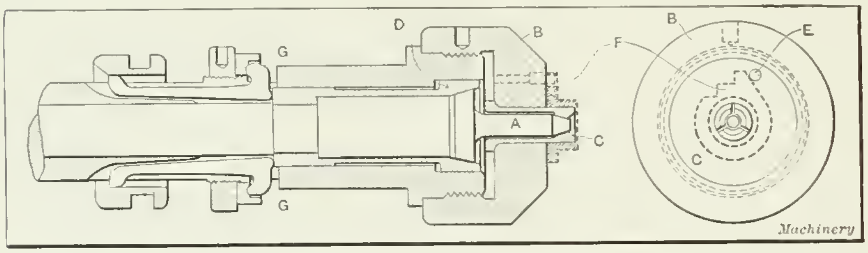
When a number of cotter-pin holes are to be drilled in a spring rod, as shown at *C* in Fig. 1, the bracket *L* is used to hold the rod, so that the holes are drilled in line with each other. This bracket L is free to slide on the rod I, and the spring rod is held against the inner surface of the bracket by means of the thumb-nut M, as shown in the illustration. The stop G is then used for locating the center distances for the holes in the piece C, Fig. 1, and can either be adjusted by loosening the set-screw J or the set-screw N, preferably the latter. The distance from the face of the V-support B to the center of the bushing K is ¾ inch, and the measurements can always be taken from the face of the V-support. As exceptional accuracy is not required in this class of work, this jig will be found very satisfactory.

Plainfield, N. J. DAVID McINNES

SPECIAL EXPANSION COLLET FOR A HAND SCREW MACHINE

In the accompanying illustration is shown a section and end view of the spindle of a Brown & Sharpe hand screw machine, the special expansion collet, and the mechanism used in operating it. It will be noticed that in place of the regular collet there has been substituted a solid plug A, which reverses the closing action of the collet, or, in other words, provides an arbor for holding the work F, on which a turning operation is to be performed. The operations previously performed on the piece F, shown in heavy dotted lines, were boring, reaming and facing one end.

The cast-iron cap B contains a bushing C, which has been bored taper from the rear and split to allow for expanding. The expanding of this bushing is accomplished by means of the tapered plug A, which is provided with two beveled ends, as shown, one of which fits into the bushing and the other into the tapered hole in the regular sleeve D used in holding the ordinary spring collet. The plug A is moved forward by means of the fingers G, which, of course, are provided with the regular spindle on the screw machine. The pin E, driven into the cap, acts as a drive for the work F, so that sleeve C is adjusted to hold the work only moderately tight.



A Special Expansion Collet for a Brown & Sharpe Hand Screw Machine

Tottenville, S. I. S. J. PUTNAM

STAMPING FIXTURES FOR PLUG AND SNAP GAGES

The production of neat, correctly spaced and well-arranged figures and letters on small tools, gages, etc., when made in the average tool-room, is frequently a problem which is not given the attention it deserves. The accompanying illustrations, Figs. 1 and 2, show two fixtures designed to perform this work in a workmanlike manner and at a minimum of time and expense. Fig. 1 shows a fixture used in stamping the handles of plug gages, round-end measuring rods, reamers, etc. B is a bronze block provided with a slot in which the work rests when being stamped, while the cap C is screwed down on the work, holding it in position. The stamps are lined up against the edge D of cap C, so as to make each line of characters parallel.

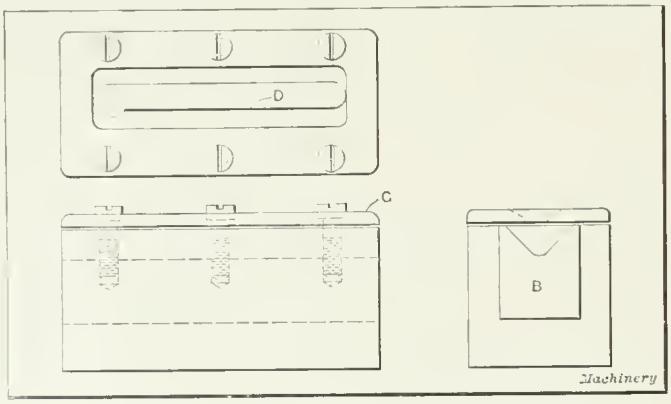


Fig. 1. Stamping Fixture for Plug Gage Handles

Fig. 2 shows a fixture designed for stamping flat work, such as snap gages, etc., the operation of which will be readily understood from the illustration. Both of these fixtures have been successfully used in the model and gage department of a leading manufacturer of small arms in this country, and have proved all that could be desired where only a few pieces of a kind are to be stamped at one time.

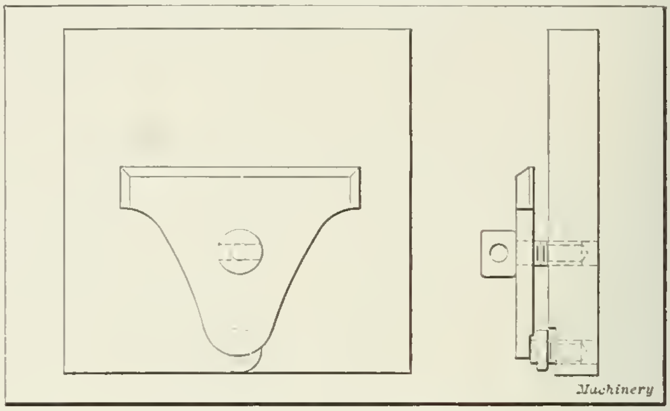


Fig. 2. Stamping Fixture for Snap Gages

Hartford, Conn. F. CHARLES SCRIBNER

AN APPEAL (?) FROM A MECHANIC IN TROUBLE

I am having a great deal of trouble in my work and write to you, thinking you may be willing to help me out. I am using a book containing over 2000 illustrations, published in 1907, "regardless of trouble or expense." First, it was necessary to do some fine drilling; the following instructions were found in the book:

"USING LATHE FOR FINE DRILLING"

"A worn lathe can be made to do fine drilling, no matter how badly it may be out of truth, or how loose the spindle may be in its bearings. So long as there is a turning motion at one end of the lathe bed, and the capability of pressing the work forward at the other end with either a handwheel or lever, all kinds of drilling, thick and thin, heavy and light, can be done, but there must be a handy chuck for holding drills and a variety of tools for drilling. If one of them is placed in the chuck and the jaws shut down solid upon it, and the lathe set in motion, it will be noticed that the drill does not run true, but a *few blows with the hammer* will soon fix this, so that at least the point will remain in one position except when the belt fastening passes the driving pulley when it vibrates for a moment. The body of the drill has a *peculiar motion*, and it is here an *old lathe* has the advantage—the drill is ready to enter wherever it finds a cavity to settle in, and the *looseness* of the spindle allows for an *adjustment* on a new center; besides, the drill is ground a little uneven, and is cutting a hole larger than the body of the drill, which is all the better as this part is so badly out of truth. As the depth increases, a *wobbling* motion comes in at the sides of the drill, striking against the walls of the hole; *this does not matter*, the drill can reach the full depth without breaking off in its socket or slipping in the jaws of the chuck. Whenever the edge is torn away, the wrench may be hooked onto the feed lever, while with *the pipe-wrench* the chuck can be set up so solid that there is no need to use the *three flat places* (if they exist, and they are not recommended) ground on the shank of the drill."

As I am using a lathe nearly new and do not know how to fix it, do you think it would be better to sell it, and buy one like that described above?

Next it was required to harden some steel, and the following rules were discovered:

"For a drill, tap, or reamer, the tool steel should be heated to a dull red only.

"For a center punch, a bright cherry red.

"A lathe cutter should be something between the two; so it must be heated to a full red.

"For hardening liquids, tallow, rosin, brine, and *molten lead* are recommended."

I worked all day with the molten lead without getting any hardness, and it was difficult to get the pieces out of the lead when it became cold. Please help me. AMATEUR

[Mechanics can appreciate the humor of this ridiculous rot, but what is the effect of such misinformation on the class for which it was written? The book from which the foregoing quotations were taken was published several years ago and has had considerable sale. It is impossible to estimate the damage done by such misinforming literature to its readers and to really meritorious publications written by practical men. Much of existing prejudice to book information could doubtless be traced to trash written by incompetent amateurs and purchased by apprentices and mechanics in the hope of being better informed about their trades.—EDITOR.]

BALL AND ROLLER BEARINGS IN MACHINE TOOLS

On page 344 of the January, 1912, number, engineering edition, I read with much interest an editorial "Ball and Roller Bearings in Machine Tools."

In this editorial you say: "It is not perhaps to be expected that ball or roller bearings will be generally applied to such parts as lathe spindles. While they have given excellent results in severe service, the jar and vibrations of heavy intermittent cuts would prejudice most mechanical engineers against their use. But even if the main bearings of working spindles are hardly feasible places to apply them, there are many other plain bearings in lathes, milling machines, drilling machines, and other machine tools, that could be displaced by anti-friction bearings with large resultant saving of power."

This editorial conception is based on error. It is a fact that ball bearings are being used on the main spindles of lathes and lathes, moreover, of the type called upon to do the heaviest kind of work, such as high-speed production lathes and similar tools. Used on such spindles the employment of the ball bearings has resulted in an increased output with a decreased power loss. Not only that, but the question of wear of the bearings has been incidentally entirely eliminated. In fact it has been possible to so arrange the spindles that the attendant could not, even if he were so inclined, adjust the bearing. With the ball bearing, the journal as it left the maker's hands is constant throughout the life of a machine. No attendant with a monkey-wrench can in any way change the bearing or affect it adversely.

A little in the way of records taken first from a European lathe—that is to say a roughing lathe built by Ludw. Loewe & Co. of Berlin might be of interest:

Feed Per Revolution	Circumferential Speed in Feet Per Minute	Depth when taken by Two Tools Simultaneously
0.0394 inch	111.5 feet	0.5 inch
0.0394 inch	65.6 feet	1.18 inch
0.0394 inch	152.5 feet	0.55 inch

Chips Removed in Pounds Per Hour	Consumption in H.P.	Consumption in H.P. Per Pound of Chips Per Hour
396 lb.	14.1 H.P.	14.1/396 = 0.0356
480 lb.	16.6 H.P.	16.6/480 = 0.0346
515 lb.	17.1 H.P.	17.1/515 = 0.0332

We believe that this table will convince you that the ball-bearing lathe main spindle makes an exceedingly efficient combination. Please note that this record was made on steel having a tensile strength of 80,000 pounds per square inch and at that with 9/16 inch depth of cut and a speed of over 150 feet per minute. The power requirement is only 3/100 H.P. per pound of chips per hour.

The other point that you raise concerning the jar and vibrations can best be answered by quoting an experience with a Lodge & Shipley lathe in our own works here in Philadelphia, which lathe some seven years ago was equipped with ball bearings on the main spindle. After five years of use, during which time absolutely no adjustment of any kind was given the bearings and during which time the lathe was used not only all day, but also for night work and on roughing work and a general range of work of very severe character, it was found that a test roughing cut taken on a bar of 5 inches diameter and 22 inches length showed maxima of variations from absolute roundness of only 0.0030 inch. Taking a finishing cut over this bar then showed maximum variations of roundness of only 0.0008 inch.

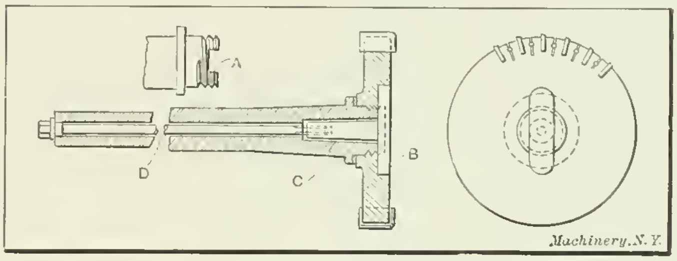
We doubt very much whether a plain spindle lathe fresh from the maker's hands would give as good results as to accuracy as this ball-bearing mounted lathe gives after five years strenuous service. HENRY HESS

Philadelphia, Pa. Hess-Bright Mfg. Co.

[The use of ball and roller bearings on machine tool spindles subjected to heavy side pressures is so limited that the cases cited are interesting, but hardly conclusive. The average lathe buyer will be likely to proceed cautiously when investing in equipment, as regards anti-friction bearings on the spindles, until he is absolutely convinced by many examples that they are reliable.—EDITOR.]

DEVICE FOR FASTENING THREADED MILLING CUTTERS TO SPINDLE

Possibly every milling machine operator has experienced some trouble when trying to remove face mills which are screwed onto the spindle nose, as it is a common occurrence for such mills to become wedged tight against the spindle collar. To overcome this tendency to "stick," the writer made a simple device for fastening the cutter as shown in the engraving. In order to use this attachment the milling machine must have a slot across the face of the spindle as shown at *A*. A recess is milled in the body of the cutter of exactly the same width as the slot in the spindle. Into this recess is fitted a plate *B* having a projection *C* on the inner side which is provided with a tapped hole for the draw-bolt *D*. The only reason for having this projection is to enable the draw-bolt which is furnished with the machine to be used.



Device for Fastening Threaded Milling Cutters to Spindle

In order to use the same cutter on different spindles, a hardened and ground washer should be put between the mill and the spindle collar. This washer may vary in width for the different spindles, and should be of such a width that the hub of the cutter will just touch it when the recess in the mill and the slot in the spindle are in line. It does not matter if the thread of the mill should happen to fit a little loosely on the spindle, as, by tightening the draw-bolt, the cutter will be clamped against the washer and spindle collar. It is of importance, however, that the counterbore in the mill should be a good fit on the blank part of the spindle nose, and that the plate *B* fit snugly into the recess and slot. If this last condition is observed, there will be no trouble from the mill's sticking, as the plate *B* will resist any wedging tendency.

H. I. N.

COMMENT ON CHAIN CASES

In the editorial in the November number of MACHINERY, on unprotected power transmission chains, attention is called to the seemingly bad practice of using uncovered sprocket chains, and it is said that the practice is indefensible and should be abolished. The use of uncovered chains on heavy motor trucks in this country is, however, defensible, owing to the varied road conditions under which these trucks operate. Even the smooth, asphalted city streets are very frequently not taken care of, and have holes deep enough to allow the rear wheel to drop into them, resulting in the breaking of the cases; and the unpaved country roads are full of ruts into which a truck will sink to its hubs. Apparently these are the very conditions against which the chains need to be protected, but they are the ones that break the cases and hold up the truck for repairs, which is a greater detriment to the efficiency of the truck, in the eyes of a business man, than the decreased efficiency of the power transmission chains. Such repairs and the loss of time entailed are costly, and in a year's time more than offset the cost of new chains. The ability of a truck to be run daily for a specified time before going to the repair shop gives the business man faith in the motor truck.

On touring car design, where the chain-drive has almost entirely disappeared and where the conditions under which the drives operate are not as severe as in the case of the motor truck, chains would have survived longer with cases, as the noise made by the uncovered chains was the great objectionable feature to their use. When one considers the time that has been spent by designers to produce quiet-running motors and transmission gears, it seems strange that more time has not been spent upon this problem. Chains are manufactured by makers of accessories, and as the makers of chains have never insisted that chain cases should be used, the reason for a seemingly bad practice is apparent.

Brooklyn, N. Y. John F. Winchester

MAKING MILLING MACHINE SPINDLES

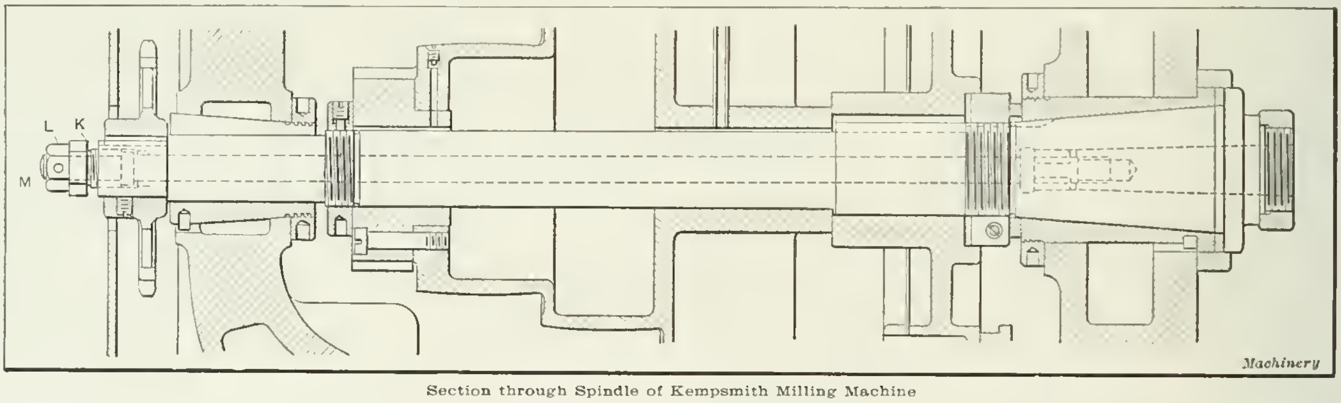
The article on the making of milling machine spindles by Mr. John Goetz in the October number of Machinery is not only interesting but instructive; particularly so is the method described for broaching the tang slots at the bottom of the taper hole, which shows a satisfactory way of doing a difficult piece of work, and incidentally illustrates the usefulness of the slot cutting attachment. But after going to the trouble of broaching these tang slots, why are they not made use of by providing the arbor with a tang?

We have recently installed a Kempsmith Lincoln type milling machine of the latest design, and after reading the article referred to, we took out the arbor to see if the spindle was broached as described. The slots had been cut, but the curious point is that there is no corresponding tang on the arbor; in fact, the end of the arbor does not reach within half an inch of the slots.

Furthermore, the draw-bolt for securing the arbor in position is screwed in with a right-hand thread, which, in the absence of a positive drive, allows the arbor to work loose under the reaction of the cut unless screwed up unduly tight, in which case the nut at the rear of the draw-bolt is absolutely useless for forcing the arbor loose when it is to be removed.

A. E. Dodwell

Works Manager for Clay & Atkinson, Bradford, England



Section through Spindle of Kempsmith Milling Machine

THE REPLY

In reply to the question asked by Mr. A. E. Dodwell, Works Manager for Clay & Atkinson, Bradford, England, the writer would like to offer the following explanation: By referring to the article mentioned, it will be seen that we have no trouble in doing the job which Mr. Dodwell in his letter says is a difficult piece of work. It is, therefore, a small outlay for us to continue putting tang-slots in spindles with small tapers to accommodate those of our customers who might have equipment of the older type (as builders of milling machines until recently supplied all millers with slots to receive tang arbors). A good many have discontinued using tang arbors entirely, and others partially, for reasons sufficient to warrant the change.

We are among those builders who by discontinuing the tang arbor thought they were doing so to the interest of the user. In the early days, when the milling machine was in its infancy, the tang on an arbor was sufficient to drive the arbor. Now, since the advent of high-speed steel with increased feeds and speed, using tools to the limit of their capacity all the time, a tang at the rear end of the arbor is not sufficient to drive the arbor; the same thing happens to the tang arbor that occurs with a taper shank drill—the tang twists off. We are all as mechanics trying to get away from that; once away from it we will never go back.

There is no provision made to hold the tang arbor in place, or to hold it snugly in its seat while under working strain. When it becomes loosened slightly, the tang alone must continue to drive the arbor, and either the tang will break or the work will be spoiled by the arbor coming out of the spindle until the arbor nut comes against the pendent, which prevents it from falling out before the trouble is noticed.

We continue putting slots in spindles to accommodate such of our customers as may have tang arbors, collets with tangs, or small end mills with tangs; or, if a customer prefers a tang arbor, we will furnish him one for the asking in exchange for one sent with the machine. These are the reasons why we continue putting slots in the spindles and also why we have discontinued using tangs on arbors unless specified. We think it the best way to hold a taper of the smaller size such as the No. 10 and No. 11 B. & S. tapers positively seated under all conditions of work.

The operation of the arrangement, as indicated in the illustration, is as follows: To draw in the arbor, screw the rod *M* by hand, by means of nut *L*, into the arbor, until the pilot on the rod bottoms in the threaded hole in the end of the arbor; then give nut *L* a short additional turn with a wrench; then screw sleeve *K* backward to the left till it is tight. This firmly seats the arbor. To push out the arbor, give sleeve *K* a quick turn to the right. This should unseat the arbor with a snap. If not, tapping with a small hammer will release the arbor, and then it can be unscrewed by nut *L*.

The object of having the pilot on the rod bottom in the threaded hole in the end of the arbor is to make a unit of the rod and arbor—as near, at least, as it is possible to make it so under the circumstances; then by drawing in the arbor with a wrench on *K*, which has 16 threads per inch, one can easily draw in the arbor tight enough to prevent it from turning; the arbor can also be forced out with ease. We do not depend upon the rod to prevent the arbor from turning, but it does hold the arbor seated so snugly that it practically makes one piece of the spindle and arbor, regardless of the direction in which the machine is revolving; and yet it allows of interchanging arbors whenever it becomes necessary.

The writer is of the opinion that discussions of this kind are a great benefit to the builders, as well as to the public; in this way we all get an insight into many things which at first seem unimportant.

Milwaukee, Wis. John Goetz

* * *

A man who has to do his work without proper appliances sure earns his wage, but whether or no he makes a profit for his employer is another question.—*Exchange.*

SHOP KINKS

PRACTICAL IDEAS FOR THE SHOP AND DRAFTING-ROOM

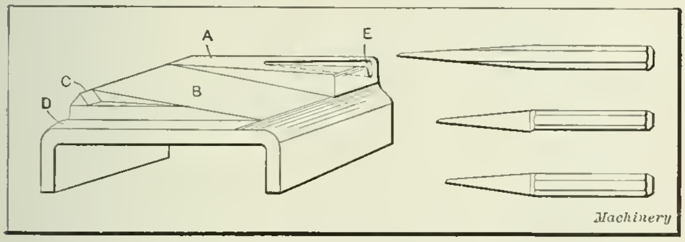
Contributions of kinks, devices and methods of doing work are solicited for this department. Write on one side of the paper only and draw sketches on separate sheets.

THE PREPARATION OF TRACING CLOTH

Much has been written on the subject of preparing tracing cloth, and each writer has his own method, which naturally appears to him to be the best. Our work requires drawing on the cloth first with a pencil, so if powder is used in the preparation it is almost impossible to draw light fine lines, as the powder makes them broad and increases the difficulty of rubbing them out. If the cloth is prepared after penciling, the rubbing in of the powder erases the pencil lines. Another objection to the powder is that it clogs up the pen. After much experimenting we have concluded that the blotting paper method is the most efficient. A soft piece of blotting paper will clean the drawing of all grease, make it take ink perfectly, and does not obliterate the pencil lines. Of course the dull side of the cloth must be used for the pencil work, and the smooth side for tracing. Alcohol is applied with a piece of cotton. This shrinks the cloth, cuts it sufficiently to take the ink, and does not destroy the gloss. J. M. H.

AN ANVIL BLOCK FOR THE STEAM HAMMER

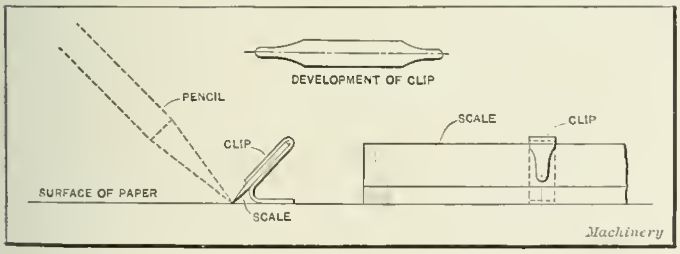
The accompanying illustration shows an anvil block which can be used under a steam hammer for making chisels of the chipping, round-nosed or cape variety. The block is made from tool steel. The part *B* is used for tapering the chisel; the part *D* for narrowing after the chisel has been tapered; the parts *A* and *E* are used for cape and round-nosed chisels; and the part *C* is used for cutting off. By the use of this anvil-block one blacksmith can easily make from 75 to 110 chisels per hour.



Nashville, Tenn. T. O. Martin

CLIP FOR A DRAFTSMAN'S SCALE

The clip shown in the accompanying illustration is used for holding a draftsman's flat beveled-edge steel scale at a convenient angle for transferring dimensions direct to the drawing. By the use of a scale held in this manner, dimensions can be laid out more quickly than by using the dividers. It also obviates the task of lifting the flat scale from the paper. The clip is made from flat spring steel, bent into the shape shown, and spring tempered. When the scale is required for measuring purposes, the clip can easily be removed. J. L.

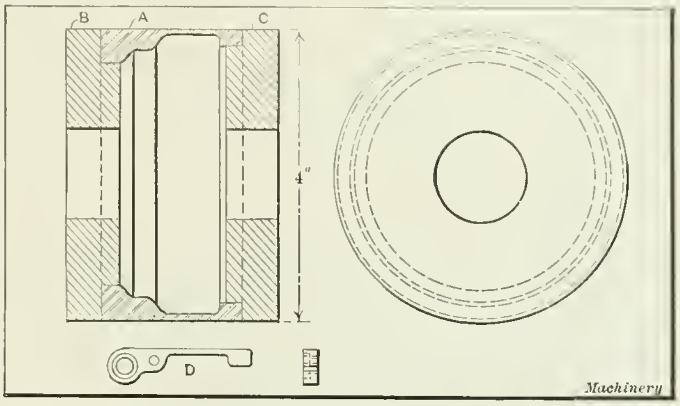


RECEIPT FOR LEAKY FOUNTAIN PENS

To prevent fountain pens leaking at the joints, place a small portion of common chewing gum at the joint only, but not on the threads. The gum should be chewed before using and applied while still warm. One application will be found sufficient, as it sticks to the surface. This does not appear to interfere with the removal of the part at any time and never leaks. O. P. L.

MAKING SPRINGS IN THE LATHE

A quick and simple method of making springs in the lathe is shown in the accompanying illustration. A piece of steel of the required diameter is gripped in the lathe chuck, bored to the shape shown at *A*, and turned on the outside; it is then cut off from the bar. After this, two cast-iron washers *B* and *C* are fitted to this ring in the manner shown, and it is placed on an arbor. The arbor is placed in the milling machine and the ring is cut up into segments of the width desired with a slitting saw, after which the rings *B* and *C* are removed and the cut segments are ground parallel. This method works very successfully in making springs, as shown at *D*, for ratchet feeds.



Subscriber

MENDING ARC LAMP GLOBES

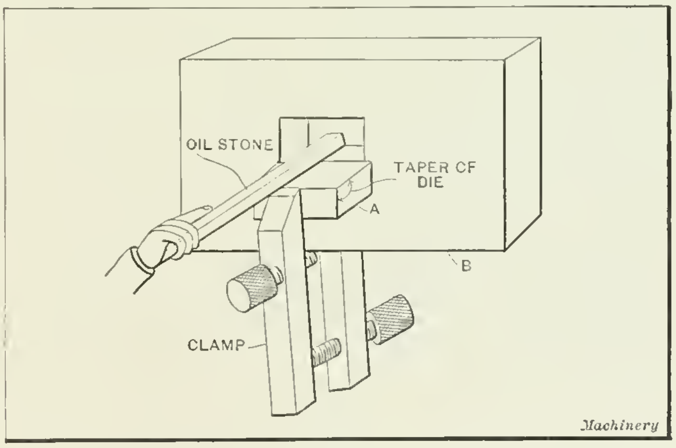
If arc lamp globes, as soon as cracks appear, are coated inside and out over the crack with silica of soda or "water glass," they may be prevented from further cracking or breaking, and thus prolong their usefulness.

The liquid glass should be spread on over the crack and allowed to dry before heat is applied, otherwise the water in the solution will "boil," thus making the "job" rough and blistered. But if allowed to dry, a hard glaze is formed when heated which binds the broken parts.

Salem, Ohio. H. W. Weisgerber

METHOD OF STONING OUT A DIE

Stoning or lapping out a die is many times a tedious job and can be much more easily accomplished by the use of suitably placed guides or guards for the lap. As an example, consider a die, like the one shown in the accompanying illustration, having a square hole to be stoned out. First the outside of the die is ground as nearly parallel with two of the sides of the square hole in the die as possible. Then a block *A*, made of soft steel, having two sides beveled at the same angle as the die, is set parallel with surface *B* and at the correct height. During the lapping operation this block *A* will furnish a good guide for the lap. Sometimes if much lapping is to be done the block *A* will have to be removed and re-surfaced, as the stone will wear it slightly rounded.



Designer

HOW AND WHY

DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST

Give details in full and name and address. The name and address will not be published with the answer.

WELDING CHROME-NICKEL STEEL

C. L. L.—I would like to know, through the columns of MACHINERY, how to weld chrome-nickel steel in an ordinary forge fire.

MAKING AND HEAT-TREATING WATCH SPRINGS

R. H. K.—How are watch and clock springs manufactured, and how are they hardened and tempered?

Answers to this question are solicited.

MAKING BRASS AND IRON TUBING

M. H. H.—How is the tubing used in bedstead manufacture made? Is the brass tubing made from cut sheets bent into the desired form and brazed? How is it formed and brazed, and how is iron tubing for the same purpose made?

Answers to this question are solicited from our readers.

UTILIZING REJECTED PARTS—REMOVING BURRS FROM METAL PRODUCTS

D. A. H.—What should be done with parts rejected by inspectors? Every plant accumulates rejected parts that do not come up to the standard in one way or another. Should these parts be thrown into the scrap pile, marketed as second quality, or treated individually so as to bring them up to the standard? What method of removing fins and burrs from manufactured metal products finds the greatest favor with manufacturers? Where small parts are made by the thousand the problem of cheaply and efficiently removing the burrs left by dies and cutters is serious.

STRAIGHTENING BRASS TUBING

T. M. W.—We have experienced considerable trouble in procuring brass tubing perfectly straight and true, and usually have to straighten it to make up rolls used in paper mill machinery. Our greatest trouble is with tubing 8 inches outside diameter, No. 8 Stubbs gage, hard and medium tempered, in lengths from 10 to 15 feet. We use this tubing for "carry rolls" on a paper machine and the face must be perfectly true to within 0.005 inch. We sometimes find short kinks and flat spots and the only method that we have been able to use is to center the tube in a lathe and peen out the kinks and curves by hand. We would be pleased if you could advise us of any method better than the one mentioned, or of a tube straightening machine suitable for the work.

A.—The defects are of a class that would seem most feasible to correct in a draw-bench, but a draw-bench of the size and power required for such heavy tubing would be a rather costly and cumbersome machine, and it would hardly pay to install it unless a large amount of tubing had to be straightened. We would be glad to receive suggestions or contributions from readers having experience with work of this sort.

SOLVING OBLIQUE-ANGLED TRIANGLES

G. E. H.—In solving a triangle, as shown in the accompanying illustration (Fig. 1), I find that the formula given in various handbooks is as follows:

$$c = \sqrt{a^2 + b^2 - 2ab\cos C}$$

I cannot obtain correct results by this formula, as it seems to me that the formula ought to read:

$$c = \sqrt{a^2 + b^2 + 2ab\cos C}$$

I assume that the formula as given in the handbooks is correct, but do not understand why it is. Will you explain this to me?

A.—The formula $c = \sqrt{a^2 + b^2 - 2ab\cos C}$ is the correct formula to use for solving any triangle in which two sides and the angle included by these two sides are known. The reason for the difficulty met with in the use of this formula is that the cosine for angles larger than 90 degrees is negative; hence, the whole expression $2ab\cos C$ becomes negative, and when a negative quantity is subtracted from another number, the effect is that of adding it, this being one of the fundamental rules relating to negative values.* An example will make this clearer.

Assume that we are to find length of side c in the triangle shown by our correspondent (see Fig. 1). We then have:

$$\begin{aligned} c &= \sqrt{1.5^2 + 1.5^2 - 2 \times 1.5 \times 1.5 \times \cos 110} \\ &= \sqrt{2.25 + 2.25 - 2 \times 2.25 \times (-0.342)} \\ &= \sqrt{4.5 - 4.5 \times (-0.342)} \\ &= \sqrt{4.5 + 1.539} = \sqrt{6.039} = 2.46 \end{aligned}$$

If the angle is less than 90 degrees, then the cosine of the angle is a positive number and the numerical value of the whole expression $2ab\cos C$ will be subtracted as indicated by the formula. An example of this is given in the following, the angle C being assumed to be 70 degrees, instead of 110 degrees, as shown in Fig. 2.

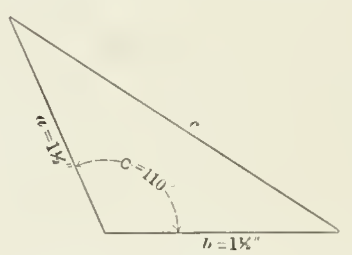


Fig. 1

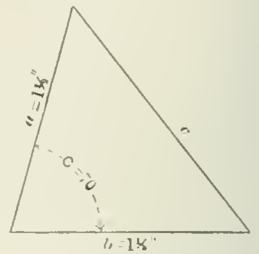


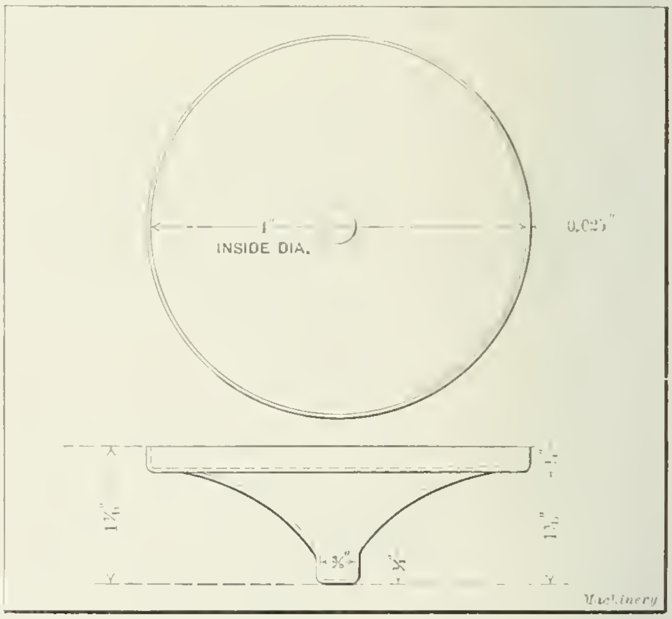
Fig. 2

$$\begin{aligned} c &= \sqrt{1.5^2 + 1.5^2 - 2 \times 1.5 \times 1.5 \times \cos 70} \\ &= \sqrt{4.5 - 4.5 \times 0.342} \\ &= \sqrt{4.5 - 1.539} = \sqrt{2.961} = 1.72 \end{aligned}$$

By studying the preceding examples, it will be clear that the formula as given in the handbooks is correct for all triangles, irrespective of whether the angle between the two known sides is greater or less than 90 degrees, but as the cosine for angles larger than 90 degrees is negative, the actual numerical calculations involve the adding of the product $2ab\cos C$ to the quantity $a^2 + b^2$.

DRAWING AN ODD-SHAPED CUP

J. M.—The odd-shaped cup shown in the accompanying illustration is to be made from 0.025 inch sheet iron. The press available for this purpose is an ordinary geared Niagara Falls press having a 2-inch stroke. What will be the size of the blank, how many operations will it require, and what are the successive sizes of the punches and dies?



Answers to this inquiry are solicited from our readers.

* * *

According to the *American Engineer and Railroad Journal*, Mr. W. B. Duff, a machinist, has recently, while turning a piece of vanadium steel, cut a spiral shaving that measured 155 feet in total length. This is believed to be the world's record in the making of long metal shavings. This achievement is, of course, more interesting than useful.

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* See also MACHINERY'S Reference Book No. 54, "Solution of Triangles," Chapter III, "Positive and Negative Quantities," and Chapter IX, "Solution of Oblique-Angled Triangles."

NEW MACHINERY AND TOOLS

THE COMPLETE MONTHLY RECORD OF NEW DESIGNS AND IMPROVEMENTS
IN AMERICAN METAL-WORKING MACHINERY AND TOOLS

THE HEALD INTERNAL GRINDING MACHINE

The internal grinding machine illustrated in Fig. 1 has been designed to meet the demand for a simple and inexpensive machine for grinding short holes in large numbers of duplicate parts. This grinder is built by the Heald Machine Co., 20 New Bond St., Worcester, Mass., and is known as the No. 75. It is recommended for work up to about 2 inches in length and is adapted for grinding such parts as transmission gears, bevel gears and pinions, bushings, milling cutters, rings, etc.

The principal novelty of this machine, as compared with the No. 70 style built by this company, is that the table is operated by hand instead of by an automatic power feed. The table movements are controlled by the large pilot wheel shown. Positive stops are provided which can be accurately set to govern the travel in either direction. This enables the operator to grind up to a shoulder or to any given point without danger of overrunning. On short work of the class mentioned, the hand machine is said to be fully as rapid as the automatic; in fact, on short holes it has been found that the average operator can produce more work with a machine of the hand-feed type and without affecting the quality. The weight of the table and the ratio of the gearing connecting it to the pilot wheel, is such that a smooth uniform motion is obtained. After a hole is ground approximately to size, it is a very simple matter to back the wheel away from the work sufficiently to permit using a sizing block or micrometer. The wheel can also be quickly returned to the grinding position and no time is wasted in engaging or disengaging the power feed.

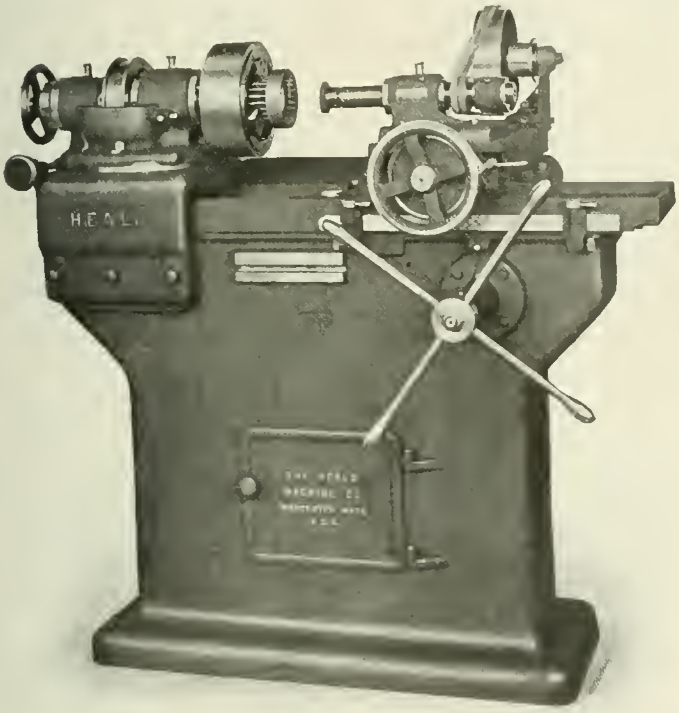


Fig. 1. Heald Internal Grinder with Hand-operated Table

Another line of work in which this machine excels is in the grinding of holes which are recessed in the middle, as for example, a bushing having a bearing 1 or 2 inches long at each end and a space of larger diameter extending for say 2 or 3 inches between. With the automatic machine the wheel would feed through the first bearing surface and then proceed through the intervening space where no work was being done, until it reached the inner surface. Obviously, considerable time would be consumed without accomplishing any results. With the hand-feed machine, however, this idle period could be practically eliminated by traversing the wheel rapidly from the end of the first bearing surface to the beginning of the next. For work of this class the machine could be used for grinding parts which were 6, 7 or possibly 8 inches in length over all. A grinder of the automatic type is recommended for long holes or for grinding miscellaneous work which is likely to be either long or short.

The machine has a heavy rectangular base fitted with a heavy table having ample bearing surfaces. The ways are protected with guards to prevent the entrance of grit or dust and they have oil pockets with rolls for the uniform distribution of the lubricant. Many of the parts used in the hand-feed machine, such as wheel-heads, chucks, etc., are duplicates of those used in the automatic type and will interchange. Owing to this feature, one or two extra wheel-heads will be sufficient to handle various kinds of work in whichever style of machine can most conveniently be used.

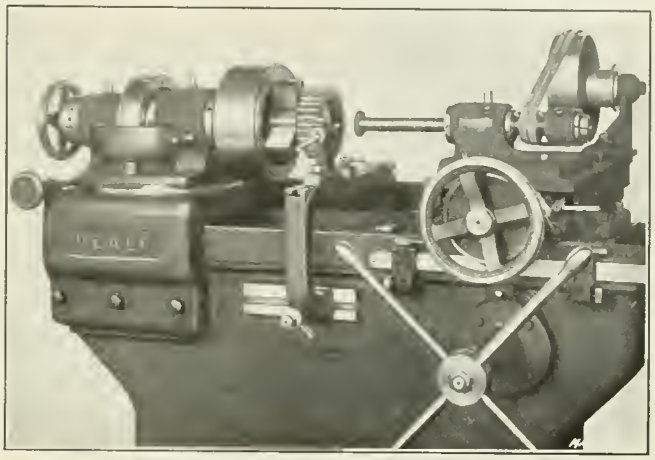


Fig. 2. Detail View of Heald Grinder

The grinding spindle of this machine is mounted directly on the main table where it is rigidly supported. The headstock, a sectional view of which is shown in Fig. 4, is mounted on a heavy bridge casting and it is arranged to swivel to any angle up to 45 degrees either side of the center line. The graduations on the swivel base are both in degrees and inches of taper per foot. The headstock is fitted with phosphor-bronze boxes made dustproof and adjustable for wear. The chuck spindle is of specially treated high carbon steel. It is ground and lapped and is of extra-large diameter in the bearings, the diameter of the front and rear bearings being, respectively, 2¾ and 2¼ inches. A hole 1¼ inch in diameter extends through the chuck spindle. This is used in connection with collet chucks and it is also convenient for exhausting dust when dry grinding, or for a water supply in connection with wet grinding.

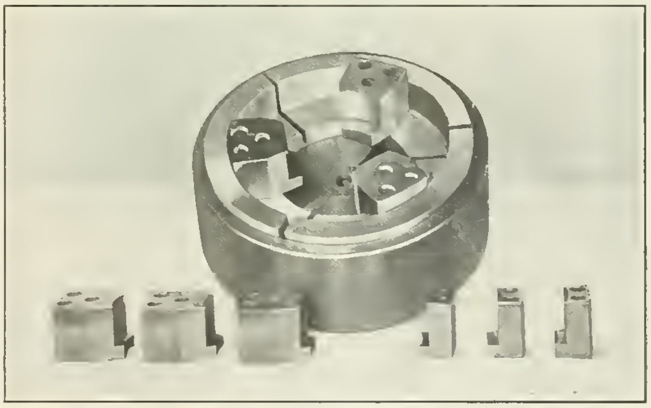


Fig. 3. Collet Chuck fitted with Solid Jaws

The construction of the cross-slide and wheel-head is clearly shown in the enlarged view Fig. 2. The idler pulley is fitted with radial ball bearings of the silent type and it is adjustable on the cross-slide for varying the belt tension. This pulley has two steps, the smaller of which is belted to the countershaft, and the larger to the wheel-spindle. With this drive the proper speeds for efficient grinding are obtained with a moderate speed of the countershaft. The bearings of the wheel-head are so arranged that endless belts can be put on and taken off quickly without making any adjustments. The wheel-heads are self-contained and interchangeable so the different sizes can be quickly substituted when changing from the grinding of large holes to small holes or *vice versa.* The pulley for each wheel-head is of the right diameter to drive the grinding wheels used on that head at the correct speed, without attention on the part of the operator. An accurate adjustment of wheel speeds, to give the most efficient speed for new or old wheels, is made possible by different diameters on the spindle pulley. This machine is adapted for either dry or wet grinding. The table is equipped with water channels leading to a water pan connecting with a tank located on the floor in the rear of the machine.

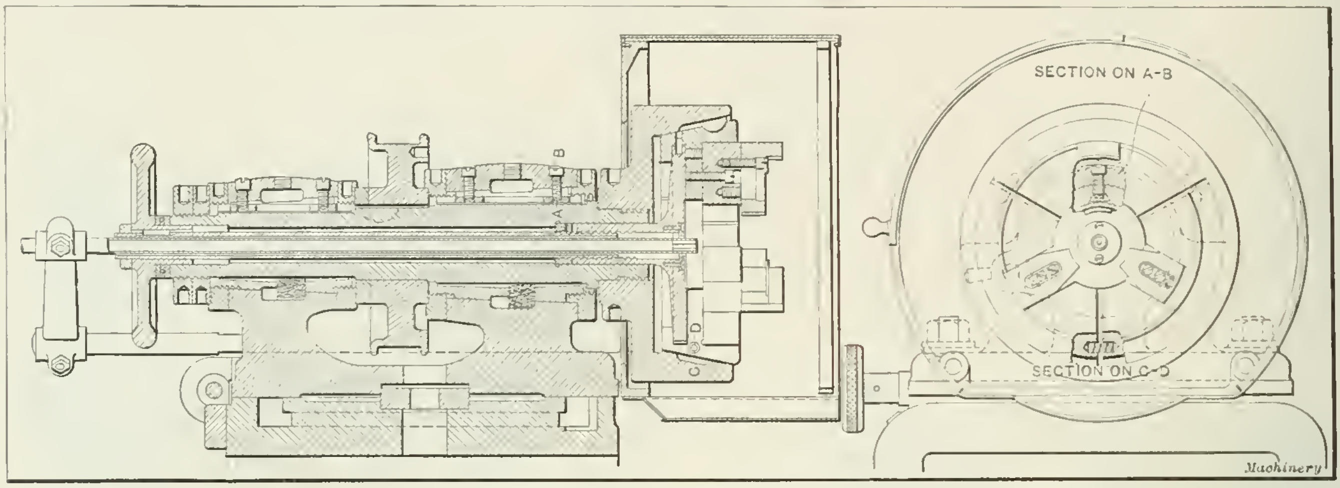


Fig. 4. Head and Collet Chuck—Heald Grinder

A draw-in collet chuck designed to accurately locate work for internal grinding is shown in Fig. 3. This chuck is also shown in section in the assembly view of the swivel head, Fig. 4. It is operated by a handwheel at the left of the head in the usual manner. The collet can easily be fitted to hold odd-shaped parts which could not be held by jaws of the ordinary type. This chuck can be fitted with either solid or adjustable jaws, the former being shown in Fig. 3 and the latter in Fig. 4. The adjustable jaws are made in two parts and they have a capacity for diameters ranging from 5/8 inch up to 8 inches.

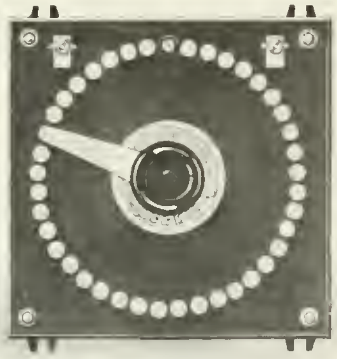


Fig. 1. Electric Controller & Mfg. Co.'s Motor Field Rheostat

ELECTRIC CONTROLLER MOTOR FIELD RHEOSTAT

The Electric Controller & Mfg. Co., Cleveland, O., has a new line of motor field rheostats for varying the speed of adjustable speed, shunt and compound direct-current motors. The construction of these rheostats, one of which is shown in Fig. 1, is fireproof throughout. The face carrying the arms and contacts is of the best quality Monson slate. The resistance units consist of small cast-iron grids insulated with asbestos and wound with resistance wire. These units are carried by the slate and are fastened directly to the contacts. The resistance wire has an unusually low temperature coefficient so that the resistance of the rheostat, for any one setting, does not increase with heating and thereby alter the speed of the motor which it regulates. A dial-plate with the words "fast and slow" on it, indicates which way to turn the rheostat handle to obtain the desired change in motor speed.

An important adjunct to these rheostats, known as a field rheostat relay, has been brought out. The combined rheostat and relay is shown in Fig. 2. It is well-known that a shunt or compound wound motor should be started from rest with full field strength. In fact, if the shunt field is weakened to a large extent, it may be impossible to accelerate the motor because of insufficient torque or a prohibitive sparking at the commutator. The admission of a large volume of current may also "blow" the fuses and circuit breakers. It is therefore the preferred practice to return the rheostat handle to the position of full field strength every time the motor is started. The field rheostat relay has been developed to prevent starting the motor with a weakened field.

This relay consists of a magnet coil or solenoid through which passes a steel plunger carrying at its lower end a disk-shaped contact plate for electrically connecting the two contact studs shown above it. The magnet coil and plunger are enclosed in an iron case which not only gives protection but also acts as a part of the magnetic circuit. The relay coil is connected in series with the armature circuit of the motor and the two contact studs are connected to the two terminals of the motor field rheostat so that the rheostatic resistance is short-circuited when the contact studs are bridged by the contact plate. The relay coil is so designed that when the armature current exceeds a predetermined maximum, the plunger is drawn up, thus bringing the contact plate against the studs and cutting out all of the resistance in series with the shunt field. This gives the motor its full field strength and consequently the maximum torque. As the current de-

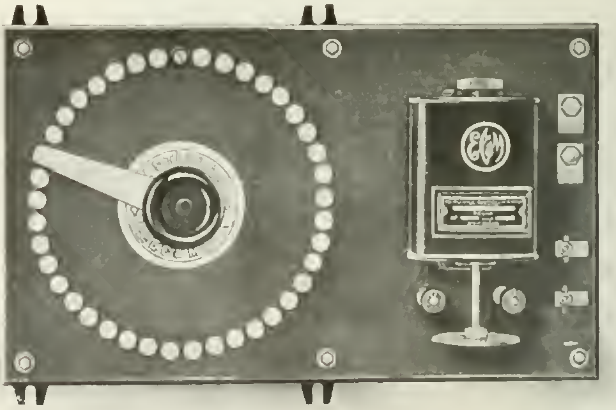


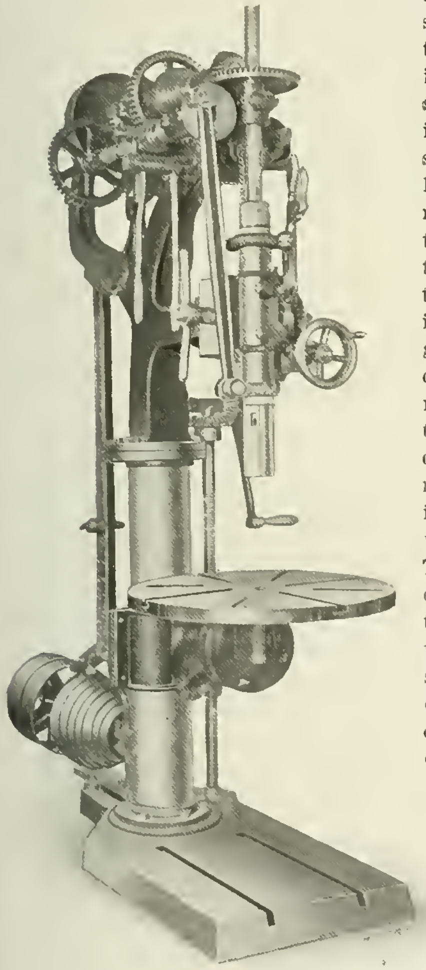
Fig. 2. Combined Motor Field Rheostat and Relay

creases due to the speeding up of the motor, the relay plunger drops inserting the rheostatic resistance in the shunt field circuit and weakening the field. This cycle of operations is repeated until the motor has been safely brought to the proper speed as determined by the setting of the motor field rheostat.

The relay permits setting the field rheostat to give the most efficient motor speed for the work at hand, and no matter how often the motor is started and stopped, it will invariably run at this speed. It also saves the time of the operator who does not have to adjust the motor field rheostat after the motor is started. The motor field rheostat is furnished either with or without the field rheostat relay. It is rated up to and including 50 horsepower at 110, 220 and 550 volts and in general will provide for a maximum speed variation of 4 to 1.

DRILLING MACHINE WITH SPINDLE-RECIPROCATING ATTACHMENT

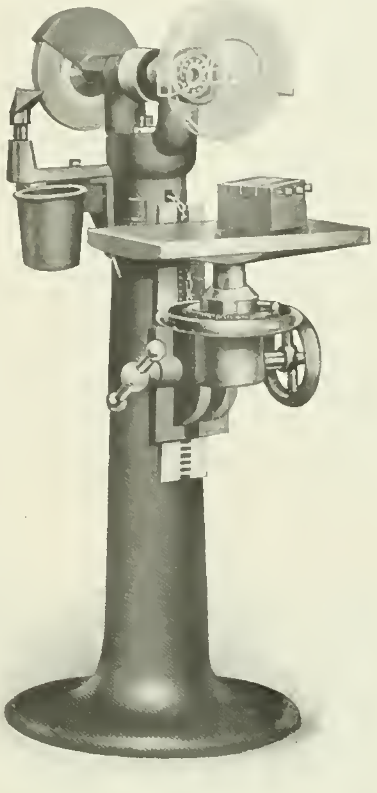
The upright drilling machine shown herewith is a novel design in that it can be used for keyseating and similar operations, in addition to drilling, the construction being such that the drill spindle can be given a reciprocating movement in addition to the rotary motion. This movement is obtained from a horizontal shaft at the top of the machine, carrying at one end a slotted crank which is connected to the spindle quill by a link or connecting-rod, as shown, when the reciprocating action is desired. When the machine is driven in this way, the back-gears for the rotary drive are placed in a neutral position, and the spindle quill is disengaged from the regular feed mechanism to permit the vertical movement. This disengagement is effected by throwing the worm out of mesh with its wheel. The stroke of the spindle can be varied within certain limits by changing the position of the crankpin with relation to the center of the crank. The machine can be quickly changed for drilling operations by simply disconnecting the rod and disengaging a clutch which connects the crank disk with the horizontal driving shaft. This clutch is controlled by one of the vertical levers shown at the left. The crankshaft is driven from the main driving shaft through spur gearing as shown. Aside from the reciprocating motion, this machine is similar in its general construction to the conventional upright drill press. It is equipped with a handwheel and lever feed, an automatic stop mechanism, and other features common to modern drill press design. The table differs from the usual type in that it can be tilted about a horizontal axis in order to accommodate angular work. This machine has been put on the market by W. J. Riordan & Co., Orange, N. J.



Drilling Machine the Spindle of which can be given a Rotary or a Reciprocating Movement

LA SALLE PLAIN AND SURFACE GRINDER

The La Salle Machine & Tool Co., La Salle, Ill., is now manufacturing a combined plain and surface grinder having ball bearings. It should be mentioned that this machine is not intended to supplant the design built by this company having plain "anti-friction" bearings. Particular attention has been given in the construction of this machine to protecting the working parts from dust or grit. Wheel guards are also provided to protect the operator. The knee and table are counterbalanced by a weight inside the column. The table is 8 by 14 inches and has a vertical travel of 12 inches on the guides with a ¾-inch adjustment by the micrometer wheel shown. This wheel carries a large dial graduated to thousandths of an inch and provides a fine adjustment for regulating the depth of cut. The opposite side of the machine is equipped for plain grinding, as the illustration shows. The distance between the grinding wheels is 15 inches and the height to the spindle center 40 inches.



La Salle Plain and Surface Grinder

HORTON INDEPENDENT CHUCK

The E. Horton & Son Co., Windsor Locks, Conn., is manufacturing a new design of independent chucks, two views of which are shown herewith. The body of this chuck is exceptionally heavy, and the jaws have wide gripping surfaces. The jaws are made of steel and are thoroughly casehardened; they have raised seats for the work to rest upon, and are ground true both on the face and gripping surfaces. The operating screws are of the best quality of steel for the purpose, and are of larger diameter than is ordinarily used; they are made to be flush with the body, and have mortised heads for the reception of the op-

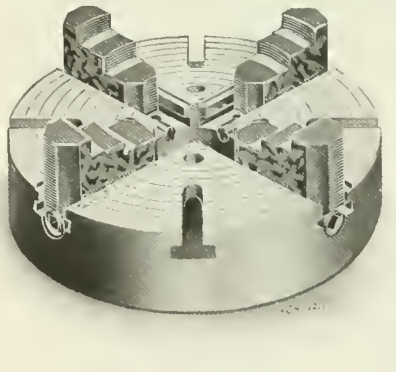


Fig. 1. Horton Independent Chuck, Model 50

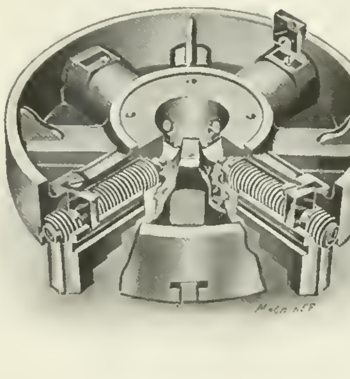


Fig. 2. Rear View showing Method of Inserting Steel Thrust Washers

erating wrench. The thrust bearings for the operating screws are of hardened steel and are removable. They are located at the place where they will sustain the greatest amount of strain when in operation, at which time this bearing is covered, preventing clogging with chips, etc. The location of these thrust bearings and the method of inserting them is clearly shown in the rear view, Fig. 2. A T-wrench of suitable size, having a hardened end, is furnished with each chuck. This design is made in sizes ranging from 6 inches to 42 inches, inclusive. This chuck, known as model 50, is not intended to supersede the other lines of independent chucks made by this company, but is an addition thereto.

NATCO ADJUSTABLE MULTIPLE SPINDLE DRILLING MACHINE

The National Automatic Tool Co., Richmond, Ind., has added to its line of multiple spindle drilling machines a smaller size, known as type M-1. This machine, in common with other multiple spindle machines built by this company, has independent speed changes for the different spindles, which makes it possible to vary the speeds of the drills in accordance with their diameter. The gears for effecting these speed changes are located inside the head and the positions of the change gears are shown by the location of the grooved shafts seen extending above the head in Fig. 1. The shaft seen in the center is in the slow speed position, and those on either side are in a neutral position, whereas the outer shafts are set for high speed. By simply changing the position of these shafts, the speed of each spindle is independently controlled. The arrangement of the change gears is shown by the sectional view Fig. 2.

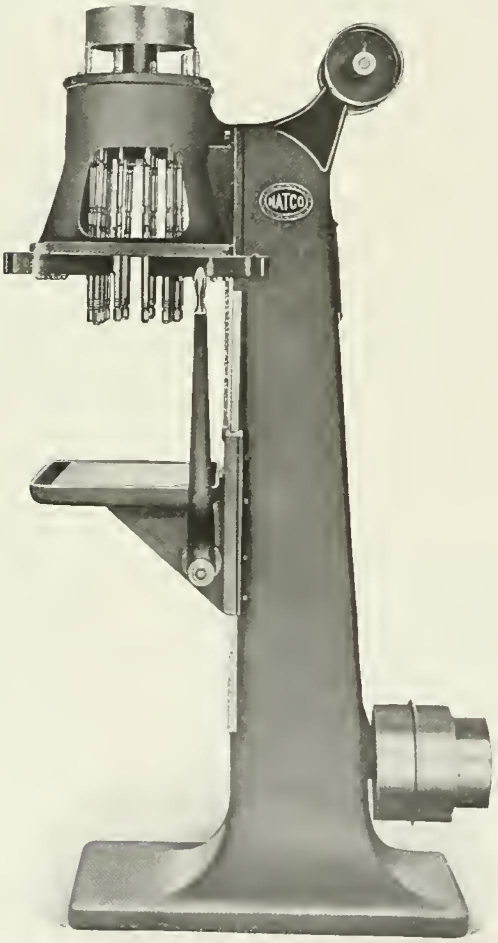


Fig. 1. Adjustable Multiple-spindle Drilling Machine, built by the National Automatic Tool Co.

All gears are cut from the solid and no cast-iron gears are used. All head gears run in a continuous oil bath, the head acting as an oil reservoir. Ball bearings are used between the gears and all bearings are bushed with a special grade of phosphor-bronze. The adjustable steel spindle rails attached to the under side of the head are bronze bushed and have ball thrust bearings, adjustment for wear, ample oiling facilities and are made rigid to withstand any deflection. These rails can be quickly adjusted when changing the machine for drilling different parts. Spring collets are used for holding the drills which are clamped by hexagonal spindle caps screwed on the ends of the spindles. In case some of the spindles are not needed, they can be disengaged by placing the change gears in the neutral position. These changes can be made while the machine is running. The universal joints used in this machine have driving blocks with pins that are milled from the solid. The wearing surfaces are also hardened, thus making a strong, durable joint.

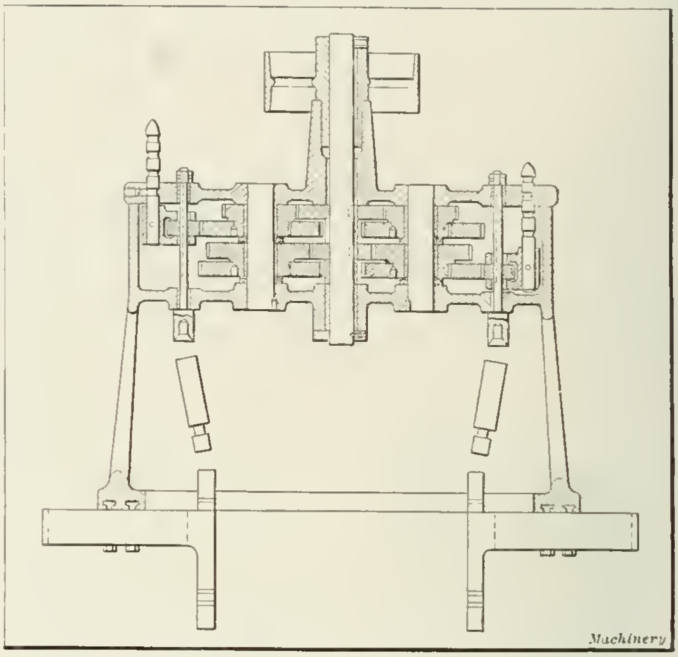


Fig. 2. Sectional View of Head showing Change Gears

These machines are built with either square or rectangular heads. The former has a drilling capacity of 9¼ by 9¼ inches between the drill centers and the latter, 12 by 18 inches between the centers. The square-head machine will take ten 5/16-inch straight shank drills, and the rectangular-head, sixteen 5/16-inch straight shank drills. The minimum center distance obtainable with either machine is 11/16 inch or 13/16 inch, depending on the diameter of the holes drilled.

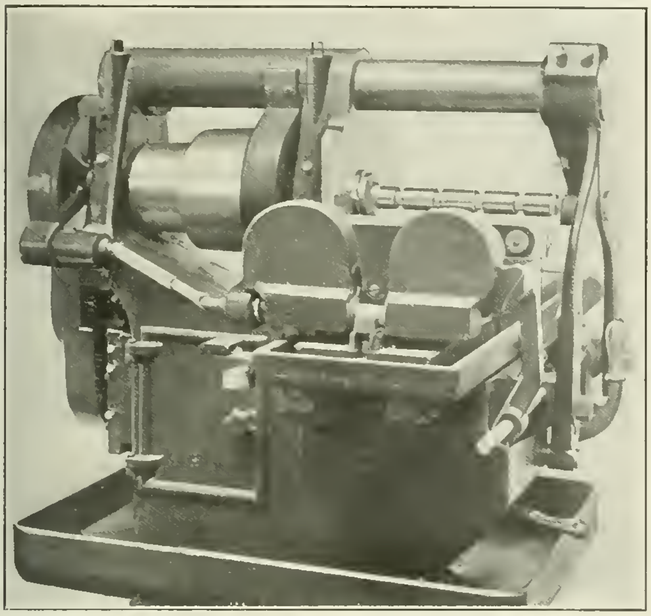
The table is counterbalanced and has a large bearing surface on the column with an adjusting gib. Either hand or power feed can be furnished. Stops are located on the side of the column for drilling holes to any predetermined depth, and an automatic throw-out is supplied with the power feed. The distance from the top of the table to the lower end of the largest spindle is 21½ inches. The table on the smaller machine has a planed surface 10¾ by 14 inches, whereas the table of the larger machine has a planed surface 13 by 21 inches. These machines can be supplied with a single speed for the spindles in place of the double speeds, if desired.

BICKFORD AUTOMATIC FLUTING MACHINE

In the department of New Machinery and Tools for June, 1911, we illustrated an automatic fluting machine built by the Bickford Machine Co., Greenfield, Mass. This company is now manufacturing a new design which has several distinctive features, aside from the indexing of the dividing head spindles and the table movement, both of which are entirely automatic as with the machine formerly illustrated.

The spindle of the machine is of crucible steel and runs in phosphor-bronze bearings arranged to provide for wear. The driving pulley is double back-geared with the spindle and is driven by a 4-inch belt. The knee is of the box type and is cast solid with the saddle. This machine has a combination drop arm and brace which are cast integral and give a very rigid support to the cutter arbor. The table is of large area and is surrounded by a channel to catch the lubricant. There is also a large oil pan bolted between the base and the column to catch any overflow. The table has a rack and pinion type of feed and its reverse movement is obtained from a gear-box in the column of the machine. This box is so arranged that a slight rolling movement of a reverse shaft throws a sliding clutch and reverses the motion with a speed increase seven times greater than the cutting speed. The mechanism of this gear-box can be easily reached by opening a door in the column.

The work-spindles are connected by spur gears and they are operated through worm-gearing by a universal shaft equipped with a sliding clutch. The spindles are locked in position by an index disk and lever and the latter also controls the sliding clutch. At the end of the return movement of the table, a special trip dog throws this lever, unlocking the index disk and starting the worm. As the spindles revolve, a pin on the index lever drops in the next notch of the disk and throws out the sliding clutch. Separate indexing disks, having any number of notches from two to twenty-four, are furnished for varying the number of divisions.



Automatic Fluting Machine built by the Bickford Machine Co.

The work-spindles in the tail-center block are equipped with heavy springs and are operated by levers, thus making it unnecessary to place the hands near the cutters when changing the work. A lever on the head-center block stops the feed when the work is completed. Only two levers are used for the table movements, one controlling the feed and one reversing the motion. A gear-driven pump attached to the rear of the machine, furnishes a flood of oil for each cutter.

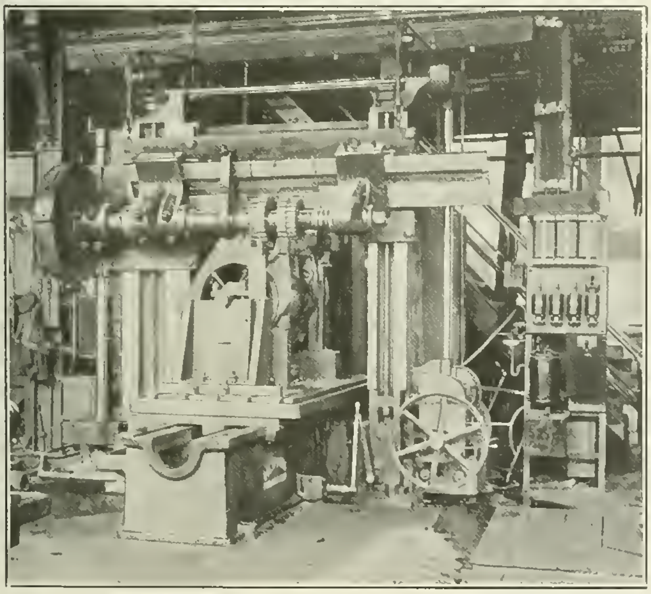


Fig. 1. Newton High-duty Planer Type Milling Machine

NEWTON HORIZONTAL MILLING MACHINE

The planer type milling machine illustrated in Figs. 1 and 2 is an addition to the line of horizontal machines built by the Newton Machine Tool Works, Inc., Philadelphia, Pa. The illustrations show this machine milling the frame castings of street railway motors in the shops of the General Electric Co. The spindle is driven by large worm-gearing located on the left side. The driving worm is mounted on a vertical shaft which is connected by gearing with the driving motor as shown in Fig. 2. The diameter of the spindle in the saddle is 6⅜ inches and it revolves in bronze-bushed cap bearings. The cutter arbor is driven by means of a broad-face key, and provision is made for holding the arbor in place by a through retaining bolt. A cross hand adjustment is provided for setting the cutters laterally and the outer end of the cutter bar is supported by an outboard bearing having bushings with taper external bearings and adjusting nuts to compensate for wear. The cross-rail is of sufficient length to permit removing the cutters from the arbor without taking off the outboard bearing. The cross-rail is counterweighted and can be raised and lowered by power. The alignment of this rail is maintained by a single bearing on the left-hand upright. The work-table has an angular rack and spiral gear drive with nine changes of geared feed, ranging from ½ inch to 8 inches per minute, which is available in both directions. It also has a fast power traverse. The minimum distance from the center of the spindle to the top of the work-table is 5 inches and the maximum distance 31 inches. The work-table is 36 inches wide and work 12 feet in length can be milled.

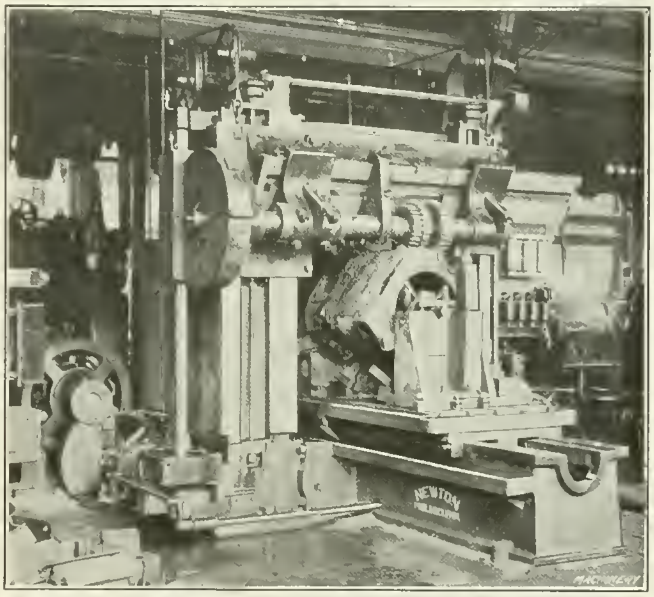
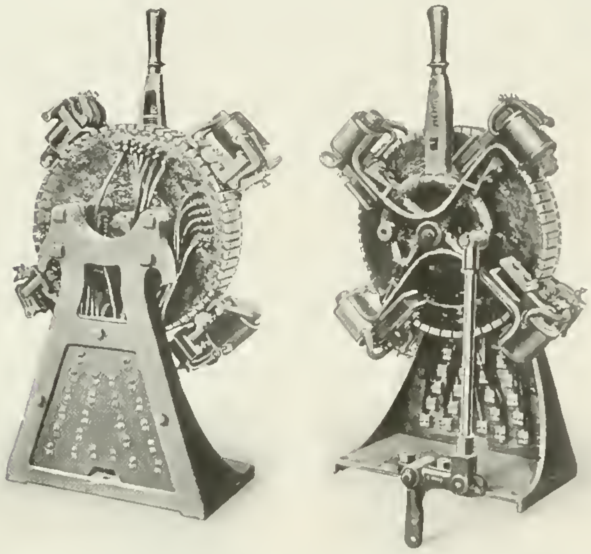


Fig. 2. Another View of Newton Machine showing Driving Motor

WESTINGHOUSE CRANE CONTROLLER

The well-known "grindstone" type of controller which is used extensively in connection with direct-current motors operating cranes, hoists, steel mill machinery, etc., consists essentially of a cast-iron frame on which is mounted a stationary disk carrying the contact pieces and cross connections. Pivoted to the center of the disk is the switch arm with four brush-holders. The resistors can either be mounted on the frame or separately.

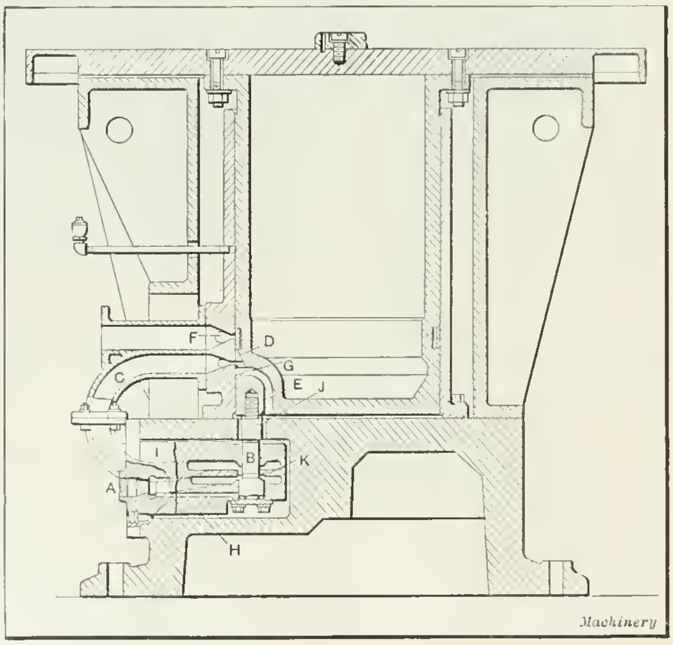
As a result of a series of experiments, the Westinghouse Electric & Mfg. Co., East Pittsburg, Pa., has recently placed on the market controllers of this type in which the disk is made of concrete instead of stone. By a special treatment, the concrete disk is made a thorough non-conductor and at the same time moisture resisting. The use of concrete permits the cross connections between the segments to be made within the body of the disk, thereby giving the latter a "reinforced" concrete construction and, at the same time, producing a more compact apparatus. The concrete disk with its self-contained cross connections also gives the controller a neat appearance. Two views of the new concrete "grindstone" controller are shown herewith. In this particular piece of apparatus, the resistors are separate and not shown. The contact pieces are attached to the disk by screws as with the older type and they are as easily renewed. A blowout coil of asbestos insulated wire is mounted on each brushholder to disrupt the arc formed in opening circuits.



Westinghouse Grindstone Type Crane Controller

MUMFORD VALVE FOR JOLT RAMMING MACHINES

Owing to the severe shocks to which jolt ramming machines are continually subjected when in operation, a simple and durable construction is especially desirable for machines of this class. The Mumford Molding Machine Co., 30 Church St., New York, in order to simplify its ramming machines as far as practicable, has brought out a new air valve which consists of a single moving piece, actuated by the air it controls.

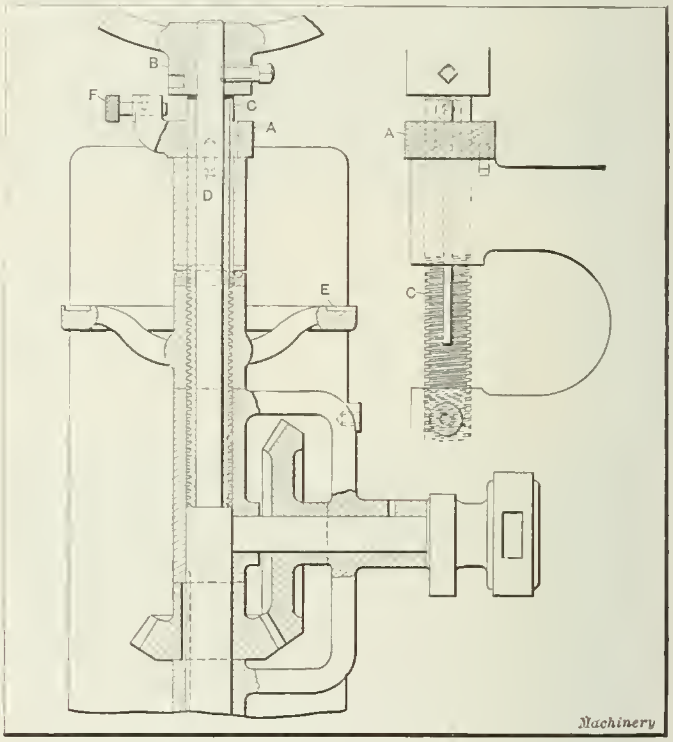


Sectional View of Jolt Ramming Machine with New Mumford Air Valve

The arrangement of this valve is shown by the accompanying sectional view of a 24-inch machine having a 72- by 72-inch table. When the machine is in operation, the action of the valve is as follows: The air enters at *A* and passes around the stem of valve *B* to the tube *C*. From this tube it enters a space inside of the main plunger at *D* and is then admitted through port *E* to the under side of the main plunger which, with its mold table, is raised. When the lower edge of the packing ring on the main plunger uncovers exhaust port *F*, the edge *G* of the plunger has risen far enough to obstruct the entering air. With the exhaust open and the air supply shut off, the pressure under the main plunger is rapidly reduced. While the table is falling, valve *B* is forced up against the reduced pressure in the cylinder and positively closes the entrance of air. Valve *B* is forced up by the "line pressure" introduced through the by-pass *H* and this pressure holds *B* up with the air shut off until just before the point of impact, when the projecting part *J* of the main plunger pushes valve *B* open and re-admits air for the next stroke. From this it will be seen that the valve is actuated by the air independently of the velocity of the rising table and without imposing any burden upon the entering air column. This valve is said to be sure in its operation and the total absence of springs and delicate parts insure durability. The valve is carried in plug *I* which can readily be removed if necessary.

QUICK-RETURN MECHANISM FOR WILEY & RUSSELL DRILLING MACHINES

The simple form of quick-return mechanism illustrated by the accompanying sectional view, is applied to the post type drilling machines built by the Wiley & Russell Mfg. Co., Greenfield, Mass. This mechanism is so arranged that when the collar *A* is engaged with balance-wheel *B*, the spindle may be quickly raised or lowered in either direction, by simply turning the regular operating crank. This is a decided improvement over the handwheel which is ordinarily used for raising and lowering the spindle on machines of this class.



Sectional View illustrating Simple Form of Quick-return applied to Wiley & Russell Hand Drilling Machines

The action of this quick-return mechanism is as follows: While the machine is drilling, collar *A*, which is splined to the threaded quill *C*, is locked by the engagement of pin *D* with a hole in the main frame of the machine. The quill is then prevented from rotating and it is slowly fed downward by ratchet-wheel *E*, which is threaded to it as shown. In order to engage the quick-return movement, collar *A* is raised and sliding pin *F* is inserted in a hole in the balance-wheel hub. The latter with the spindle is then locked to the quill which is screwed rapidly through the hub of the ratchet-wheel in either direction, by turning the driving crank. The detail view to the right shows the spline which prevents any rotary movement between the collar *A* and the quill. By this simple means the spindle can be rapidly raised or lowered to any position within the full range of the machine.

THE SPIRO STEAM TURBINE

A new type of steam turbine, which is unique because of its simple construction and efficient as a prime mover, has been developed by Mr. John H. Van Deventer, superintendent of the Buffalo Forge Co., Buffalo, N. Y. One of the striking features of this turbine is its small size, considering the power developed. Fig. 1 shows a 185 horsepower unit which has been used for the last three years for driving fans, gas scrubbers and other apparatus. We are informed by the builders that this turbine has not been apart or had a single adjustment made since its installation. The power of this turbine, namely 185 horsepower, was developed with 100 pounds initial pressure which is the standard by which all the turbines built by this company will be rated.

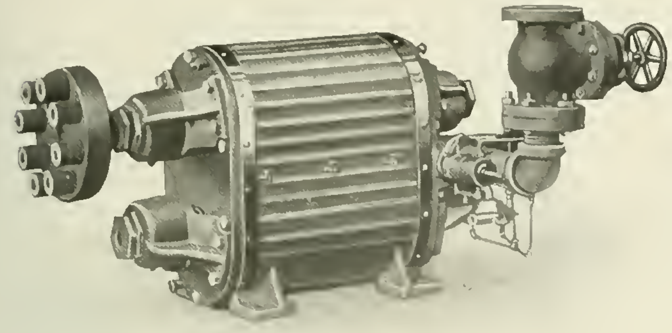


Fig. 1. One Hundred and Eighty-five Horsepower Steam Turbine built by Buffalo Forge Co.

This type of turbine consists principally of two rotors in the form of herringbone gears which are contained in a cylinder having suitable heads and bearings. The rotors are shown in detail in Fig. 2 and the cylinder and cylinder heads in Fig. 3. When the turbine is in operation, the steam is admitted to the central pocket formed by the right- and left-hand spiral teeth of each rotor, from a double port located at *A* in the center of the V-shaped rib which extends across the cylinder. The rotors, which are accurately fitted and mounted with relation to the cylinder bore, revolve outward from this central steam port. When any given tooth space has passed this port, the steam is automatically cut off, after which it expands in the spiral groove as the rotor continues to revolve, until the end of the groove is reached. As the apexes formed by the spiral grooves come opposite the exhaust port on the upper side of the cylinder (in this particular case), the steam exhausts into the atmosphere. The expansion of the steam takes places at a high velocity owing to the angularity of the rotor teeth and the peripheral speed, and as the steam enters every groove in the circumference of each rotor during a revolution, there are a great many expansions per minute. It will be seen that the length of the port determines the point of cut-off and, consequently, the ratio of expansion, so that any predetermined ratio can be obtained by changing the port construction. The size of this port could also be automatically varied by a governor, though the turbine illustrated in Fig. 1 is not so equipped.

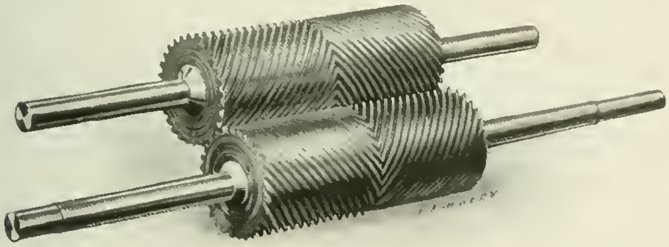


Fig 2. Rotors of the Spiro Turbine

The action of the "Spiro" turbine is said to be practically noiseless, the only sound being a slight hum similar to that of an electric motor. There is also very little vibration, and foundation bolts are not necessary for direct-connected units. The teeth of the rotors are accurately cut, and metal-to-metal contact is said to be prevented by a film of steam which cushions the teeth. The length of these rotors is much greater than would be necessary for spiral gears transmitting equal loads at equal speeds and, consequently, the maximum tooth pressure per square inch is limited to five pounds, which is much less than would be applied to gears for transmitting power. The lubricating system of the bearings is so designed that each bearing acts as an individual oil pump, circulating oil through the bearing between the shaft and bushing with positive pressure. This forms an oil film which is automatically maintained as long as there is any oil in the reservoir which forms a part of each bearing.

Fig. 4 shows a turbine of 10 horsepower capacity that is directly connected to a 25-inch fan which, at present, is furnishing forced draft through Jones underfeed stokers for a 300 horsepower boiler. These turbines are said to be highly adapted to fan service as the high rotative speeds enable the size of the outfit to be reduced to a minimum. When the turbines are coupled to fans having a constant load, no governor is used, but for variable loads, a sensitive quick-acting governor is provided. These turbines are also applicable to the driving of centrifugal pumps, for auxiliary service on shipboard where economy of space is so important, and for many other obvious purposes. The starting torque is high and the maximum speed quickly obtained.

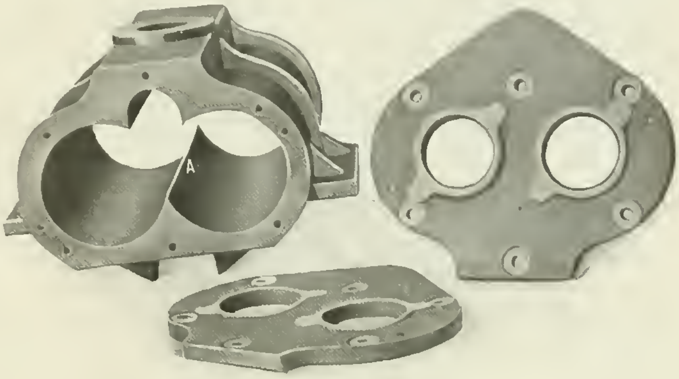


Fig. 3. Cylinder and Heads of Spiro Turbine

Tests made on two turbines of this type show the following results: (1) Capacity of turbine, 25.3 horsepower; boiler pressure, 120 pounds; initial pressure, 101.5 pounds; speed, 2450 revolutions per minute; water per brake horsepower, 53.2 pounds (non-condensing). (2) Horsepower, 151; boiler pressure, 130 pounds; initial pressure, 115 pounds; speed, 2710 revolutions per minute; water per brake horsepower, 31.8 pounds (non-condensing). These turbines are at present

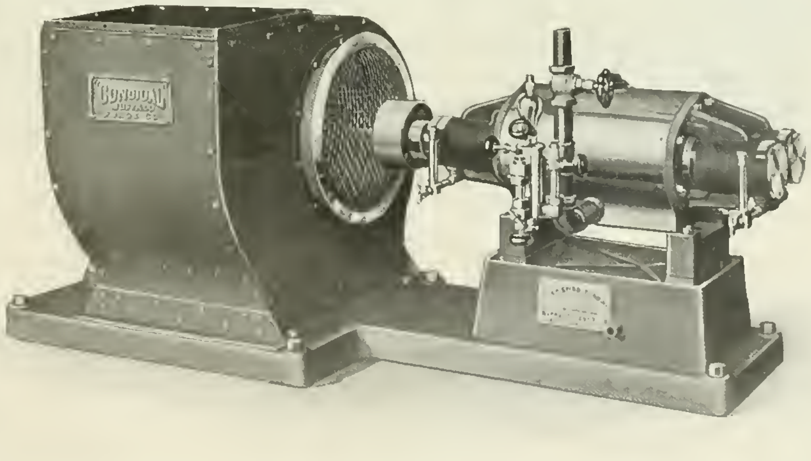


Fig. 4. Ten Horsepower Turbine coupled to 25-inch Fan

manufactured in sizes ranging from 1 to 50 horsepower, non-condensing, and capacities up to 300 horsepower are in process of manufacture.

WATSON-STILLMAN SHEET-METAL SCRAP BALING PRESS

Scrap from sheet iron such as is used in the manufacture of electric motors can be increased in value about six dollars per ton by compressing it into bales, because of the greater convenience in handling. The illustrations show a press and its operating system recently designed for the baling of scrap sheet metal by the Watson-Stillman Co., 192 Fulton St., New York. This particular type, which was installed by the General Electric Co., takes scrap from the floor, compresses it, pushes the bale out and drops it beneath the floor onto a runway. From the end of this runway the bale can be dumped onto an elevator from which it can be delivered by another runway to a freight car. With suitable pump and accumulator service, this press forms from fifteen to twenty-five bales (from two to three tons of material) per hour, the output depending upon the skill of the operator.

The press is approximately twenty-three feet long, four and one-half feet wide, and it is set in a pit about six feet deep and rests on pedestals to give room for repairs if necessary. The working parts consist of a scrap or pressing box, the top of which is flush with the operating floor line, and which has a hydraulically operated cover and two opposed hydraulic cylinders. One of these closes the box and the other compresses the bale and pushes it out. The pressing box is 60 inches long by 20 inches wide by 30 inches deep, which depth is reduced to 10 inches by the closing of the cover. The larger of the cylinders (seen at the left in Fig. 1) closes the front end of the press, and at the same time acts as a lock to the cover when it is closed. This cylinder is controlled by the same valve as the main or compressing cylinder at the right. The compressing cylinder is double-acting. Pressure is supplied to the closing cylinder and the working end of the compressing cylinder from a variable-pressure, belted, hydraulic pump. This pump has large pistons which deliver pressure up to 1500 pounds per square inch and it is automatically stopped as the pressure goes above the figure mentioned. Pressure for the cover-closing cylinder and for pulling back the ram of the compression cylinder is furnished at 1500 pounds per square inch from an accumulator, served by a separate small pump, and loaded with about fifteen tons of pig iron.

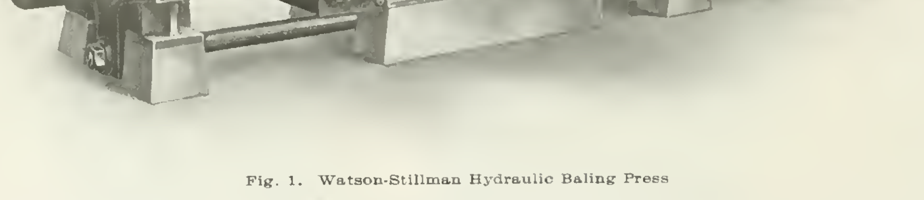


Fig. 1. Watson-Stillman Hydraulic Baling Press

In service, the action of the press is as follows: About 250 pounds of material are shoveled into the box and the valve *A*, Fig. 2, is moved. This admits accumulator pressure to the cover cylinder, forces its ram outward and closes the cover through the rack and segment pinion seen in Fig. 1. One movement of the valve *B* then puts pump service simultaneously upon both closing and compressing cylinders. This sends the ram of the closing cylinder forward which locks the box cover in the closed position when the limit of travel is reached; then as the pump pressure in the outer end of the compressing cylinder goes above and overcomes the accumulator pressure in the pull-back end of the cylinder, the compressing ram moves forward until the pump pressure reaches the maximum of 4900 pounds per square inch. The parts are so proportioned that this gives a total finishing pressure of 200 tons upon the bale, which reduces its dimensions to about twenty inches by ten inches by ten inches and makes it so compact that no straps are required. A second movement of the valve *B* releases the forward pressure in the closing cylinder, thus permitting the compressing cylinder ram to continue pushing the bale to the left and out of the press, and at the same time returning the closing cylinder ram to its initial position. A third and final movement of the valve *B* then releases the forward pressure on the compressing cylinder ram, the bale drops down into the delivery chute, and the accumulator pressure, which has been constantly acting on the return end of the compressing cylinder ram, returns the latter to the initial position.

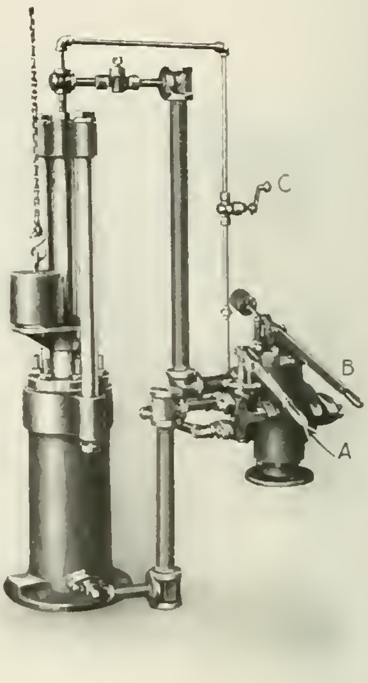


Fig 2. Safety Governor for Baling Press

Protection from harmful over-pressure is provided by the safety governor at the left in Fig. 2, which shuts off the pump at the limiting pressure. This governor has two cylinders with pistons of different diameters. The larger at the bottom is in direct contact with the accumulator pressure of 1500 pounds per square inch. The smaller piston is directly connected to the discharge pipe of the large automatic variable pump. As the accumulator pressure is constant on the larger piston, the shelf supporting the weight is normally in its highest position. The pump then discharges through the large operating valve either to the press cylinders, or back to the reservoir. When the valve is set for admission to the press cylinders, pressure in the top part of the governor is gradually increased. As the bale compresses, the low-pressure plungers are first thrown out automatically, after which the two high-pressure pistons continue the work until the maximum pressure of 4900 pounds per square inch is reached. When this happens, the 4900 pounds pressure also acting on the top or small cylinder of the governor, overcomes the pressure in the other end, forces the piston with the shelf downward, releases the weight, and causes the high-pressure plungers of the pump to be by-passed. By opening the small valve *C* shown in the vertical pipe line, the pump is started again.

Where desirable to deliver the finished bale onto the operating floor, a three-cylinder construction is necessary, the extra cylinder being placed vertically under the bale, and the upper end forming the bottom of the baling box. The dimensions and the method of operating can, of course, be varied.

LANGELIER AUTOMATIC DRILLING AND FORMING MACHINE

One of the special automatic machines designed and built by the Langelier Mfg. Co., Providence, R. I., is shown in Figs.

1 and 2. Fig. 1 shows the front or operating side of the machine and Fig. 2 is a rear view. The purpose of this machine is to automatically round or chamfer both ends of round rods and also to drill, simultaneously, a cotter-pin hole crosswise near each end of the rod. The machine can be adjusted to handle rods from ¼ to ½ inch in diameter and from 3 inches to 13½ inches in length. The output for rods of 5/16-inch diameter is 3½ per minute.

The horizontal bed of this machine has along its entire length a dovetailed slide on which the crossheads that carry the drilling and end-forming spindles, as well as the feed hoppers, are located. The left-hand crosshead is stationary and is fastened permanently on the end of the bed. The right-hand crosshead can be adjusted along the bed to accommodate rods of different lengths. The main cam-shaft from which the various movements are obtained, is mounted horizontally midway between the oil pan base and the dovetailed slide. This shaft is driven by a friction-ring clutch pulley through a worm and gear, as shown. The drilling heads, which are shown in the rear view, are attached to each of the crossheads. The feeding movements for the drill spindles are obtained from a horizontal shaft connecting both drill heads, upon which is fastened segment gears meshing with racks cut into the yokes of each head. The shaft obtains its movement through a cam lever engaging the inner face of the large face-cam seen to the right of the machine, Fig. 2. This rear shaft also carries two segment cams for actuating the feed for the end-forming spindles.

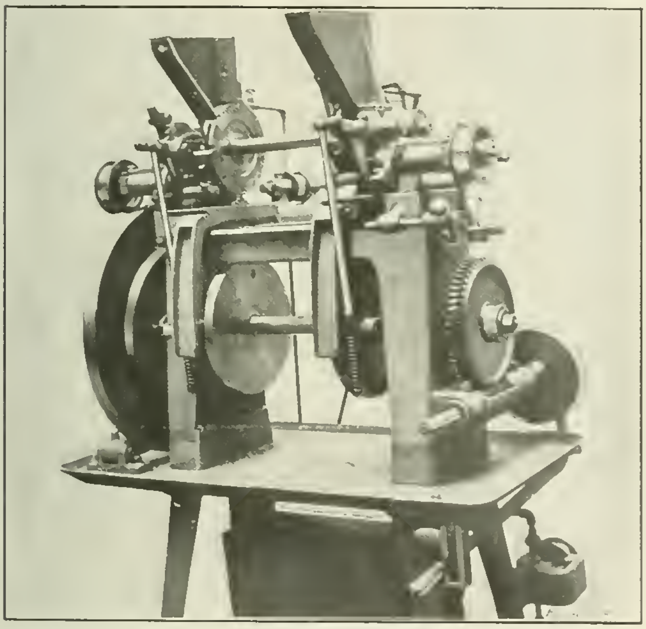


Fig. 1. Langelier Automatic Rod-drilling and End-forming Machine

The hopper feed consists of two triangular end guides located above the notched carrier disks. The latter are mounted on a shaft having bearings through each crosshead. This shaft derives its motion from a pawl and ratchet wheel linked to the outer face of the large face cam. The notched carrier disks, in passing the opening in the hopper guides, allow the rods in the hopper to fall into the notches in the disks which, in turn, carry them to their respective drilling and end-forming positions. Each carrier disk has a rectangular slot cut into its outer face to allow the ends of vises to enter and bind the rod firmly while being drilled. These vises are located at the lowest notch position directly under the center of the disks and are actuated by the two face cams mounted on the main cam-shaft between the legs of the frame. These vises also serve as jigs for drilling the cross holes in the rod accurately. The end-forming spindles are located on the front and the third notch up from the drilling position. Alligator jaws fulcrumed to a bellcrank lever and actuated from the cam-shaft, are provided to hold the rods firmly while being operated on. The end-forming spindles run in opposite directions and neutralize the turning effect on the rods. All connections to the feed disks are flexible, so as to prevent any breakage, in case the rods should happen to clog in the hopper and not enter the notches properly. After the drilling and end-forming operations are performed, the rods are carried up and ejected at the front of the machine.

An automatic oil pump is used to force oil to the cutting tools. The oil and chips fall in cavities cast in the base of the crossheads. The oil is separated from the chips and falls into the lower oil pan where it is again filtered before entering the oil tank. The machine clutch pulley, drilling and end-forming spindles, are each belted separately to an overhead countershaft. The action of the machine is absolutely continuous and automatic. The hopper is of sufficient capacity to run one hour without refilling.

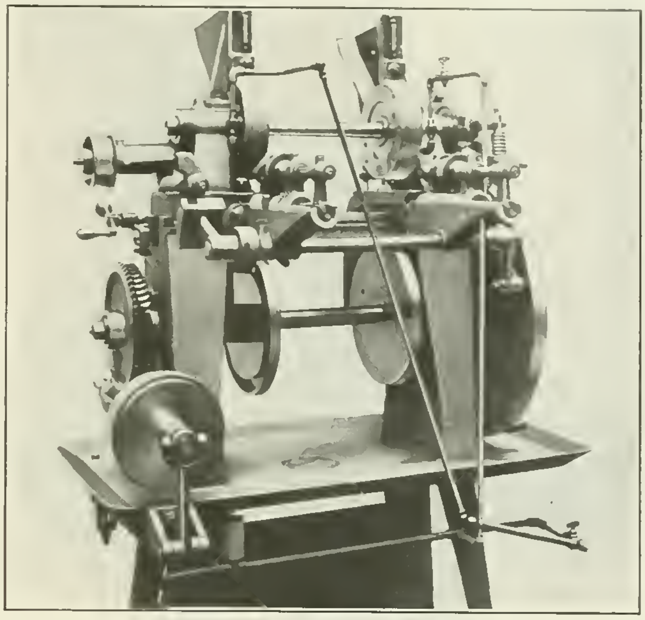
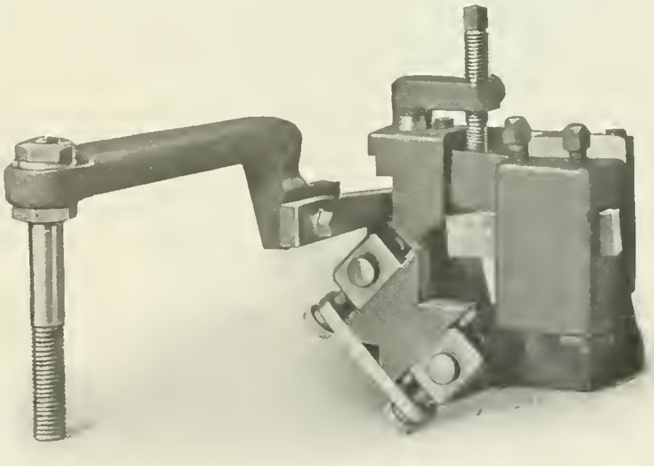


Fig. 2. Rear View of Langelier Machine

ACME TAPER TURNING TOOL

The taper turning tool illustrated herewith is so arranged that the taper bar or templet which controls the movement of the turning tool, forces the cutter out from the center of the work in a positive manner, and insures the proper taper.



Acme Taper Turning Tool

This design differs in this respect from the type which depends on a spring to force the tool out against the taper bar. With the latter construction there is nothing to prevent the tool from gouging into the work, but any trouble from this cause is completely eliminated with the improved construction shown in the illustration. The cutter is mounted in a vertical slide connected by means of the long adjustment screw shown, to an L-shaped piece with which the taper bar engages. The pressure of the cut and a small spring holds the tool firmly against the taper guide. The bracket carrying this guide or templet is held in position by a bolt at the left end, which is screwed into the head-cap of the machine. The back-rest precedes the cutting tool and bears against the straight part of the work. This tool is a design of the Acme Machine Tool Co., Cincinnati, O.

KEARNEY & TRECKER VERTICAL SPINDLE MILLING MACHINE

The Kearney & Trecker Co., Milwaukee, Wis., is the builder of the vertical spindle milling machine shown in Fig. 1. This machine is similar in many respects to the horizontal type made by this company, the changes in the feed and driving mechanism, aside from the drive to the vertical spindle, being confined to differences in dimensions. The spindle of this machine is non-adjustable, the knee being depended upon entirely for vertical adjustment, which is a departure from the usual custom in the design of vertical spindle machines of the knee type. This construction was adopted because the experience of the builders has shown that with machines of the heavier type more is lost than gained by using the adjustable spindle, as the latter is less rigid than the fixed non-adjustable type.

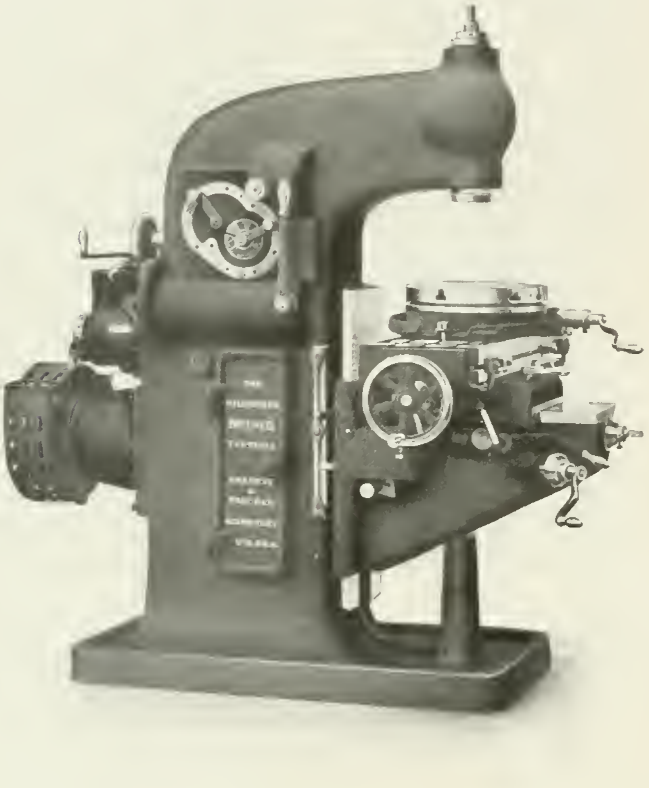


Fig. 1. Vertical Milling Machine built by Kearney & Trecker Co.

The sectional view, Fig. 2, shows clearly the arrangement of the spindle driving mechanism and its lubricating system. The boxes are of bronze and the spindle has a taper bearing on the lower end and a taper sliding sleeve on the upper end which enables wear to be taken up by the collar shown. The lubricating oil for the driving gears and spindle is pumped upward through pipe *A* by a pump of the spur gear type, located in the base of the machine. This pipe delivers the oil to the perforated distributing pipe *B* which lubricates thoroughly all the horizontal bearings and gears, these being so constructed that the oil "cascades" downward from one bearing to another. It will be noted that these bearings are grooved in such a way that the oil can flow freely through them. This prevents any foreign substance that might be in the oil from lodging in the bearings, the rapid flow washing out any such impurities. The surplus oil flows into the passage *D* through a hole *C* drilled in the main casting. Engaging with this passage there is a horizontal hole *E* connecting with the vertical hole *F*. The latter is plugged at the top, the object being to provide an overflow of the surplus oil so that, in effect, a reservoir is maintained in contact with the upper bearings at the height of the hole *E*. The surplus oil flowing through *F* discharges onto gear *G*, lubricating it thoroughly, and then flows downward through the horizontal bearings at the front of the machine, overflowing successively each pocket and cascading downward the same as for the back bearings.

The grooves in the upper spindle box are so constructed that the oil is carried upward into the annular groove *H*, thoroughly lubricating both thrust collars and bearings. The oil discharged from the gear *G*, flows through the lower spindle bearing onto the collar *I* and is prevented from running downward over the end of the spindle by the collar *J* which is made oil-tight in the main frame of the machine. The front end of this spindle is of the company's flanged construction having a hardened steel driving collar that can be removed, thus permitting face milling cutters to be screwed solidly against the flat face of the spindle which is always protected from injury by the hardened collar referred to and therefore maintains its accuracy.

This machine has eighteen spindle speeds, varying in geometrical progression, and ranging from 15 to 354 revolutions per minute. These eighteen speeds are obtained by the use of ten gears only. One of these gears is located on shaft *K* and engages with the middle step of the three-step cone *L* which is an idler carried in the swinging frame *M*. This frame is supported on one side by shaft *K* and on the opposite side by a pinion, so that there is no overhang whatever to the idler *L*. The three steps in the idler *L* are arranged so that they can be engaged successively with the gears *N* and *O* which gives six changes of speed. The spindle sleeve gears *P* and *Q* are arranged to engage with *O* and *N* and also slide into engagement with the pin *R* on the large driving gear *S*, which engages with the pinion *T* for slow rotative speeds. This gives three changes of speeds which, combined with the six obtained through the medium of the cone *L*, makes a total of eighteen changes obtained by the use of ten gears, as mentioned.

The machine has an automatic table feed of 24 inches and an automatic cross-feed of 12 inches. The work-table can be lowered 18½ inches from the end of the spindle and the vertical feed is automatic. The table has a working surface of 11½ by 38⅜ inches. The rotary table is 14 inches in diameter on the working surface, 18 inches diameter over the

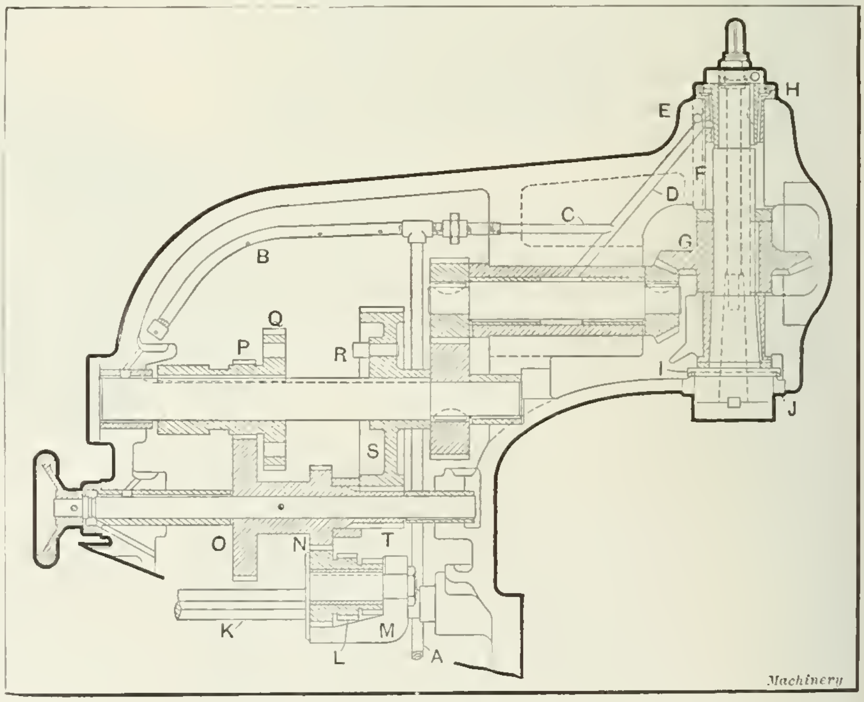


Fig. 2. View showing Driving Gears and Lubricating System of Vertical Milling Machine

oil pan and is 5 inches high. The driving pulley is 14 inches in diameter for a 4-inch belt, and runs 250 revolutions per minute. The pulley is guarded by a neatly designed guard that is made of perforated sheet metal and is so constructed that it can be turned to any angular position around the pulley. This feature makes it possible to place the belt at any angle. No countershaft is needed with this machine.

GARVIN NO. 22 MONITOR LATHE

The monitor lathe shown herewith is built by the Garvin Machine Co., Spring & Varick Sts., New York. This machine is equipped with automatic power feed for the turret slide, an improved turret mechanism, and an automatic chuck equipment. The power feed is automatically tripped by individual stops controlled by the rotation of the turret. The automatic chuck reduces the time required for inserting and removing the work. The air cylinder for operating this chuck is located at the rear end of the spindle. When air pressure is admitted to this cylinder, the chuck jaws are operated by a piston and multiple wedge mechanism. The chuck illustrated is known as the 6-inch adjustable blank-jaw type. The gripping power of the jaws is controlled entirely by the air pressure used. When machining delicate parts, the proper reduction of grip can be obtained by placing a reducing pressure valve in the line of pipe connecting the source of supply and the operating valve. The latter is located in front of the headstock. A spring-operating mechanism can be supplied for factories not equipped with air pressure.

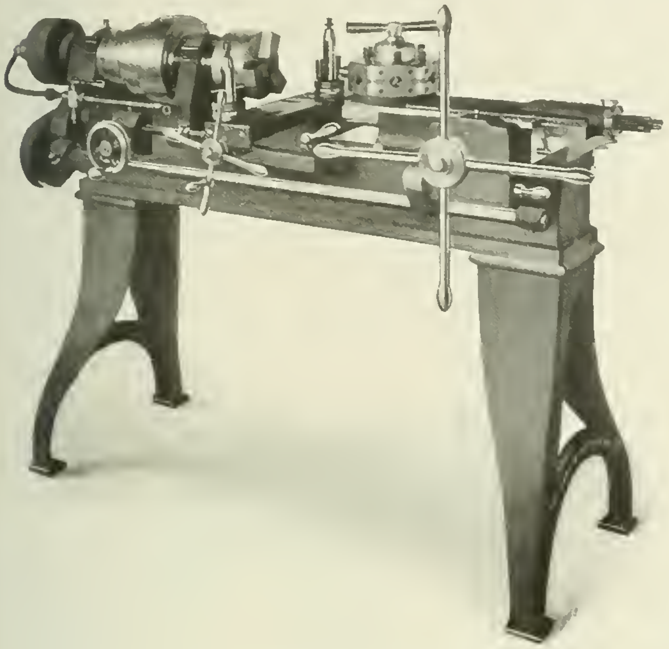


Fig. 1. Garvin No. 22 Monitor Lathe

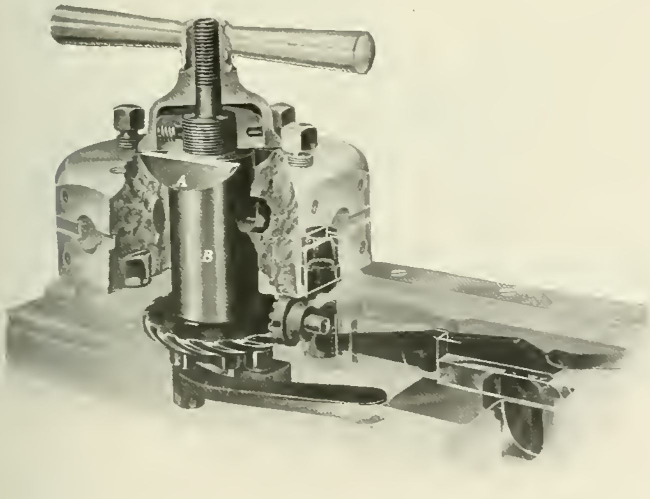


Fig. 2. Turret of Garvin Lathe

The gripping power of the three-jawed chuck operated by a heavy spiral spring, was shown by a recent demonstration. The chuck used was a 9-inch size fitted to a geared-head turret lathe of standard make. A machine-steel disk, 8 inches in diameter and 1 inch thick, cut from bar stock, was inserted in the chuck jaws and a 1¾-inch high-speed twist drill was forced through this plate. A grooving tool ¾ inch wide was then sunk into the face of the blank on a circle 7 inches in diameter, to a depth of ½ inch. This was followed by a third operation in which the cross-slide tool took a 3/16-inch cut across the entire face of the blank. The back-gears were used to obtain the full belt power and the belt frequently slipped, showing that the grip of the chuck jaws was up to the full belt power of the machine.

The pressure for closing the chuck jaws automatically releases a brake and starts the rotation of the spindle. The removal of the pressure, whether air or a spring is used, stops the rotation and opens the chuck jaws to their full limit. In addition to the three-jawed chuck referred to, two-jawed types of various sizes and styles are furnished.

As will be seen by referring to Fig. 2, the turret is of hexagonal shape, there being six flat surfaces with four cap-screw holes for securing rigidly either tools or fixtures. The turret rotator *B*, as now furnished on Garvin monitor lathes, is made of one piece as shown. It is hardened and ground on the cylindrical fit and is secured to the rotating turret by two Woodruff keys *A*.

STANDARD MACHINERY CO.'S STOCK STRAIGHTENER

Figs. 1 and 2 of the accompanying illustrations show two views of a new five-roll stock straightener built by the Standard Machinery Co., Providence, R. I. This machine is arranged in two ways. One type is made without a base or clutch and driving pulley. The machine is built in this way when it is to be attached to the bed of a heavy power press for straightening stock previous to the press operations. In place of a driving pulley, either a friction or ratchet feed mechanism is used and this is attached to a slotted disk on the outboard bearing of the press crankshaft, the mechanism acting as a roll feed as well as a straightener.

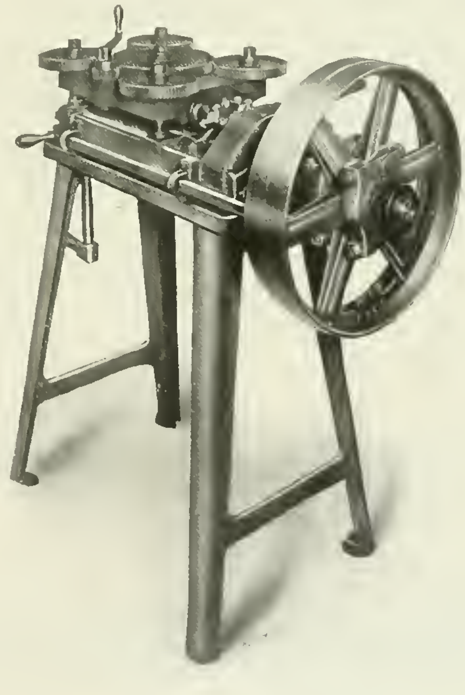


Fig. 1. Standard Five-roll Stock Straightener

This machine is also made with a base supported by legs as shown in the illustration. When constructed in this way, a friction clutch and driving pulley are used. The machine is driven through a transmission case located next to the driving pulley. The spur gears in this transmission case are connected to the rolls by universal joints which can be seen in Fig. 1. The main roll, which is the middle roll of the bottom train, is directly driven by gearing as are its two mates on each side. These rolls are 2¾ inches in diameter and 10 inches long. The upper ones are adjusted by the spur gears and crank shown, which permits raising and lowering the upper head to accommodate different gages of stock.

On the left end of the main roll shaft, there is a ratchet crank and ratchet, as shown in Fig. 2, which may be fed either backward or forward. This ratchet is used to feed the stock into the rolls by hand and in case the stock becomes buckled, it permits turning the rolls in either direction for the purpose of re-straightening the stock. This ratchet is also used for securing better control over perforated material or stock having large holes punched in it. The adjusting gears, as well as the transmission gears, are cut from steel. The rolls are made of tool steel and are hardened and ground. This machine is for the use of manufacturers of sheet-metal parts in connection with power presses or for firms manufacturing cold-rolled sheet steel, sheet copper and sheet brass.

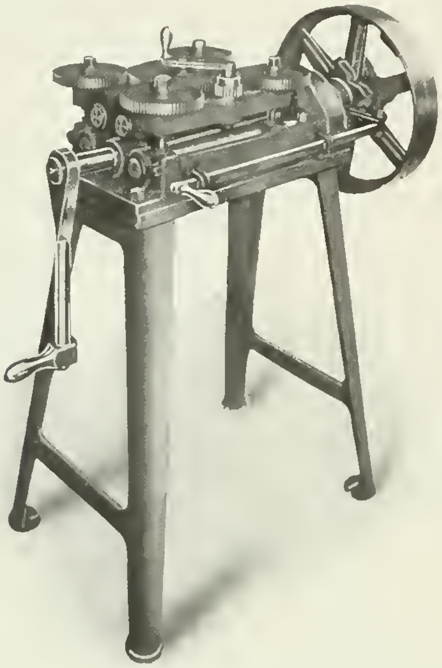


Fig. 2. Another View of the Stock Straightener

RYERSON-RICH FORGED DRILL

A forged drill for high-speed service is now being manufactured by Joseph T. Ryerson & Son, 16th and Rockwell Sts., Chicago, Ill. This new drill is hammered or forged to shape instead of being milled, in order to refine the metal and retain the continuity of the fiber or grain of the steel. This forged drill, which is illustrated herewith, has the same general shape and cross-section as a milled drill. The cutting lip is of the same form and the clearance is also the same as with the milled type, so that the good cutting qualities of the latter are combined with the strength of a twisted drill in this new product. The hammering of the raw stock to shape is said to increase the strength to such a degree that splitting of the web is entirely overcome. This prevention of splitting is said to be due, principally, to the greater strength and homogeneity of the core as a result of the hammering or forging process. This strength at the core also permits very coarse feeds and, consequently, an increase in production.

Ryerson-Rich Forged High-speed Drill

The following data relating to the performance of this forged drill on different classes of work indicate its durability, cutting qualities and strength. As an illustration of durability, six 13/16-inch drills bored 40,000 holes through structural beams varying from 1 inch to 2⅝ inches in thickness, and the drills were in good condition after doing this work. As an example of fast drilling, a 2¼-inch drill bored three holes through a 40-point carbon steel block 8¾ inches thick, at the rate of seven minutes per hole for two of the holes and six and one-half minutes for the remaining hole. One-hundred-sixty 9/16-inch holes were also drilled in ordinary 3-inch angle-iron in one hour, actual drilling time. No cooling water or lubricant was used and no stops made for re-sharpening, and the drill was in good condition after doing this work. A ¼-inch size drilled 600 holes through a ¾-inch steel bar without re-sharpening and a 15/32-inch size drilled 100 holes through a hard casting without re-sharpening. These drills can be furnished with regular taper shanks or with one size larger, if desired.

BARNES 26-INCH GEARED DRILLING MACHINE

The W. F. & John Barnes Co., 231 Ruby St., Rockford, Ill., has just brought out an upright drilling machine of the geared type having a new feeding mechanism which gives a more complete automatic control of the drilling spindle. The operator has the choice of two automatic stops, one of which can be set to disengage the worm from the worm-gearing, thus permitting the drill spindle to be quickly returned, while the other disengages the miter feed gears, which arrests the feeding movement but leaves the worm and worm-gear in mesh for further hand-feeding in connection with accurate facing and combination tool operations. As far as we know, this feature is new to drilling machine design.

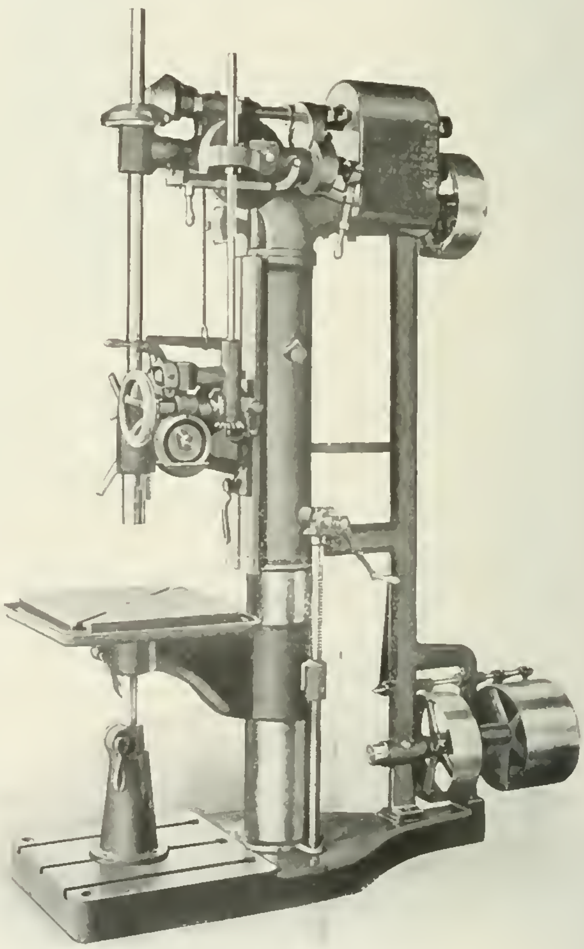


Fig. 1. Barnes 26-inch Geared Drilling Machine

A general view of this machine is shown in Fig. 1 and a detail sectional view of the feeding and automatic trip mechanism in Fig. 2. The feeding movement for the spindle quill is transmitted through miter and worm-gearing in the usual manner. The worm is carried by yoke *A*, fulcrumed at the rear end. This yoke is normally held down by lever *B* which engages a curved seat in the yoke, as shown in the side view. Lever *B* is pivoted at *b*, and when the lower end is swung toward the front, the yoke *A* is drawn upward by a spring *C*, thus disengaging the worm from the worm-gear. This movement of lever *B* can be effected by hand or by the engagement of a trip *D* with finger *E* attached to a bracket *F* that is clamped to the rack of the spindle quill.

The small lever *G* is used to disengage the miter gears. This lever is connected, as shown in the side view, with a trigger or latch *H* which ordinarily holds the miter gears in mesh. When lever *G* is shifted far enough to disengage catch *I*, the trigger *H* drops, allowing the lower miter gear to fall out of engagement with its mate. This trip can also be operated either by hand or automatically. The automatic trip is set for lever *G* by simply swinging the adjustable finger *E* to the left, as indicated by the dotted lines, in which position it strikes trip *J*, thus disengaging the lever. The position of bracket *F* on the feed rack can be varied as required, and it is permanently attached to the machine by a retaining chain.

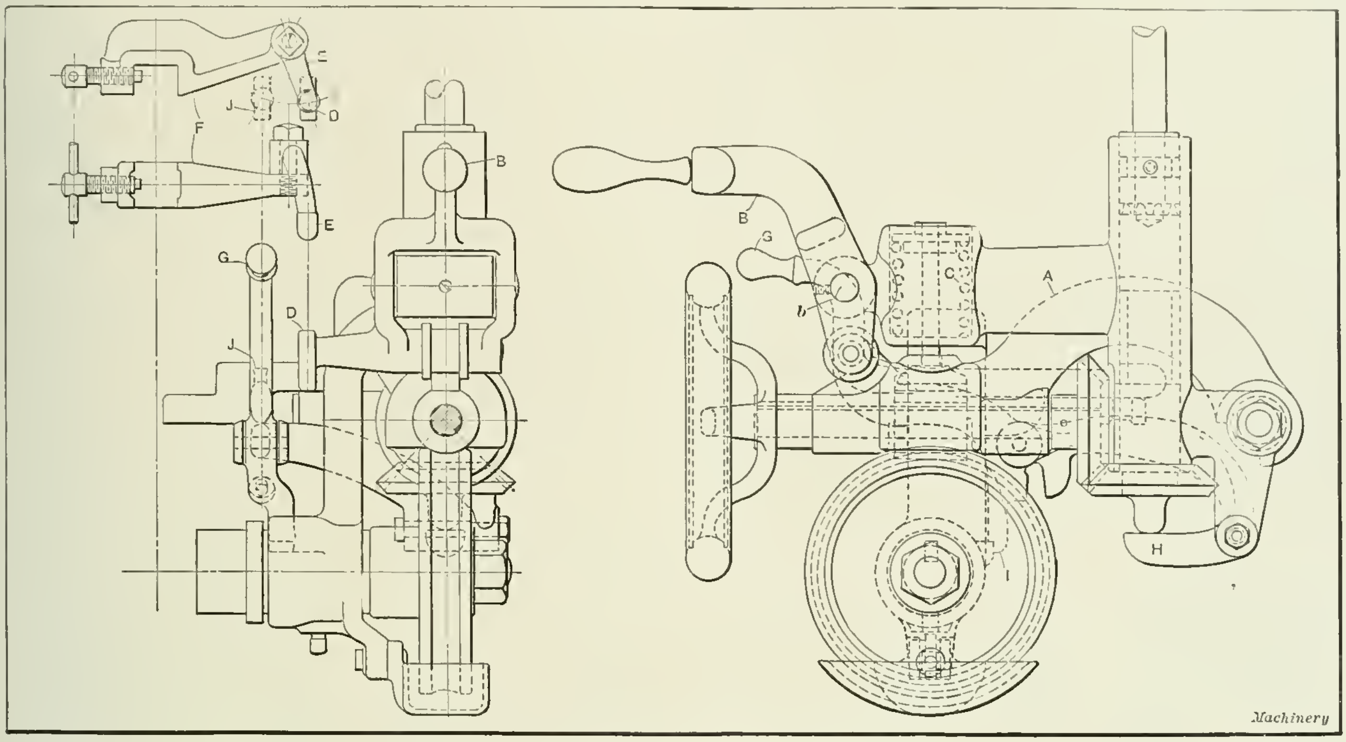
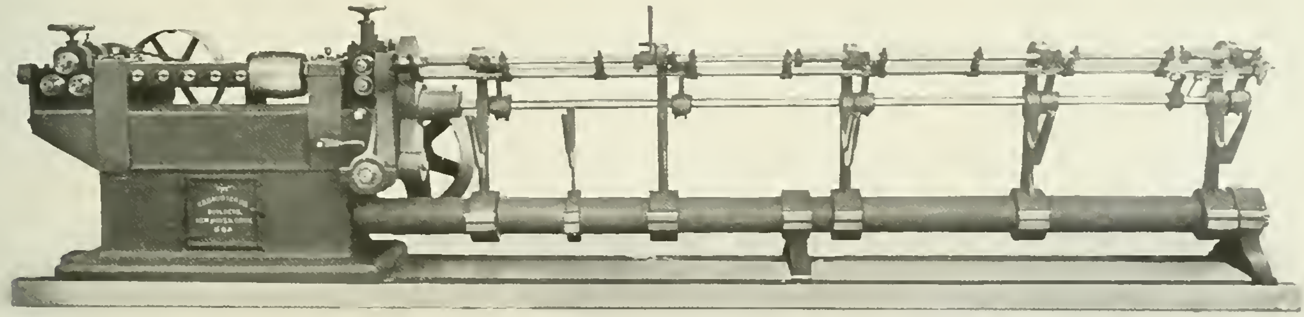


Fig. 2. Feed and Automatic Stop Mechanism for Barnes Drill

In addition to this universal trip mechanism, this machine has a positive feed, a double-splined spindle equipped with roller thrust bearing, a quick-return lever and steel crown gearing. There is a geared speed box of simple but durable construction which gives nine speed changes. These changes are obtained by the use of only nine gears. The speeds vary from 48 to 417 revolutions per minute. All gears run in light lubricating grease. The positive feed mechanism gives eight changes varying from 0.006 to 0.064 inch per revolution of the spindle. The machine will drive a 1½-inch high-speed drill in steel. The principal dimensions are as follows: Maximum distance from spindle to base, 50½ inches; minimum, 20½ inches; maximum distance from spindle to table, 37½ inches; diameter of spindle, 1 11/16 inch; travel of spindle, 11 inches; size of taper hole, No. 4; diameter of column, 7 inches; travel of sliding head, 21 inches; travel of table, 17½ inches; size of table, 18 by 18 inches; weight of machine, 1850 pounds.

SHUSTER AUTOMATIC WIRE STRAIGHTENER AND CUTTER

The automatic wire straightener and cutter shown herewith is a new model built by the F. B. Shuster Co., New Haven, Conn. This machine has a continuous feed, and it is fitted with an arbor and dies of such design that after they are once adjusted for a wire of given size, coil after coil may be fed through without stopping the machine or readjusting the dies. This feature means a considerable saving of time in the course of a day and, consequently, an increase in production. The arbor is longer than usual and it has long bearings as well as end thrust bearings. During the cutting operation, the arbor oscillates somewhat to prevent the dies from injuring the wire while the feed is stationary. Another special feature is a clutch trip which enables the operator to control the cutting mechanism by hand when this is desirable. This clutch trip is operated by the hand lever seen at the front of the machine.



Continuous Feed Automatic Wire Straightener and Cutter built by F. B. Shuster Co.

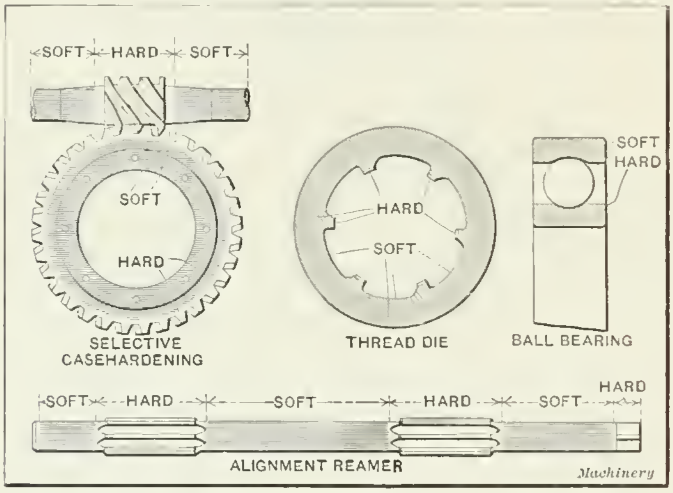
As the engraving indicates, this machine is the "long-cut" type, which as its name implies, is intended for straightening and cutting long lengths. The machine can also be used for any length less than the maximum. When the machine is in operation, the wire passes from the coil through the rough straightener and the rotary arbor, after which it is fed by the two rolls shown at the right, onto a V-shaped guide bar. The guide bar is equipped with an adjustable gage, which is connected by a wire with a clutch on the cam-shaft. When the end of the wire strikes this gage, the clutch is thrown and the cutting-off lever swings over, thus severing the wire. From this it will be seen that the length of the wire is determined by the position of the gage. The same movement which operates the cutting-off lever also causes the cut wire to drop from the guide bar into the forked holders shown.

The three-roll rough straightener at the left, through which the wire first passes, is similar to the type used on former models, except that it has double-grooved feed rolls, the same as the front feed rolls and it is connected with the front rolls by a sprocket and chain. These three rolls straighten the material roughly before it enters the rotary arbor, and they are supplied only on the ½-inch machine and larger sizes, the smaller machines not requiring such a device.

This machine may be used for straightening and cutting gold, silver, brass, cold-drawn or rough stock, with equally satisfactory results. The illustration shows a ⅝-inch size designed for handling wire ⅝ inch in diameter and smaller and for cutting lengths up to 12 feet. Other sizes are built on the same general lines, and the length of the machine is made to suit individual requirements.

ENAMELITE FOR SELECTIVE HARDENING

When hardening or casehardening machine parts of various kinds, there are often reasons why some surfaces should be very hard and others soft. One method of hardening steel locally is to cover the part which is to remain soft with a thin metal shield which prevents the covered surface from being suddenly cooled by the direct action of the cooling medium. The Shore Instrument & Mfg. Co., 555-557 W. 22nd St., New York, has placed on the market a compound for selective or local hardening which is much more easily applied than a shield and, consequently, more economical. This preparation, which is known as "Enamelite," makes it possible to either harden tool steel or caseharden locally, wherever a hard surface is needed. There are two preparations, one of which is for casehardening and the other for use when hardening tool steel. The first is known as Enamelite, No. 1, and the second as Enamelite, No. 2. Both preparations are in the form of a powder which is mixed with a suitable quantity of hot water before being applied.



Examples of Work hardened locally by the Use of Enamelite

When a part is to be casehardened locally, the mixture, which is impervious to the action of carbon, is applied to the surface to be left uncarbonized or soft, either with a brush or by dipping when the latter method is feasible. The Enamelite has no affinity for carbon and it is non-oxidizable and, therefore, prevents the penetration of the carbon vapors or the oxidation of the carbon in tool steel when annealing and also the rapid oxidation of the iron in casehardening boxes, pyrometers, etc. Enamelite is used when it is desired to harden locally such parts as gears, etc. For example, the rims, teeth and bore of the hub of a gear could be hardened without hardening the web which would prevent undue warping and insure a more silent running gear. The selective method of hardening can also be applied to advantage in connection with many other parts, either to prevent serious warping or to save unnecessary work after the hardening process in connection with fitting or grinding.

Enamelite, No. 2 for tool steel is also a powder and is mixed with hot water to form a paste or cement. This is readily applied to the surfaces that are to remain soft, and it has the property of clinging to these surfaces and liberating hydrogen (the greatest known non-conductor) when the heated steel is plunged into water. This causes the steel to retain its heat long enough to escape the chill, with the result that it remains soft where Enamelite has been applied. The fused mixture absorbs water, generates steam and automatically separates from the steel after cooling, thus leaving it as clean as though it had not been in the fire. The accompanying illustration, which is self-explanatory, shows some typical examples of work to which Enamelite is applicable.

NEW MACHINERY AND TOOLS NOTES

Swivel Chuck Jaws: Griggs & Henderson, 212 Water St., Fitchburg, Mass. Chuck jaws having swiveling grips set in the ends, which adjust themselves to either taper or parallel surfaces.

Instrument Tray: H. D. Pomeroy, 812 Dillaye Building, Syracuse, N. Y. Draftsmen's instrument tray supported on double-hinged polished aluminum brackets. The tray or shelf is of wood and is covered with felt. A pocket is provided to hold an ink-bottle securely.

Saw-setting Machine: Rotary File & Machine Co., Brooklyn, N. Y. Band-saw setting machine having a capacity for saws varying from ⅛ to 1½-inch in width. Two saw-teeth are set for each revolution of the pulley or crank and the movements of the machine are automatic. The teeth of old saws which are uneven in height, are set uniformly.

Brazing Outfit: Turner Brass Works, Sycamore, Ill. Portable brazing outfit using either gasoline or kerosene as fuel and adapted for brazing, tempering, annealing, etc. It has two burners which are attached by copper-covered flexible tubing to a ten-gallon seamless steel tank equipped with an air pump and gage. The flame is regulated by needle valves and the outfit will burn full blast for five hours without refilling.

Tool-holder: Precision Machine & Tool Works, 273 Seyburn Ave., Detroit, Mich. Boring-bar and adjustable tool-holder having a split cylindrical block which contains in an offset position a hollow cold-drawn steel bar, in which the cutter is held by means of a draw-bolt. There are two of these bars of ⅞ inch and 1⅛ inch diameter, respectively. The construction of this holder provides vertical or angular adjustment, and the regular toolpost is used for clamping.

Hydraulic Press: Watson-Stillman Co., 192 Fulton St., New York. Hydraulic press especially adapted for forcing the brass bearings or "shells" in or out of locomotive driving boxes. The press is provided with a ¾-inch by 2-inch duplex pump. A safety valve is used in connection with the pump to prevent a dangerous overload. This press is made in two sizes, having capacities of 60 and 100 tons, respectively. It can be operated either by hand or with a belt or motor drive.

Tool-holder: Ernest Stoecklin, Ridgefield Park, N. J. Lathe tool-holder consisting of a cylindrical piece, clamped horizontally in a split block which, in turn, is bolted to the tool-slide. The cylindrical tool-block has six holes of different diameters in which tools of various sizes are inserted. The hole for each tool is split and the tools are clamped by a single bolt which holds the split block to the tool-slide. The tools vary in diameter from ¼ to 1 inch, are 12 inches in length, and have cutters at each end.

Collapsible Tap: Manufacturers Equipment Co., 165 N. Jefferson Ave., Chicago, Ill. Collapsible tap for accurately threading iron, brass and steel and especially adapted for threading close to internal shoulders. There is adjustment for both diameter and depth to be tapped. The tap proper is composed of cylindrically shaped chasers which are in engagement with one another and in rolling contact, thus insuring rigid support. This tap is made in ten sizes varying from 15/32 to 2 1/2 inches, including straight or taper iron pipe sizes from ¼ inch to 2 inches.

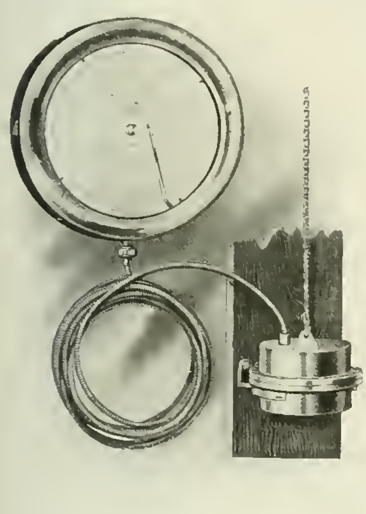
Cold Saw: Espen-Lucas Machine Works, Front St. & Girard Ave., Philadelphia, Pa. Cold saw cutting-off machine having a 40-inch blade and capacity for sawing round and square bars up to twelve inches in diameter. This machine is furnished with either a belt or motor drive. The saw carriage has a feed of from ½ inch to 6 inches per minute, obtained through a friction plate and controlled by a lever which is automatically locked. This same lever also controls a quick-return movement for the carriage. Either air-clamps or screw clamps are furnished, depending on requirements. For the rapid handling of stock where multiple cuts are to be made, the machine is equipped with a stock feeding attachment, capable of handling bars 12 inches in diameter and any length up to 20 feet. In practice, as well as in shop tests, this machine has cut 10-inch square billets of 0.35 carbon steel in 4 minutes, 52 seconds. Bars of the same carbon content, having a 12-inch section, have been cut off in 6 minutes; 9-inch sections in 3 minutes; and 6-inch sections in 1 minute, 27 seconds.

Universal Grinder: Modern Tool Co., Second & State Sts., Erie, Pa. Full universal grinding machine of small size, designed for general tool-room work or the grinding of small parts in manufacturing. The sliding table is controlled in all its movements by a handwheel mounted on a sleeve which carries at its opposite end a clutch. This clutch engages the table driving clutch, when moved outward, at which time the handwheel is motionless, whereas a movement in the opposite direction brings the table under hand-control. The reversing transmission is an improved type of clutch motion which is simple and positive in its action. The cross-feed is so arranged that the minimum or maximum feed may be obtained by a hand lever within convenient reach. There is a minimum feed of 0.0001 inch and a maximum feed of 0.001 inch. Intermediate positions of the feed lever dial indicate 0.0001 inch. This machine has a normal swing of 5 inches, which is increased to 7¾ inches by removing the water guards. The maximum distance between the centers is 16 inches.

* * *

RECORDING LIQUID LEVEL GAGE

A new form of recording liquid level gage has been designed by the Industrial Instrument Co., Foxboro, Mass. to make continuous records on a circular chart of the height of water or other liquids in tanks, reservoirs, dams, tail races, etc. This instrument consists of a recording gage which is connected by a small copper tube with a rubber diaphragm enclosed in a brass case, the lower section of which is perforated for the admission of the liquid. A pressure equivalent to the depth is exerted against the diaphragm, and this pressure is transmitted, as compressed air, through the connecting tube and is recorded in ink on a circular chart which revolves once in twenty-four hours or seven days, as desired. The accompanying illustration shows the compact diaphragm movement which is employed for depths up to 20 feet. The bent arm of the recorder is attached to and supported by a small but substantial shaft which serves as an axis of rotation. The recorder is made moisture- and dust-proof by means of a gasket between the door and body of the case and by cementing the glass in the door, and it may be located at any convenient place. A connecting tube 100 feet long can be used, if necessary, and the equipment is not affected by freezing temperature.



Gage for Recording on Circular Chart Height Variations of Water or other Liquids

* * *

FINISH ON AUTOMOBILE CHASSIS

A feature of the automobile shows that never fails to attract attention is the chassis of cars in various finishes. An approved finish is polished metal throughout. Some manufacturers provide a mirror underneath the chassis to reflect the underside of the frame and mechanism. The mirror makes inspection easy, and heightens the general effect. Other kinds of finish are paint and enamel of colors chosen for general effect and contrast. The polished, painted and enameled chassis can be accepted as legitimate forms in which to present the mechanical features of cars advantageously, but we draw the line at gold leaf finish. A chassis shown at the Grand Central Palace show in January was "completely covered with pure gold leaf." The effect was displeasing to the tastes of good judges of automobile construction, being inharmonious with the subject. Gold leaf has its place on the frames of paintings and the domes of fine public buildings where the color and durability are desirable characteristics, but on a stock chassis—never!

AMERICAN MUSEUM OF SAFETY AWARD OF MEDALS

Three gold medals were presented at the annual exercises of the American Museum of Safety, held in the Engineering Societies Bldg., New York, January 18. The award of medals was as follows: The Travelers Insurance Co.'s medal to the Pennsylvania R. R. Co.; the *Scientific American* medal to the Norton Co., Worcester, Mass.; and the Louis Livingston Seaman medal to Dr. Alvah H. Doty, health officer of the port of New York.

The presentation was made by Dr. F. R. Hutton to the representatives of the Norton Co., the Pennsylvania R. R. Co., and Mr. Doty, these being Messrs. George N. Jeppson, superintendent of the Norton Co.; W. W. Atterbury, vice-president in charge of the operating department, Pennsylvania R. R. Co.; and Dr. John W. Brannan, president of Bellevue and Allied Hospitals, New York, respectively. Mr. Arthur Williams of the New York Edison Co., presided. Dr. Hutton made the presentation speech in a particularly gracious and effective manner. He said in part:

"The first medal has been awarded to the Norton Co., for achievements promoting safety in machinery for grinding processes manufactured in its shops, rapidly revolving emery wheels and the like, all attended with numberless dangers, most of which have been eliminated through the careful study and improved protective devices adopted by the Norton Co. The second medal is awarded to the Pennsylvania R. R., for achievements of safety in its shops, for the diminishing of accidents to its employes at the bench or operatives on the line, and to the traveling public it carries. The Louis Livingston Seaman gold medal has been awarded to Dr. Alvah H. Doty, who for many years has been the watchful Cerberus of the door of the Port of New York, guarding the Nation's health."

Mr. Jeppson responded briefly and referred to the medical inspection system lately instituted by the company, which was described in MACHINERY, January number.

Mr. Atterbury said in part:

"Industrial safety is an important branch in the broad humanitarian scheme that has characterized the policy of the Pennsylvania R. R. for many years in the conservation of human life and energy. The American Museum of Safety is rendering a great public service by directing attention to the enormous waste of human industrial efficiency; in giving to the country at large the results of expert investigation; and in spreading broadcast a knowledge of the methods and means which will overcome a large measure of this waste.

"Our public schools afford possibilities for educational work in impressing upon the children the doctrine of caution in protecting themselves and others against common everyday dangers of street and home. If the necessity of caution is impressed on the child's mind, in his after life it will have become instinctive. We carefully step aside from a snake in the road, and as carefully avoid crossing a field if there happens to be a bull in it. These are common examples of what has become instinctive caution. The necessity to 'Stop, Look and Listen,' and the danger of trespassing, might well form subjects of elemental instruction in our public schools. Already one of our neighbor-states has inaugurated a course of elementary instruction, requiring every teacher or instructor in every public, private or parochial school to devote not less than thirty minutes of each month to the instruction of pupils on fire dangers.

"While through its own efforts much has been done by the Pennsylvania R. R., in reducing the hazard of its passengers, employes and travelers on the highway, it is necessarily dependent upon constituted authority finally to eliminate that greatest source of death and injury—trespassing. In England and on the Continent, the laws are stringent and zealously enforced. In our country we receive but little aid and encouragement in the enforcement of such laws as we have, nor can much be accomplished until proper and uniform laws have been passed and the authorities recognize their responsibility and cooperate with us in our efforts. The Pennsylvania R. R., by the installation of protective devices, decreased the number of serious injuries to employes in its shops by more than 63 per cent from January 1 to November 1 of last year. In the Fall of 1910, experts from one of the large accident insurance companies were employed by the railroad to inspect all of the larger shops, and to make recommendations as to what should be done to increase the safety measures then in force. The result of this campaign was marked by a decrease in serious injuries, per one thousand shop employes, from 8.7 in January to 3.2 in October; the average number of employes was 33,242."

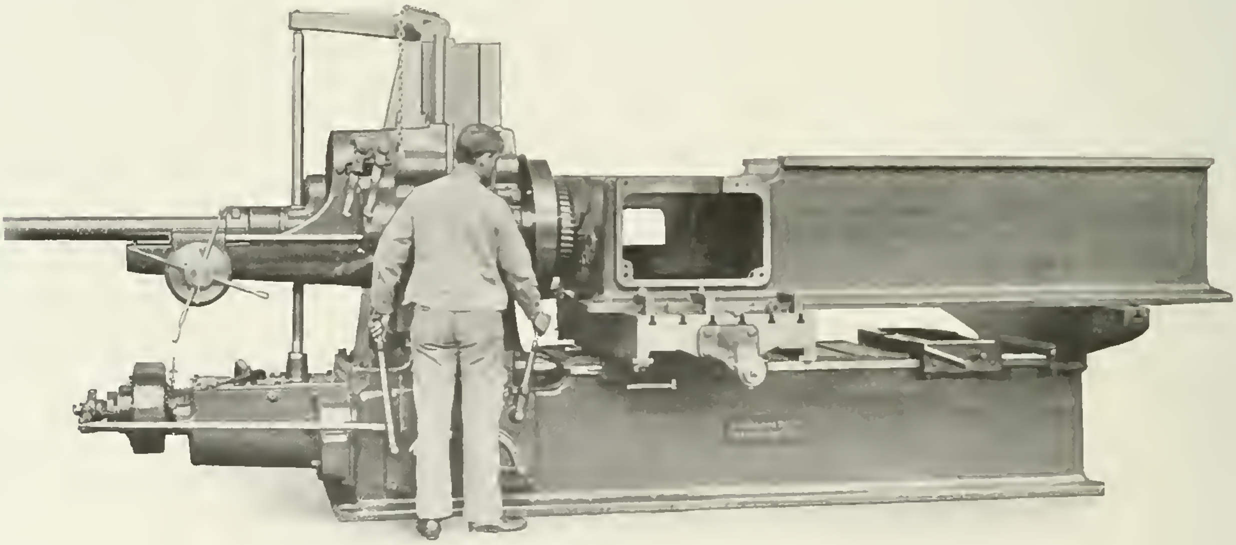
Following Dr. Brannan's tribute to Dr. Doty, lantern slides were exhibited by Dr. W. H. Tolman, director of the American Museum of Safety, showing the grinding wheel guards and safety collars made by the Norton Co., and the safety devices used by the Pennsylvania R. R., for the protection of trainmen and workmen in the shops and elsewhere, etc.

MACHINING LARGE BED ON LUCAS BORING, DRILLING AND MILLING MACHINE

The latest and largest "precision" boring, drilling and milling machine built by the Lucas Machine Tool Co., Cleveland, O., is shown in the accompanying view milling the pad for the speed change gear-box of a bed which is similar to the bed of the machine doing the work. After the milling is done, the bed is already in position for drilling the holes for the bolts which hold the gear-box to the bed. On this size machine, the 18-inch milling cutter shown, and other smaller cutters down to a certain size, are bolted to the internally geared faceplate which is driven by a pinion at the top. When still smaller cutters are used, or if for any reason higher speeds than those given by the faceplate drive are required, the pinion is withdrawn and the sleeve by which the spindle (bar) is driven and through which it slides, is then driven directly by a smaller gear at the left, thus eliminating excessive speed and wear. This change is made by the two levers shown at the left of the operator's shoulder, which interlock, thus making it impossible to engage both drives simultaneously.

The internally geared faceplate can be entirely removed, if it is in the way of smaller work or if for any other reason this would be desirable. In such a case the smaller milling cutters are bolted directly to the sleeve through which the spindle slides, giving a much stronger drive than if driven by the spindle itself. Whether the internally geared faceplate is on or off, it is not necessary to remove the milling cutter in order to use the spindle for other purposes. In the example of work illustrated, the spindle is, of course, used for drilling holes in the end of the bed.

It will be seen that on account of the length of the bed which is being milled, the tail-block and yoke have been removed. The base of the yoke, which is shown between the platen at the left and the auxiliary table support at the right, does not need to be removed, as the yoke can be taken off the base simply by removing four bolts, thus allowing easy and quick preparation for the class of work shown.



Milling End of Bed on Lucas Boring, Drilling and Milling Machine

* * *

Chemical analysis of lubricants discloses many facts which go to explain the judgment of lubrication experts that most plants spend a good deal more money than is necessary for this item. A report by Arthur D. Little, Inc., chemists and engineers, of Boston, gives some details as to a branded cylinder oil of medium price, which is declared to be a good oil so far as the cylinder stock is concerned, but analysis disclosed that its 6 per cent of fatty oil was not tallow oil as it should have been but degras or wool grease, which is very inferior to tallow oil. Degras is the less expensive, but a cylinder oil compounded with it cannot give first-class service.

BROWN & SHARPE THREAD CHASING ATTACHMENT

The Brown & Sharpe Mfg. Co. has lately designed an attachment for its automatic screw machines for chasing threads of such form that it is not practicable to cut them with a die. This attachment is shown fastened to a No. 0 machine in Figs. 1 and 2.

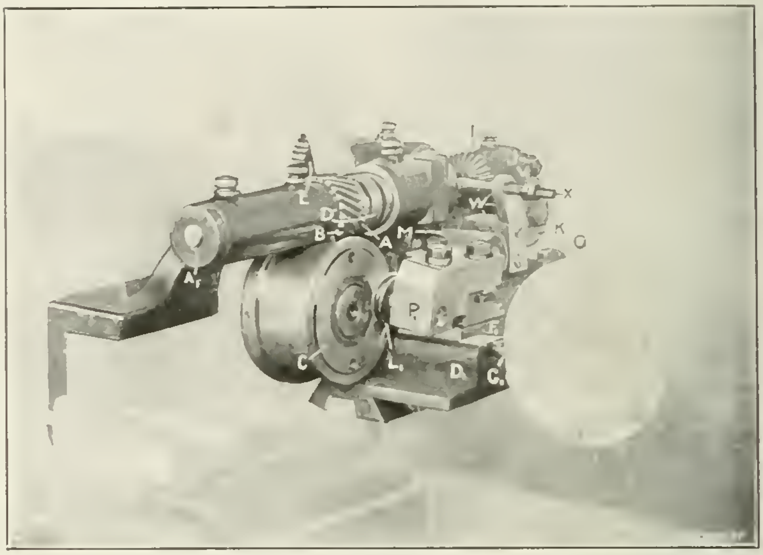


Fig. 1. Front View of Thread Chasing Attachment showing Chaser and Means of Driving from the Main Spindle of the Machine

When the work in the chuck is ready for chasing, the driving spindle is generally operated at a reduced speed, and it is rotated backward. The rear cross-slide is advanced by the cam on the front cam-shaft, which brings the movable part of the attachment up until the one-tooth clutch is engaged. One part *A* of this clutch (see Figs. 1, 2 and 3) is keyed to the shaft on which the helical gear *B* is also held by a key. This gear is driven by a helical pinion *C*, formed in a special cap which replaces the ordinary cap used in holding the chuck in place. This cap is prevented from loosening when driving the attachment, by a brass plug held by a headless set-screw. A plug is threaded into the nose of the cap to prevent the chips from getting into the gear teeth.

As the two parts *A* and *D* of the one-tooth clutch engage, they drive the spur gear *E* through the bevel gears *F* and *G*, and also the spur gear *H* through the bevel gears *F*, *G* and *I*, and the worm and worm-wheel *J* and *K*. Gear *E* meshes with a smaller gear keyed to the shaft *L* on which the leader *M* is held. This leader is provided with a buttress thread—the best type of thread for this purpose—which acts as a guide for the leader plate *N*, the latter guiding or traversing the top-slide K_1, holding the chaser L_1.

The spur gear *H* drives a smaller gear *O*, which is keyed to the shaft *P*, and rotates the advancing cam *Q* and the retarding cam *R*. The advancing cam *Q* keeps the leader plate *N* in contact with the leader *M* when the roll *S* held in the bellcrank *T*, is on the largest part of the cam. When this roll drops into the cut-away portion of the cam *Q*, the roll *U* on the other arm of the bellcrank is on the top of the lobe on cam *R*. This action of cam *R* disconnects leader plate *N* from leader *M*.

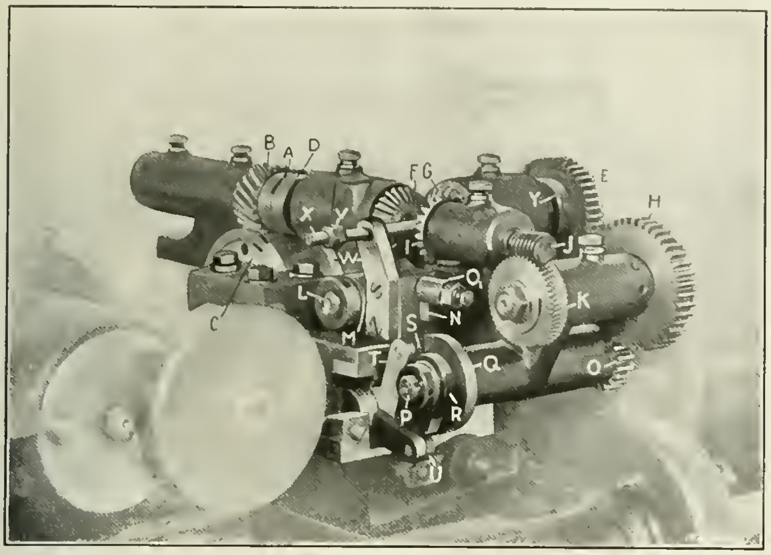


Fig. 2. Rear View of Thread Chasing Attachment showing how the Top-slide and Cams for Operating it are driven; also the Leader for Controlling the Pitch of the Thread

Should spring M_1 fail to return the top-slide to its backward position, the adjusting lock-nuts *V* can be set so that when the arm *W*, held on the top traversing slide, comes in contact with them it pulls out the rod *X* which disconnects the one-tooth clutch *Y*. Part of this clutch *Y* is made integral with the gear *E*, which is bronze-bushed, while the other part is held on the shaft Y_1 (Fig. 3) and is provided with a pin driven through it and the shaft, and fitting in an elongated slot in the sleeve holding gear *E*. This allows for a lateral movement of the pivoted part of clutch *Y* so that gear *E* is disconnected from the driving mechanism. The one-tooth clutch *Y* is kept in contact by means of a spiral spring, which is more clearly shown in the plan view, Fig. 3.

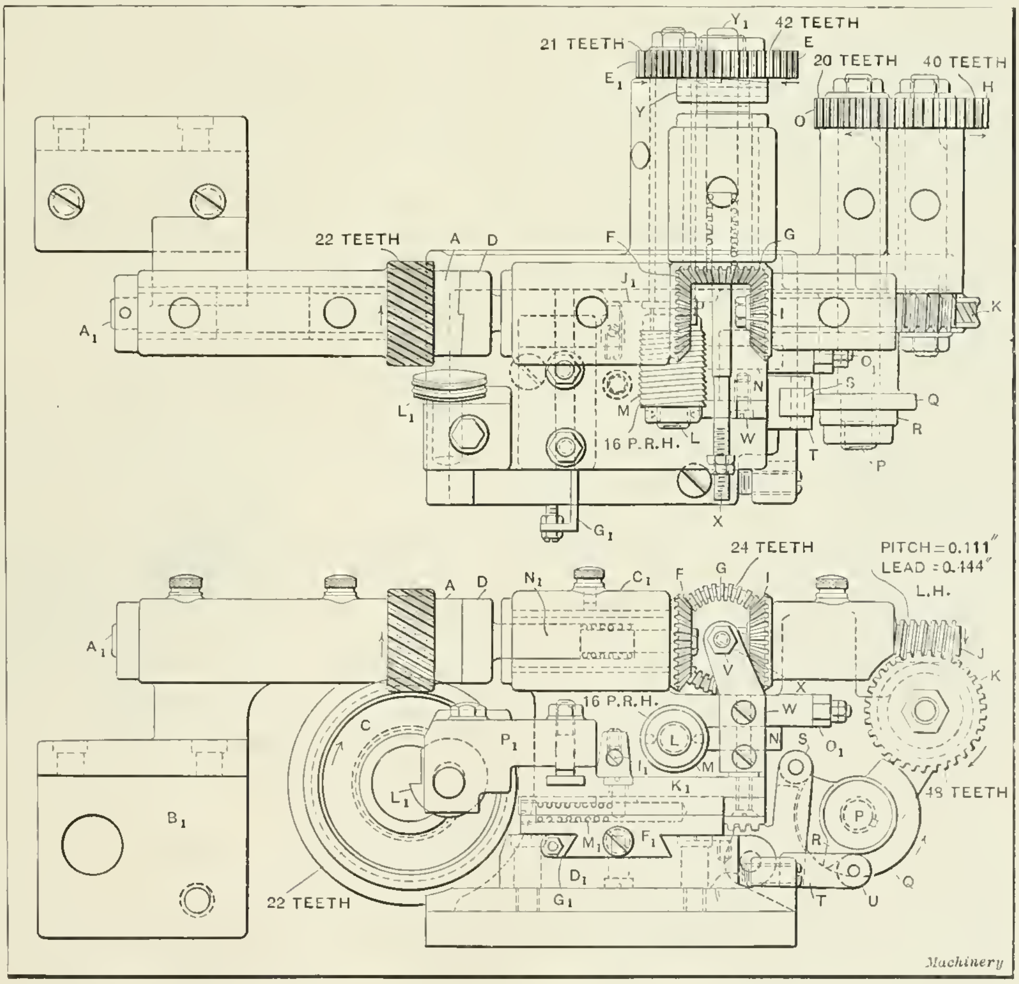


Fig. 3. Elevation and Plan Views of Thread Chasing Attachment showing its Construction

Construction of the Thread Chasing Attachment

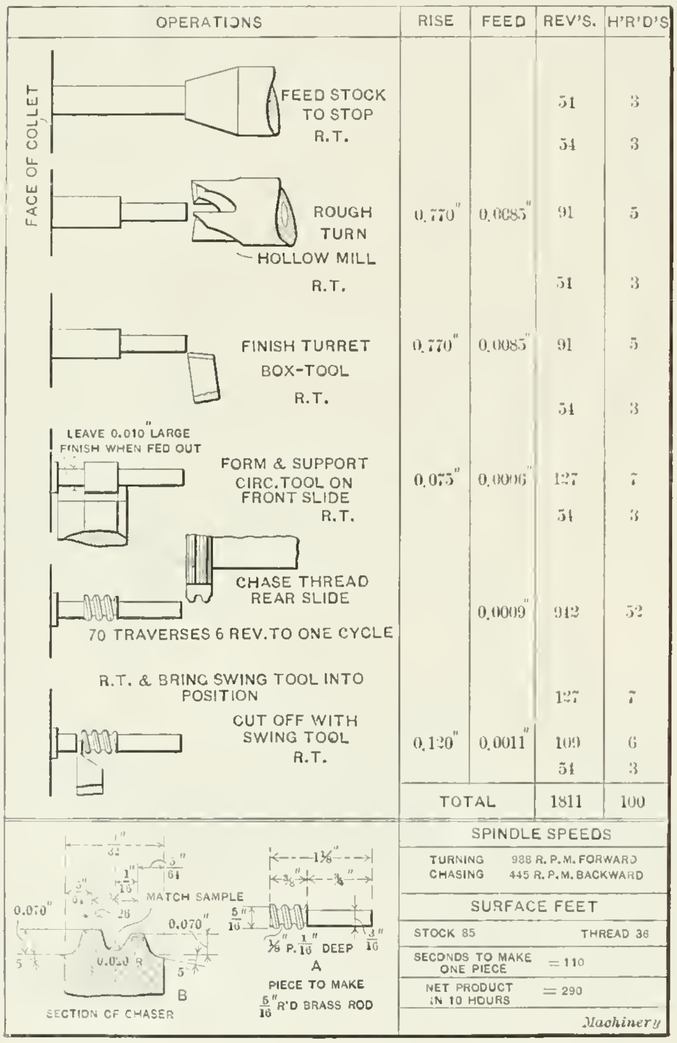
Referring to Fig. 4 where the piece to be made is shown at *A*, it will be seen that the thread is ⅛ inch pitch and is of special form. The means by which this thread is chased will be better understood by referring to the elevation and plan views of the attachment shown in Fig. 3. Here the method of driving is more clearly shown. The helical pinion *C*, which is formed on the special cap, is provided with 22 teeth, having a tooth angle of 63 degrees, 26 minutes, while the helical gear *B*, held on the main driving shaft of the attachment, is provided with 22 teeth, and has a tooth angle of 26 degrees, 34 minutes. By having the tooth angles thus arranged, it is possible to get the same number of teeth in both gear and pinion; hence the main driving shaft of the attachment is rotated at the same speed as the spindle of the machine. If the gear and pinion were provided with teeth cut at an angle of 45 degrees, it would be necessary to have them of the same diameter.

As the main driving shaft of the attachment A_1, Fig. 3, rotates at the same speed as the spindle of the machine, it is evident that the gear *E* will also rotate at the same speed, because the bevel gears *F* and *G* have the same number of teeth. As gear *E* has 42 teeth and meshes with gear E_1, which has 21 teeth, it follows that the leader *M* must rotate at twice the speed at which the spindle of the machine is rotating. This makes it necessary for the leader to have a thread of 1/16 inch pitch instead of 1/8 inch, which is that required on the work.

The machine is rotated backward for chasing at 445 R.P.M., and as four threads or convolutions are required on the piece, it is evident that the leader plate *N* should be kept in contact with the leader *M* for a sufficient space of time to complete the thread. This is accomplished by arranging the ratios of the worm *J* and worm-wheel *K*, as well as the gears *H* and *O*, to suit the time required for the top-slide to traverse. Worm *J* rotates at 445 R.P.M., and as it is provided with a quadruple thread it moves the worm-wheel *K* through a space of four teeth for every revolution of the spindle. As worm-wheel *K* has 48 teeth, it means that the worm-wheel, relative to the spindle, rotates at about 37 R.P.M. Now as gear *H* is provided with 40 teeth and gear *O* with 20 teeth, the cam-shaft *P* is rotated at 74 R.P.M. It now is a simple calculation to obtain from these data the required amount of "dwell" on the cam *Q*.

By referring to Fig. 3, it can be seen that this attachment consists of two brackets B_1 and C_1. The bracket B_1 is fastened to the frame of the machine, while the bracket C_1 carrying the operating mechanism is cast integral with a base which replaces the ordinary cross-slide. This base carries a plate D_1, having a dovetailed groove cut parallel with the axis of the machine spindle. Fitting in this groove is a slide F_1, furnished with a taper gib G_1 to provide for wear. This slide is returned to its "back" position, when, by means of a spiral spring, the leader and leader plate are disengaged, the slide being stopped by the set-screw I_1 which comes in contact with the boss J_1. This allows the slide to start from the same point for every traverse of the chaser across the work so that work and chaser are always in step.

The chaser L_1 which is held to the block P_1 on top-slide K_1, is brought up in contact with the work by the cam Q, and is operated by the bellcrank T, the latter being provided with a segment gear that meshes with a short rack attached to the top-slide. The chaser L_1 is cut down ⅛ inch below center, similarly to an ordinary circular tool, and is held at the required angle with the work so that it will not drag. The rolls S and U in the bellcrank T are kept in contact with the cams R and Q by means of a spring M_1, as shown. The plate D_1 is provided with a slight adjustment for cutting straight threads, and the leader plate N is adjusted by means of the device O_1.



OPERATIONS	RISE	FEED	REV'S.	H'R'D'S
FEED STOCK TO STOP			51	3
R.T.			54	3
ROUGH TURN HOLLOW MILL	0.770"	0.0085"	91	5
R.T.			51	3
FINISH TURRET BOX-TOOL	0.770"	0.0085"	91	5
R.T.			54	3
FORM & SUPPORT CIRC. TOOL ON FRONT SLIDE	0.075"	0.0006"	127	7
R.T.			54	3
CHASE THREAD REAR SLIDE 70 TRAVERSES 6 REV. TO ONE CYCLE		0.0009"	912	52
R.T. & BRING SWING TOOL INTO POSITION			127	7
CUT OFF WITH SWING TOOL	0.120"	0.0011"	109	6
R.T.			54	3
TOTAL			1811	100

SPINDLE SPEEDS

TURNING	988 R. P. M. FORWARD
CHASING	445 R. P. M. BACKWARD

SURFACE FEET

STOCK 85	THREAD 36
SECONDS TO MAKE ONE PIECE	= 110
NET PRODUCT IN 10 HOURS	= 290

Fig 4. Chart showing Order of Operations, Work and Other Data pertaining to the Production of a Piece having a Chased Thread

All shafts of this attachment run in phosphor-bronze bearings provided with oil grooves. The shaft X_1, to which the bevel gear F is held, is provided with a coil spring so as to facilitate the free locking action of the one-tooth clutch. To adapt this thread chasing attachment to other work it is only necessary to change the gears E, E_1, H and O, leader M and leader plate N. A still greater range can also be obtained by changing the worm J and worm-wheel K, as well as cams Q and R. These latter parts, however, can be used for a considerable range of pitches.

Order of Operations

The order of operations followed in completing the part to be chased is presented in Fig. 4. In operation, the stock is first fed out to the stop, and then the turret is revolved, bringing in the roughing hollow mill which roughs down the end of the work. The turret is again revolved and the finishing box-tool is brought into operation. After this, the turret is revolved and the front cross-slide advances carrying the circular forming tool. A support held in the turret is then brought in contact with the work to steady it while roughing down the diameter at the rear of the shoulder.

Following the turning operation, the rear cross-slide advances connecting the two parts A and D of the one-tooth clutch. This starts the operation of the attachment, when the top-slide K_1, Fig. 3, is traversed back and forth. This slide is carried forward by the leader and leader plate, then released by the cams Q and R, and returned by the spring until the set-screw I_1 touches the stop, when the cam Q again brings the leader and leader plate into contact, and the chasing continues. Seventy traverses of the chaser across the work are necessary to complete the thread, requiring six revolutions of the spindle to one cycle, that is, one back and forward movement of the top-slide. While the top-slide is traversing back and forth in this manner, the cam on the front cam-shaft is feeding the chaser into the work. As this cam is provided with a constant rise, it is evident that the tool is being fed in further all the time, so that at first it produces a tapered thread on the work, but as the slide approaches its full travel, the thread is "straightened"—made of equal depth from one end to the other. Before the chaser is brought into operation the spindle is reversed from 988 to 445 R.P.M., and from a forward to a backward direction.

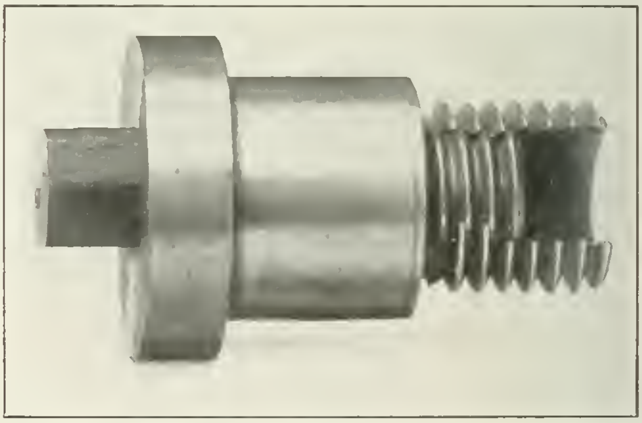
As it is impossible to hold a circular tool on the rear cross-slide for cutting off the work, a cut-off tool made from rectangular stock is held in a right-hand swing tool, which is retained in the turret and operated by a rising block on the front cross-slide. Before the cut-off operation takes place, the attachment is disconnected by the cross-slide dropping back. After the piece is cut off the turret is revolved and the cycle of operations repeated. An enlarged section showing the shape of the chaser is illustrated at B in Fig. 4.

* * *

UNUSUAL DEFECT RESULTING FROM A PIPED INGOT

The accompanying illustration shows a shouldered bearing screw made by the Cleveland Planer Works, Cleveland, Ohio, which after completion was found to have a curious defect. Part of the screw near the center was found entirely detached, and so loose that it was easily driven endwise, as shown in the illustration, about one-half inch.

The explanation is that the ingot from which the bar was rolled, was piped and when "plugged" with molten metal, the plug did not properly weld with the exterior. In rolling, the filling plug and the outer part extended together, but completely separated leaving them in the state found when the piece was machined. The pipe extended 14 inches in the bar and was not discovered until eight pieces had been finished and cut off. While defects of this class are often found in rolled stock, it is seldom that a complete separation of the parts is discovered.


Unusual Defect Resulting from a Piped Ingot

* * *

The world's production of aluminum has risen from 12,500 tons in 1905 to 37,000 tons in 1910.

NEW YORK MONTHLY MEETING OF THE A. S. M. E.

The members of the American Society of Mechanical Engineers, New York, held their first meeting of the year on January 9 to consider the work of the society for the current year. Prof. Rautenstrauch of Columbia University opened the meeting with a few general remarks in which he stated that 10 per cent of the success of the work of a society of this kind is due to the proper planning, and 90 per cent, to the proper carrying out of the work. He introduced the new president of the society, Dr. Humphreys. The substance of Dr. Humphreys' remarks was that the fundamental requisite for success in the work is harmony. He stated that the mechanical engineering field includes thirty-five or forty branches, and it is necessary to determine in advance how much can be done and done thoroughly. He expressed the hope that the society would be able to enlarge its membership along the right lines, and then briefly took up the financial details.

Dr. Lucke of the meetings committee was the next speaker, and he designated the work of the committee as consisting of the soliciting and judging of the manuscripts presented, and the directing of the meetings. It was his opinion that the transactions of the society's meetings should reflect upon their practice. As this practice varies in its scope, he considered that the five members of this committee were inadequate to judge intelligently of the merits of the manuscripts received. The commitee concurs with this idea, and has appointed several sub-committees, the members of which are specialists in their particular fields. These committees serve without recompense, and it is believed that the judging of manuscripts will be more intelligently, as well as more easily, done in the future. The members of these various committees will be shortly announced.

Mr. F. A. Waldron of the New York local committee was next heard from. For the local committee he stated that all suggestions in regard to the work of the committee would be very welcome and his remarks were along the lines of the work of the local committee. Particularly is the committee anxious to instil enthusiasm in the 1100 New York members. For various reasons the Boston meetings seem to be better attended than the New York meetings, although the membership is smaller in Boston. This is due partly to the stringent calls upon the New York members in their business and kindred reasons. The question of raising funds for the entertainment of out-of-town members seems to him to be a difficult one. Various plans for accomplishing this work were considered.

A brief discussion of the raising of funds for special entertainment of non-resident members then followed, which was participated in by Messrs. Gilbreth, Pomeroy, Van Winkle, Meier, Cobleigh, and others. The consensus of opinion seemed to be that the difficulty was due to the fact that the dues of the American Society of Mechanical Engineers are much lower than other similar organizations, and it was generally conceded that the subscription method is not the proper way of raising these funds. Further statements in regard to finances came from Mr. R. M. Dixon. In the absence of Mr. G. J. Foran of the membership committee, Mr. Hosea Webster spoke of the work of the membership committee. Their main problem is to advise members as to the necessary qualifications that prospective members must have, to furnish application blanks that convey the necessary information, and to advise indorsees of applicants what their responsibilities are. The addition of associate members from the allied trades is perhaps desirable from the numerical standpoint, but it is the aim of the membership committee to keep the society an engineering society rather than a business society. Mr. F. R. Low made a few remarks for the publication committee. The work of this committee embraces the *Journal* and the year book as well as the issuing of the various papers. Its policy is to give the technical press latitude in regard to the publication of reports, abstracts and papers. The *Journal* is now regularly reviewing 220 foreign publications in nine or ten languages, and it has been fortunate in securing for this work an efficient engineer who is also a linguist of some note. The *Journal* is self-supporting through its advertising matter and is offered to the public practically at cost. It is expected that the earnings of the *Journal* will increase in the future and it is the desire of this committee to give the members a better journal in proportion to the increased earnings.

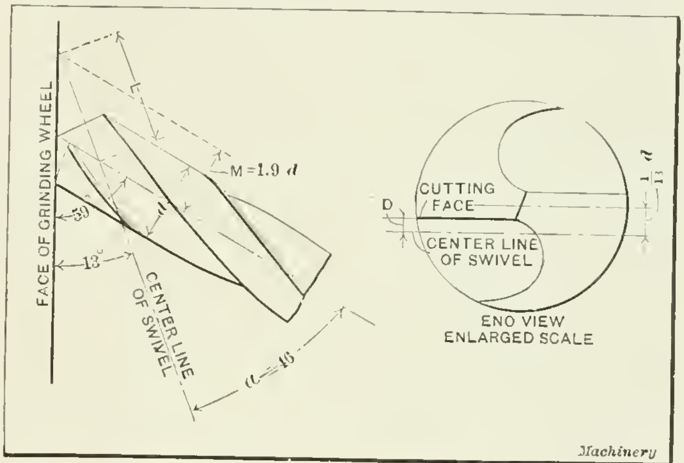
Dr. Leonard Waldo was next heard from in regard to the society's library. Dr. Waldo talked in an entertaining way, dealing particularly with the research work that is carried on so extensively in Germany. He drew the attention of the members to the fact that complete collections of the patents of the leading foreign countries are now available in the New York Public Library. Mr. Edward Van Winkle of the house committee then gave a brief talk on the business of this committee, after which general remarks were offered by several members, and the meeting adjourned.

* * *

DESIGN OF TWIST DRILL GRINDER

In the September, 1911, number of MACHINERY, L. K. S. submitted three questions relating to the design of twist drill grinders. In the November, 1911, number of the German publication *Werkstattstechnik* an article appears which gives some information on this subject. Referring to the accompanying illustration L. K. S. asks, "What should be the angle α from the center line of the swivel of the drill grinder to the center line of the drill?" According to the source referred to, the angle between the center line of the swivel and the face of the grinding wheel should be about 13 degrees, as shown, which with an angle of the cutting lip of the drill of 59 degrees, gives angle $\alpha = 59 - 13 = 46$ degrees.

The second question submitted was as follows: "What should be the distance L from the point where the center line of the swivel intersects the face of the grinding wheel to the point where the same center line intersects the center line of the drill?" This dimension should be a function of the diameter d of the drill and should be practically $2.64d$. This dimension is calculated from the dimension $M = 1.9d$, as shown in the illustration, which is the distance between the point where the center line of the swivel intersects the face of the grinding wheel to the axis of the drill.



Dimensions for the Design of a Twist Drill Grinder

The third question asked is, "What should be the distance D from the cutting face of the drill to the center line of the swivel for all sizes of drills?" As the location of the cutting face of the drill may vary somewhat in drills of different makes, the dimension determining the location of the center line of the swivel is not given with reference to the cutting face, but with reference to the axis of the drill, the dimension being $1/13d$, as shown in the illustration.

* * *

The German electrical industry is in a flourishing state, and the Siemens & Halske and Siemens-Schuckert Werke, especially, have had an exceptionally good business during the last financial year. The business of Siemens & Halske for the last seven years has shown a tendency to steadily improve. In 1905 a dividend of nine per cent was declared, the following year ten per cent, during the two following years, eleven per cent, and for the last three years, twelve per cent. The Siemens-Schuckert Werke pay a dividend of ten per cent on their stock regularly.

THE NATIONAL AUTOMOBILE SHOW

The National Automobile Show, held under the auspices of the National Association of Automobile Manufacturers, at the Grand Central Palace, New York, January 10-17, offered a great deal of interest to those who are concerned in the mechanical innovations in, and the commercial development of, the automobile trade. There were more than seventy exhibitors of automobiles, and nearly that number of exhibitors of accessories. The exhibition was distributed over three floors of the exhibition building, which, by the way, is entirely new and offers unusual advantages for the proper setting of a show of this kind. The first floor was devoted almost exclusively to passenger automobiles, many of which, however, were of a type designed especially for business uses. The second floor was devoted to trucks and commercial vehicles in general, delivery wagons, etc. It is apparent that a great deal of attention is now being given by automobile builders to the commercial vehicle business. Large high-powered trucks with a loading capacity of from three to four tons and an available power of from 30 to 40 horsepower were everywhere in evidence, but many firms also exhibited smaller trucks and delivery wagons for light loads. The use to which the automobile truck is being put is now extremely diversified. Large covered moving vans, coal delivery wagons, heavy brewery trucks, and wagons intended for general trucking purposes for manufacturing establishments, were exhibited side by side with dozens of different models of department store delivery wagons, newspaper delivery trucks, etc. A few models of ambulances were also exhibited. It would seem, to the casual observer at least, as if there is hardly a field where horse-drawn vehicles are used in which the automobile is not gaining ground.

Four or five of the models were provided with friction drive and a transmission chain from the friction wheel to the rear axle carrying the differential. The majority of the trucks exhibited, however, had the common bevel gear drive with double chain drive from the jack-shaft to the rear wheels which are mounted on a dead axle. The chain guard was not in evidence. The worm drive was also conspicuous by its absence, and it would appear that commercial vehicle builders have not taken kindly to this type of drive. In general, there were few radically new mechanical features, but the improvements are rather along the lines of minor changes in previous designs. Innovations in engine construction were displayed in two cars having three-cylinder, two-stroke-cycle air-cooled engines. With these cylinders connected to cranks set 120 degrees apart, the two-stroke-cycle engine develops the same evenness of turning movement as the six-cylinder four-stroke-cycle type.

It is apparent that the tire question is receiving considerable attention, and a great many different types of tires claiming special advantages as regards resilience and wearing qualities were exhibited both in place on the automobiles and in the separate accessories exhibitions, which occupied the third floor of the building. The majority of the cars exhibited were, of course, of the gasoline engine type, but there were five electric passenger cars and two electric commercial vehicles on exhibition. Electric delivery cars have a special field of service which they fill more efficiently than the gas engine car. Where the service required is a comparatively short haul, say twenty-five miles in a day, but involving a large number of starts and stops, the electric car is at advantage. Its simplicity and ease of operation relieve the driver from all concern, for the operation of the car leaves him free to concentrate his mind on his delivery work.

As regards the arrangement of the exhibition, credit should be given to the management for providing wide aisles and ample space for the crowds which are always sure to attend shows of this kind. Comparatively few decorations—so often used to excess in show buildings—were in evidence, and this tended to give the exhibition a still more dignified and pleasing appearance, particularly as the new Grand Central Palace, where it was held, is in itself a building of such attractive architectural appearance that additional decoration is hardly necessary.

THE SHAPER DESIGN—A REPLY

We fully agree with the writer of the article on page 403 of January Machinery, engineering edition, that an extended argument between us would be of little avail, and also when he says, "The question of friction is one that can only be determined by tests," although we think "best" would have been a better word to use than "only."

We do not consider that his article was merely "a study in kinematics" as will be patent to any one who will read the first article. We are not willing to take tests made on the same machine changed to suit the maker. We do not question Mr. H. P. Fairfield's honesty, nor do we doubt the tests shown as advertised; we are surprised that they showed so well. It would be interesting to know if the friction of the bull-gear on the column was present, or if the bull-gear was running on that short hub bearing shown in our dissected view. The only tests we would consider conclusive would be with the "Queen City" against the two-piece crank type. Will our competitor put his machine up against ours on fair competitive tests? Will he do this at some intermediate point between factories? We suggest the Case School of Applied Science, Cleveland, Ohio, as a place where we could both have a "clear field and no favor test." Let them understand the discussion and make the tests to satisfy all parties concerned. We will agree to almost any terms.

We understand the size machine in question was a 24-inch, and we are very willing to use our 24-inch as against theirs. Our competitor says, or intimates, that there is too much overhang or some other defect in design that allows spring or cramping, and if this cramping does exist in our shaper, it is self-evident that it will increase as the duty becomes heavier, so we lay ourselves open by challenging them to a series of power efficiency tests, especially on heavy-duty cuts.

We suggest that the loser pay all expenses of the tests, and the greatest possible publicity be given to them, no matter who wins. While the features of accuracy, handiness, durability, etc., also come into the question of machine tool supremacy, we believe the power efficiency test is the most important.

We have always claimed power efficiency for "Queen City" shapers, and would consider ourselves very dishonest if we were not ready to defend this claim against all comers. Neither would we accept as conclusive any tests that were made between our competitor's machine and any other as showing superiority over the "Queen City." We are not from Missouri, but we like to be "shown" just the same.

Cincinnati, Ohio. Queen City Machine Tool Co.

* * *

Hardly is a very high building erected in New York before another is projected to exceed its height. The highest structure now in process of construction is the Woolworth Building on Broadway, between Park and Barclay streets. The total height of this fifty-five story structure is about 750 feet. Plans have been made for the Equitable Life Assurance Society for a still higher structure to be erected on the site of the building burned January 9. The proposed building was designed to occupy the block bounded by Broadway, Nassau, Pine and Cedar streets, measuring about 489 by 168 feet. The plans called for a main structure thirty-four stories, surmounted by a tower of twenty-eight stories. The total height of the building and tower was 909 feet and the top of the flag-pole was to be carried to a greater height than the Eiffel Tower in Paris.

* * *

The aeroplane industry is apparently booming in France. During 1911, 550 aeroplanes were built in the country. A great many of these were for the French army which, it is estimated, at the end of 1912 will have a corps of over 200 aeroplanes. In Germany, also, the interest in aeronautics is very great. An international aviation and aero exhibition will be held in Berlin, from April 3 to 14, 1912, and will include aeroplanes and dirigible balloons of all kinds, together with motors, propellers, materials, and all kinds of equipment. For information in regard to this exhibition address the Verein deutscher Motorfahrzeug-Industrieller, Potsdamerstr, 121 h, Berlin, W. 35.

FIXTURE FOR MILLING SPIRAL CAMS

By G. W. A.

The barrel cam shown in Fig. 1 was at one time considered a difficult proposition to make, for the reason that we only required a few of these cams, which would not warrant the purchase of a special machine. To overcome the difficult proposition of cutting the grooves in this cam, we devised the fixture shown in Fig. 2. This fixture was made to be used on the drill press. The shank *A* was made a good fit in the socket of the drill press and the fixture *B* was bolted to the table by screws passing through the holes *C* in its base.

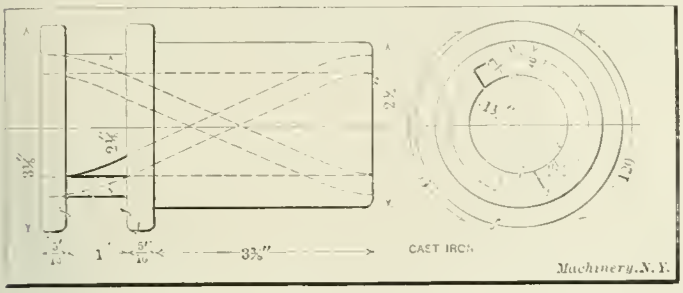


Fig. 1. Barrel Cam with Two Internal Spiral Grooves

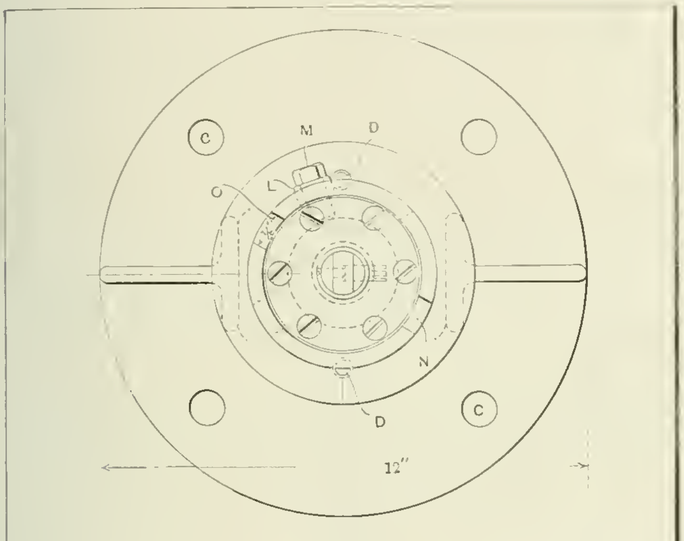


Fig. 2. The Fixture used in Cutting the Spiral Grooves in the Barrel Cam, Fig. 1

This fixture as is clearly shown is ribbed, and the sides of the lower section of the casting, instead of being circular are parallel with each other. A circular cap is formed on the top of these parallel sides, in which two holes *D* are tapped for holding the clamping bolts used in holding a clamping strip not shown. This clamping strip holds the casting down firmly on the base of the fixture. A recess the same diameter as the base of the casting Fig. 1, is cut in the fixture to locate the casting in the correct relation to the spindle. The spindle *E* is made 1½ inch in diameter and fits in the hole in the casting, in which the grooves are to be milled. It is fastened to the shank or driver *A* by a cap *F*, which is held down with six button-head screws. Two fiber washers *G* are placed one beneath the cap *F* and one beneath the shoulder on the shank *A* to decrease the friction.

The shank *A* has a bevel gear cut on its lower end which meshes in a corresponding bevel gear held in the spindle *E*. The bevel gear which is held in the spindle *E*, also forms the holder for the end mill *P* used in cutting the spiral grooves. This end mill is kept from rotating by a small key-pin *H* which fits in a groove cut in the shank, and is adjusted outwardly by the headless set-screw *I*. The block *J* acts as a seat for the end mill holder *K*, and is held to the spindle *E* by two fillister-head screws as shown. This cap facilitates the insertion of the mill-holder and forms a seat or bearing for the rear end of it. A roll *L* is fastened to the top part of the sleeve *E* by a shouldered screw *M*, which is made so that the roll is free to rotate. Master grooves *N* and *O* are cut in the cylindrical part of the casting *B* in which this roll is guided while the mill is cutting the groove in the cam.

The manner in which this fixture is operated is as follows: The shank *A* is inserted in the socket of the drill press and the casting *B* clamped to the table; then the casting Fig. 1 is inserted in the fixture and held down by a clamping strip which, in turn, is held by screws inserted in the holes *D*. The spindle of the drill press is then elevated and the roll placed in the grooves *N*. Then the spindle is brought down slowly while the end mill cuts the groove in the cam. After one groove has been cut the spindle is raised again and the roll brought around and placed in the groove *O* and the same operation continued. These grooves, *N* and *O*, as can be seen, travel about three-quarters of the way around the periphery of the upper part of the fixture.

It may be interesting to know that the cam grooves are completed in this fixture, and that it takes exactly fourteen minutes to complete one cam, including the time required to place and clamp it in the fixture. Previous to making this fixture, a milling machine was used for doing the same job and it required eight hours to complete one cam, so it can easily be seen that this fixture was a decided advantage over the previous method.

* * *

Plate-girders of record size have been placed in a crossing of the Boston & Albany R.R. over the New York, New Haven & Hartford R.R. at South Worcester, Mass. They form part of the extensive track-elevation work of the Boston & Albany, at Worcester, which has been in progress during the past year. The crossing is four-track, and comprises five lines of plate-girders in two spans over the New Haven tracks and a truss span over Southbridge Street. The longer of the two girder spans is 122½ feet outside to outside; its girders are 10½ feet deep and each weighs 170 tons. Longer plate-girders have been built in the past, but none of a weight approximating those of the present girders. An unusual feature of the detail construction of the girders is that rivets of 1⅛ inch diameter are employed.—*Engineering News.*

* * *

A large Curtis vertical steam turbine for a rated capacity of 20,000 kilowatt or about 27,000 horsepower, was recently placed in service at the Waterside Station of the New York Edison Co. This turbine has the distinction of being the largest in the world, and would be sufficient to supply all the electric current for a city of about 250,000 population. The turbine is 35 feet, 7 inches high and approximately 17 feet in diameter, covering a floor space of nearly 300 square feet. Its total weight is 420 tons. Two more units of the same type are to be installed at the station. The compactness of these large steam turbines is remarkable. These three 20,000 kilowatt units will occupy no more space than was formerly taken up by four 3500 kilowatt engine-driven units.

PERSONALS

J. W. Higgins has been appointed general manager of the Missouri Pacific-Iron Mountain R. R., to succeed A. W. Sullivan, resigned.

Ellsworth Haring, representing Hermann Boker & Co., New York, left January 13 for a ninety days' stay in Cuba, to look after his uncle's estate.

A. Metivier, a partner in the firm of E. Isbuque & Cie., Antwerp, Belgium, machine tool dealers, will visit the United States early in February.

Fred W. Belcher, for several years with the Knox Automobile Co., Springfield, Mass., has taken the position of superintendent for the Grant Automobile Co., Orange, Mass.

S. Sakuragi, of the South Manchuria Railway Co., Manchuria, China, who for two years has been in the United States studying railway conditions, sailed for China, January 24.

Walter A. Sanders has resigned as superintendent of the Grant Automobile Co., Orange, Mass., to take a position in the engineering department of the General Electric Co., at Lynn, Mass.

Walter Knapp has left the employ of the Niles-Bement-Pond Co.'s engineering department at Plainfield, N. J., to take the position of assistant superintendent of shops, League Island Navy Yard, Philadelphia.

George C. Lasares, draftsman for the past two years with the Parker Transmission Appliance Co., Springfield, Mass., has taken a position with the Bosch Magneto Co., of the same city as purchasing inspector.

D. DeVries, engineer with R. S. Stokvis & Zonen Ltd., Rotterdam, Holland, and author of the works "The Calculation of Change Wheels," and "Milling Machines and Milling Practice," will sail for America in February.

George E. Hallenbeck, for twelve years superintendent of Baker Bros., Toledo, Ohio, manufacturers of high-duty drilling machines, tapping machines, etc., was taken into the firm January 1. The firm name will not be changed.

Francis W. Frost, formerly secretary and treasurer of the *Engineering News* Publishing Co., has been elected to the office of vice-president and treasurer of Suffern & Co., importers and exporters, New York.

J. E. Bellows, representing Cadbury Bros., Birmingham, Eng., sailed for England January 22 following a two months' sojourn in the United States, where he has been studying scientific management of manufacturing plants.

Albert A. Gordon, Jr., has been appointed superintendent of the Crompton-Knowles Loom Works, Worcester, Mass., succeeding William Wattie, resigned. Mr. Gordon is a graduate of the Worcester Polytechnic Institute, class of 1886.

Charles M. Lyle, for several years with Manning, Maxwell & Moore, Inc., in charge of their Southwestern territory, with headquarters in St. Louis, Mo., has resigned to become manager of the Niles-Bement-Pond Co.'s St. Louis office at 516 N. 3rd St.

Monks & Johnson, architects and engineers, 7 Water St., Boston, have associated themselves with Henry F. Keyes, architect, 161 Devonshire St., Boston, for the preparation of plans and specifications for certain large industrial developments.

Clarence Harter, for several years draftsman for the Remington Arms & Ammunition Co., at the Ilion plant, has been promoted to the position of chief draftsman in the company's cartridge works at Bridgeport, Conn., the promotion taking effect January 1.

D. W. Patten, who for several years was salesman for Schuchardt & Schütte, New York, and for the past year salesman with Marshall & Huschart Machinery Co., is now connected with the Windsor Machine Co., Windsor, Vt., selling Gridley "automatics" in Ohio.

Edgar Bloxham, a well-known machine tool dealer of Paris, France, expects to visit the United States early in February and will make his headquarters with A. G. Thompson, 587 West End Ave., New York City, where he may be addressed by any manufacturers who desire to get in touch with him.

Mahlow E. First has been appointed mechanical engineer of the Indiana Harbor plant of the American Steel Foundries, succeeding B. H. Reddy, resigned. Mr. First was formerly with the Morgan Eng. Co., Worcester, Mass., and later with the Pawling & Harnischfeger Co., Milwaukee, Wis., before going to the Indiana Harbor plant as assistant to Mr. Reddy.

Harry G. Stoddard has become associated with the Wyman & Gordon Co., Worcester, Mass., manufacturers of drop forgings, in the capacity of vice-president and general sales manager. Mr. Stoddard was formerly manager of the Washburn & Moen branch of the American Steel & Wire Co., of Worcester, and for the past seven years was president of the Trenton Iron Co., Trenton, N. J.

William Wattie, who resigned his position as superintendent of the Crompton-Knowles Loom Works, Worcester, Mass., in January, after twenty-two years as superintendent, and ten years as foreman of the shop, was given a case of one hundred pieces of silver by the employes of the factory, and a three-piece silver tea service by Messrs. Henry F. and George F. Hutchins of the company. Mr. Wattie is giving up active work, and intends to sail February 8, for a three months' trip abroad.

Col. G. N. Whistler and Major J. E. Bloom, U. S. A., retired, have joined the Institute of Experts, 50 Church St., as technical experts in their respective specialties, explosives, ordnance and supplies. Brig. Gen. T. A. Bingham, U. S. A., retired, at present the chief engineer of the department of bridges of New York City, has consented to act as consulting engineer, when his other duties permit, in subdivisions pertaining to cement, constructions, drainage, terminals and bridges.

F. A. Haughton, formerly general superintendent of the Taylor Iron & Steel Co., has been appointed works manager of the Remington Arms & Ammunition Co.'s gun plant at Ilion, N. Y. Mr. Haughton will be in charge of the manufacturing operations at Ilion and will report direct to Mr. Tyler, the general manager of works who has general charge over the works of the Remington Arms & Ammunition Co.'s gun plant at Ilion and the ammunition plant at Bridgeport, Conn., commonly known as the Union Metallic Cartridge Co. His appointment took effect January 15, and it relieves Mr. Tyler of many of the details of chief management. Mr. Haughton has had several important positions, among which was the superintendency of the American Locomotive Co.'s automobile plant at Providence, R. I.

* * *

OBITUARIES

Almon P. Wint, secretary of Dienelt & Eisenhardt, Inc., Philadelphia, Pa., died at his home November 15. He was also secretary of the Lovekin Pipe Expanding & Flanging Machine Co., and treasurer of the Charles Este Co. Mr. Wint's death will cause no interruption of the activities of Dienelt & Eisenhardt, Inc.

Richard T. Crane, president of the Crane Co., Chicago, died January 8, aged eighty years. Although a very successful manufacturer who, in common with the manufacturing world in general, had profited largely from the results of technical research, he was violently opposed to college education, and achieved national prominence through his publications and speeches against colleges and universities devoted to higher education. He was a supporter of manual training schools and contributed $200,000 annually for manual training instruction in Chicago.

Franklin Farrel, one of the best known business men of the Naugatuck Valley, died at his home in Ansonia, Conn., January 10, aged eighty-three years. He began at the age of fourteen to learn the mill trade with his father. In 1849 he became interested in the foundry business as a member of the firm of Farrel & Johnson. Later this firm was reorganized under the name of Farrel Foundry & Machine Co., with Almond Farrel, president. Franklin Farrel succeeded his father in the presidency, which position he held until his death. The Waterbury-Farrel Foundry & Machine Co., and the Ansonia Machine & Tool Co., were the same until March, 1880, at which time the late E. C. Lewis purchased the Waterbury plant from Mr. Farrel. Mr. Farrel was interested in all the commercial enterprises of his home town and died worth several million dollars.

William Donaldson, superintendent and secretary of the Champion Tool Works Co., Cincinnati, died January 15 of Bright's disease at his home in Ludlow, Ky. He was born in Cincinnati, 1842, and commenced his trade as a machinist at the early age of twelve, which business he has followed during his lifetime, except to serve throughout the Civil War as a quarter gunner on the gun boat *Chillicothe* plying on the Mississippi River. In the early 70's he was, for a number of years, in business in Cincinnati as a manufacturer of screw cutting engine lathes. His later work after disposing of his lathe business was as superintendent and designer of machine tools for a number of the most prominent shops in Cincinnati, having been connected at different times in these capacities with Lodge & Davis, American Tool Works Co., Fosdick Machine Tool Co., Bradford Machine Tool Co., Dreses Machine Tool Co., and Greaves, Klusman & Co., all of Cincinnati. For the six years prior to his death he was superintendent and secretary of the Champion Tool Works Co. Mr. Donaldson was a man of very wide experience in the design and manufacture of the various types of machine tools, and was frequently consulted as a patent expert and in other advisory capacities on the design and construction of intricate machinery for various purposes.

Franklin E. Snow, for thirty-two years connected with Wells Bros. Co. of Greenfield, Mass.—for many years as vice-president and general manager—died in Boston on January 6. To Mr. Snow's untiring energy and remarkable business ability is due, in a great measure, the success of the Wells Bros. Co.; for the business and selling end was entirely in his charge for many years, and under his direction increased from a small beginning until the concern became one of the largest in its line in the country. With all his shrewdness and

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care for the interests of his concern Mr. Snow impressed every one who met him in a business way with his genial and wholesouled personality. Although he worked unceasingly to build up the business, he found time to devote to many local undertakings of a business, social and philanthropic character, and in his death Greenfield has sustained a loss which can hardly be repaired. Mr. Snow was born in Griswoldville in 1849. He received a common school education, and in 1867 became bookkeeper for the Shelburne Falls National Bank, which position he left to engage in the banking business in Halifax, Nova Scotia, afterwards going to Wisconsin, where he established a general store. Then he entered a bank in Chicago and afterwards became cashier of the First National Bank, Negaunee, Mich., later returning to Chicago as the teller of the Northwestern National Bank. In 1880 Mr. Snow returned to Greenfield and became associated with the firm of Wells Bros., which was afterwards incorporated as the Wells Bros. Co. At the time of his death he was president of the Greenfield Machine Co., a director of the First National Bank, and a trustee of the Franklin Savings Institution, besides giving his time in various capacities connected with charitable and other institutions. Mr. Snow was a 32nd degree Mason, and for many years had been prominent in the order. He left a widow and three daughters.

* * *

It is necessary for the well-being of man that he should be dissatisfied. He must want something he has not got, and want it badly enough to be willing to exert himself to the full extent of his powers to get it. That is the way that humanity makes progress.

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COMING EVENTS

February 5-10.—Commercial vehicle exhibition, Coliseum and First Regiment Armory, Chicago, Ill.

April 3-14.—International Aviation and Aero Exhibition, at Berlin, Germany. For further information address Verein deutscher Motorfahrzeug-Industrieller, Potsdamer str. 121, Berlin, W. 35.

May 13-15.—Triple convention of the American Supply and Machinery Manufacturers' Association; National Supply and Machinery Dealers' Association; and Southern Supply and Machinery Dealers' Association, at Norfolk, Va., Monticello Hotel, headquarters. F. D. Mitchell, secretary-treasurer, 309 Broadway, New York.

May 14-17.—Sixth annual convention of the Master Boiler Makers' Association at the Fort Pitt Hotel, Pittsburg, Pa. J. R. Flannery, of the Flannery Bolt Co., Frick Bldg., Pittsburg, Pa., secretary and treasurer of the general committee of arrangements.

June 12-14.—Annual convention of the American Railway Master Mechanics' Association at Atlantic City, N. J.

June 17-19.—Annual convention of the Master Car Builders' Association at Atlantic City, N. J.

August 20.—Annual convention of the International Railroad Master Blacksmiths' Association at Hotel Sherman, Chicago, Ill. J. F. Carrigan, Rutland Railway, Rutland, Vt., chairman of the executive committee.

September 2-7.—Sixth congress of the International Association for Testing Materials at the Engineering Societies Building, 29 W. 39th St., New York. One of the important functions of this association is to establish standard specifications for materials used in manufacture and construction. The cooperation of engineers and others who are engaged in the purchase and use of the raw materials of the trades is requested. The annual dues are $2, with no initiation fee. Mr. H. F. J. Porter, secretary, 1 Madison Ave., New York.

October 4-26.—Engineering and Machinery Exhibition, Olympia, London, England. The exhibition will be especially of machine tools.

SOCIETIES AND COLLEGES

American Society of Engineer Draftsmen, headquarters, 116 Nassau St., New York, has been granted a charter for its St. Louis, Mo., section. Mr. L. T. Maconer, chief draftsman of the Missouri Pacific Railway, is the first chairman.

School of Mines and Metallurgy, University of Missouri, Rolla, Mo. Bulletin No. 1 on friction in air pipes, giving the results of a series of tests on small pipes to determine the value of a constant. While the results are indeterminate for ¾ and ½ inch pipes, the value of the tests will no doubt be appreciated by engineers interested in the subject.

American Museum of Safety, 29 W. 39th St., New York. Leaflet illustrating improved methods of emergency treatments for wounds. This leaflet is one of a series issued for the instruction of men in shops, mills and factories. The series issued No. 1 Alcoholism in Industrial Safety; Leaflet No. 1 Presses and Punches; Industrial Hygiene; Leaflet No. 1, Safety for the Molder.

American Museum of Safety, 29 West 39th St., New York. "Manual of Safety—Yard Practice, Walks and Railings," by Charles Kirchhoff and Dr. Wm. H. Tolman. The manual illustrates various warning signs, crossing gates, stairways for crane operators, means for safely repairing electric overhead cranes, and numerous other improvements in the conditions of industrial works that reduce the hazard of life and limb.

American Society of Swedish Engineers, 271 Hick St., Brooklyn, N. Y., has arranged a program for two lectures a month during March, April and May. At the March 2 meeting Mr. A. L. Valentine, of the Pratt & Whitney Co., Hartford, Conn., will speak on "Comparison between Industrial Conditions in the United States and Europe"; on March 16, Mr. H. L. Gantt, consulting engineer, New York City, will speak on "Scientific Management"; and on April 20, Mr. Ralph E. Flanders, of the Fellows Gear Shaper Co., Springfield, Vt., will speak on "The Larger View of Scientific Management."

Society of Automobile Engineers held its annual convention in New York beginning January 8 and concluding January 20. The membership has continued to increase during the past year. In June, 1910, the society had 310 members, in January, 1911, 614 and in January, 1912, 1200. The technical work carried on by the society is of great general value to the industry, comprising a wide range of subjects, all having directly to do with the design and construction of automobiles and auto-trucks. The following technical papers were contributed: "Motor and Transmission for Commercial Cars," by Eugene P. Batzell; "Silent Chains," by Chester S. Ricker; "Second Report of the Sheet Metals Division of the Standards Committee"; "Starters for Gas Engines," by J. W. Fitzgerald; "Second Report of Springs Division of the Standards Committee"; "Proportional Elastic Limit and Elastic Limit," by Henry Hess; "Efficiency of Compound Gas Engines," by Eugene P. Batzell; "Automatic Spark Control," by Lon R. Smith; "Balance of Automobile Motors," by Ernest R. Fried; "Increasing the Utility of Commercial Cars by Auxiliary Loading and Unloading Devices," by Edward W. Curtis, Jr.; "Wire vs. Wood Wheels," by Bert Morley; "The Importance of the Consideration of the Magneto in Relation to Engine Design," by F. E. Moskovics; "Worm and Gear as the Ultimate Drive Applied to Heavy Power Vehicles," by Ralph H. Rosenberg; "Comments on Metal Gages," by T. V. Buckwalter; "Details and Peculiarities of Design of Foreign Cars," by Wm. Guy Wall; "Wood Artillery Automobile Wheels," by C. B. Hayes.

National Metal Trades Association has appointed a safety inspector in accordance with the spirit of the following resolution which was adopted by the association's committee on systematic compensation for industrial accidents: Whereas, the question of systematic compensation for industrial accidents is receiving wide attention in this country; and whereas, the matter of the prevention of such accidents is of the first importance and demands the greatest consideration by all employers: be it resolved that this convention of the National Metal Trades Association recommends to its administrative council the consideration of a plan for the inspection of the shops of its members, which plan will furnish to the members themselves an opportunity of judging the comparative state of their own equipment and system for the preservation of human life, and will show to the association what progress, if any, may be made from time to time in the furnishing of adequate safety devices; and be it further resolved that the administrative council be authorized to appropriate the funds to a reasonable amount to make such inspection, if upon their investigation the plan appears feasible. Robert Wuest, commissioner, New England Bldg., Cleveland, Ohio.

Franklin Institute Alumni Association, organized by graduates of the School of Mechanic Arts of the Franklin Institute, is desirous of obtaining the addresses of all graduates and former students in this country and elsewhere. The school was established in 1824, and has been conducted continuously since that time, graduating each year a number of students, some of whom have taken an important part in the industrial activities of the country. The records on file at the institute are incomplete, in that they do not contain the present addresses of many former students, and it is therefore impossible to reach a great number of them. The association was formed for the purpose of promoting closer relations among the graduates, and by cooperation to further, if possible, the professional interests of each member. The officers recently elected are anxious to get into communication with the many graduates of the school who are scattered throughout the country with a view of presenting to them the objects of the association and the advantages of membership. Former graduates or those who may have any information relating to them are requested to communicate with the secretary of the association, Mr. Charles E. Hubsch, who can be addressed care of the Franklin Institute, Philadelphia.

NEW BOOKS AND PAMPHLETS

The Essentials of Soil Fertility. By Alva Agee. 61 pages, 3½ by 5¼ inches. Published by the Pennsylvania Railroad Co., Philadelphia, Pa.

Fertility and Fertilizer Hints. By James Edward Halligan. 155 pages, 6 by 9 inches. Published by the Chemical Publishing Co., Easton, Pa. Price, $1.25.

Tests of a Suction Gas Producer. By C. M. Garland and A. P. Kratz. 91 pages, 6 by 9 inches. 33 illustrations. Published by the University of Illinois, Urbana, Ill.

A Brief Laboratory Guide for Qualitative Analysis. By Arthur E. Hill. 80 pages, 5 by 7 inches. Published by the Chemical Publishing Co., Easton, Pa. Price, $1.00.

Publications of the Bureau of Standards, containing a list of all the publications issued by this Bureau. 43 pages, 7 by 10 inches. Published by the Department of Commerce and Labor, Washington, D. C.

Proceedings of the Nineteenth Annual Convention of the International Railroad Master Blacksmiths' Association. 251 pages, 6 by 9 inches. Published by the Association, A. L. Woodworth, secretary, Lima, O.

Report of the Apprenticeship Committee to the Annual Convention of the National Metal Trades Association. 16 pages, 6 by 9 inches. Published by the National Metal Trades Association, Robert Wuest, commissioner, 605 New England Building, Cleveland, O.

Dictionary of English and Spanish Technical and Commercial Terms. By William Jackson. 164 pages, 4 by 6¾ inches. Published by Spon & Chamberlain, New York. Price $1.00.

In this work the compiler has endeavored to present a comprehensive list of the expressions used in the iron, steel, hardware and machinery business, for the use of those who are engaged either in a commercial or engineering capacity in the trade with the Spanish-speaking countries of Central and South America.

Portland Cement. By Richard K. Meade. 512 pages, 6 by 9 inches. 169 illustrations, 53 tables. Published by the Chemical Publishing Co., Easton, Pa. Price, $4.50.

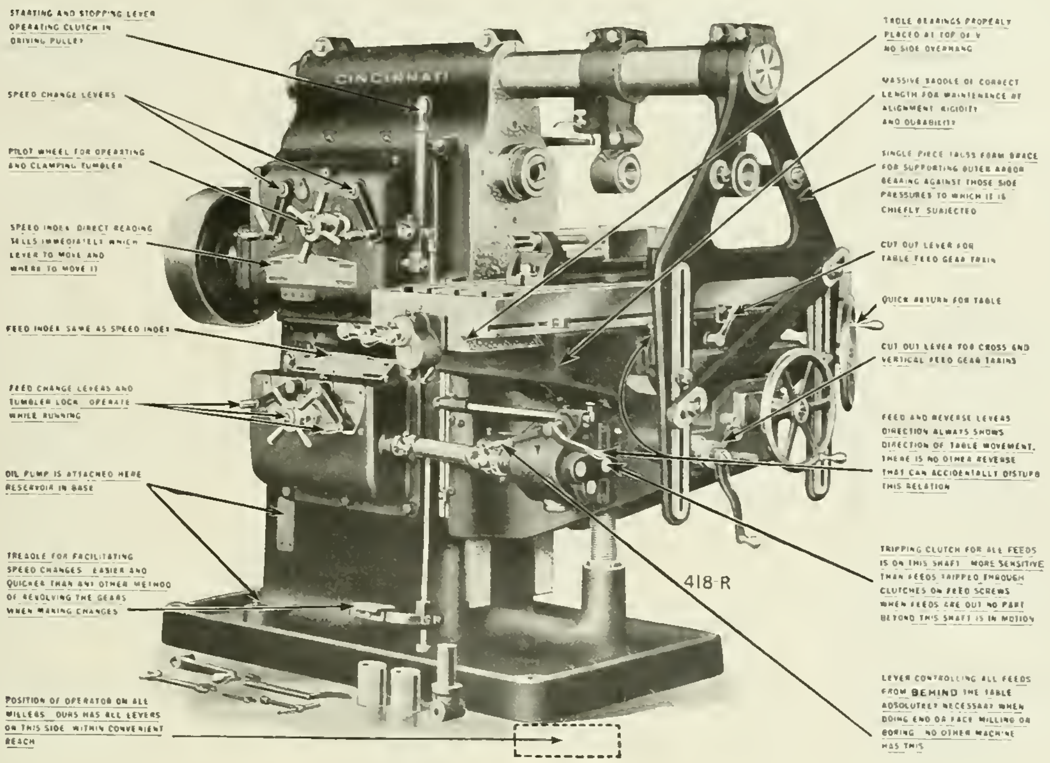
This treatise is the second edition of a work on Portland cement prepared to meet the requirements of both the chemist and engineer. The new edition has been entirely revised and much new matter has been added, particularly on the manufacture of cement. Descriptions of new appliances are included so that the work represents fairly well the present state of the industry in this country.

Official Report of the Tenth Annual Convention of the National Machine Tool Builders' Association. 154 pages, 6 by 9 inches. Published by the Association, Charles E. Hildreth, Whitcomb-Blaisdell Machine Tool Co., Worcester, Mass., secretary.

This report contains the proceedings and the papers read before the association at its convention in New York City, October 10-11, 1911. Besides the president's, secretary's and treasurer's reports, the following papers are included: Task Work—the Basis of Proper Management, by H. L. Gantt; Shop Hygiene as a Factor in Efficiency, by Winthrop Talbot; Standardization of Machine Tools for the Benefit of the User, by L. P. Alford. The reports of the various committees of the association, presented to the meeting, are also included.

A Short Course in Graphic Statics. William Ledyard Cathcart and J. Irvin Chaffee. 183 pages, 5 by 7½ inches. 58 illustrations. Published by D. Van Nostrand Co., New York. Price $1.50.

The purpose of this book has been to provide students of mechanical engineering with a brief course in graphic statics. Owing to the necessary limitations as to space thus imposed, the treatment has been restricted mainly to such matter as seems especially necessary for the solution of the problems met with in practice by mechanical engineers. The discussion of principles, as given in this book, is largely a summary of similar portions of the authors' treatise, "The


STARTING AND STOPPING LEVER OPERATING CLUTCH IN DRIVING PULLEY
SPEED CHANGE LEVERS
PILOT WHEEL FOR OPERATING AND CLAMPING TUMBLER
SPEED INDEX DIRECT READING TELLS IMMEDIATELY WHICH LEVER TO MOVE AND WHERE TO MOVE IT
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MASSIVE SADDLE OF CORRECT LENGTH FOR MAINTENANCE OF ALIGNMENT RIGIDITY AND DURABILITY
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FEED AND REVERSE LEVERS DIRECTION ALWAYS SHOWS DIRECTION OF TABLE MOVEMENT. THERE IS NO OTHER REVERSE THAT CAN ACCIDENTALLY DISTURB THIS RELATION
TRIPPING CLUTCH FOR ALL FEEDS IS ON THIS SHAFT MORE SENSITIVE THAN FEEDS TRIPPED THROUGH CLUTCHES ON FEED SCREWS WHEN FEEDS ARE OUT NO PART BEYOND THIS SHAFT IS IN MOTION
LEVER CONTROLLING ALL FEEDS FROM BEHIND THE TABLE ABSOLUTELY NECESSARY WHEN DOING END OR FACE MILLING OR BORING NO OTHER MACHINE HAS THIS

THE combination of the operator and his machine forms a production unit. The efficiency of that unit depends largely upon the handiness of the machine. On most jobs, the operating time is longer than the cutting time. The handiness of Cincinnati Millers reduces the operating time. This feature is as important as heavy cutting capacity. That is why we have given it special attention in all our designs and have developed handiness farther than any of our competitors.

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Elements of Graphic Statics." A number of problems are given at the end of the book which will be found useful whether the book is used as a text-book in an engineering school or by the individual student of this subject. The book contains six chapters as follows: Force and Equilibrium Polygons; Trusses—Stress Diagrams: Stationary Loads—Shears and Moments; Live Loads—Shears and Moments; Center of Gravity—Moment of Inertia; Friction.

Works Management. By William Duane Ennis. 194 pages, 6 by 9 inches. Numerous tables and diagrams. Published by the McGraw-Hill Book Co., New York. Price $2.00.

In the preface of this book the author, who is professor of mechanical engineering at the Polytechnic Institute of Brooklyn, states that the book is not (other than incidentally) a presentation of Taylor's system of scientific management, although the casual reader would have this impression from its title and the present trend of writers on subjects of this kind. The reason for not dealing specifically with the Taylor system is that, while the author highly admires Mr. Taylor, in his opinion the Taylor system of shop management deals largely with mechanical method rather than with management proper, and the Taylor plan of management is, therefore, not a universal plan; hence, it seemed to the author of this book that a presentation of some of the underlying principles of factory administration would be profitable, and he has endeavored to be specific as to some of the principles on which are based the methods of what seems to him good management. The book contains chapters on Management Units; Cost Elements and Classifications; Statistical Records; Labor; Material; Expense Burden; Depreciation; Industrial Organization; Principles of Accounting; and on The Industrial Plant—the Physical Basis of Industry. At the end of the book a number of problems, mostly numerical, have been incorporated, which are intended for use when the book is employed for class-room instruction, in order to emphasize the principles presented.

Valves, Valve Gears and Valve Diagrams. By Franklin DeR. Furman. 130 pages, 8 by 10 inches. 152 illustrations. Published by the author, Stevens Institute of Technology, Hoboken, N. J. Price, $3.75.

The material in this book, aside from the drafting-room problems, has been arranged for class-room work, but is based upon the methods in which the work in the design of valves and valve gears is carried out in actual practice. The author, in his capacity of professor of mechanics and machine design at Stevens Institute of Technology, has arranged the material in such a way as would best fit in with a general course of mechanical engineering at Stevens Institute. Some features that have been original in their conception, have been introduced. Principal among these features may be mentioned the introduction of numbers for marking the order of the drawing of lines in the construction of valve diagrams in the early exercises; the formula for determining exactly the steam lap by the Zeuner diagram; the combining of the valve ellipse with the steam engine indicator card; the method of determining the proper width of cut-off blocks for the Meyer valve; and the Corliss valve-gear design, etc. The book is divided into five sections of which the first deals with simple steam engines, the second with valve diagrams, the third with types of valves, the fourth with eccentrics and shaft governors, and the fifth with valve gears. Typographically, the width of the printed page, the lines being six inches long, is objectionable, as it makes the book difficult to read. If, on account of the illustrations, a large size page was deemed advisable, a double-column arrangement of the printed matter would have been preferable for the convenience of the reader.

Foundry Practice. By R. H. Palmer. 332 pages, 5¼ by 8¼ inches. 154 illustrations. Published by John Wiley & Sons, New York. Price $2.00.

This book is written by a man who has had not only the practical experience so necessary to write an authoritative work on foundry practice, but who has also for some time been instructor in foundry practice at the Worcester Polytechnic Institute, and thereby acquired the necessary experience in putting his knowledge in such forms as to be most easily comprehended by others, to whom he wishes to impart it. The book is intended as a reference and hand-book for molders, students and apprentices, and was written especially to meet the demand for a suitable text-book on this subject, the lack of which proved a handicap to the author while engaged as instructor at the Worcester Polytechnic Institute. The book begins with a description of the simplest type of mold and leads the student gradually through the more difficult kinds of work in green and dry sand and loam. The contents and scope of the book can be best understood from a review of the chapter heads which are as follows: The Mold—Its Form and the Methods of Making It; Irregularly Shaped Patterns; Floor Molding; Light Crane Floor Work; Bedding Patterns in the Foundry Floor; Molding Columns; Molding with Sweeps; Molding Car-wheels; Skin-dried Molds; Dry-sand Molds; Loam Molding; Molds for Steel Castings; Dry-sand Cores; Setting Cores and Using Chaplets; Gates and Gating; Risers, Shrinkheads and Feeding Heads; Treatment of Castings While Cooling; Cleaning Castings; Molding Machines; Mending Broken Castings; Molding Tools; Molding Sands; Iron and Its Composition; The Cupola and Its Operation; The Air Furnace and Its Operation; The Brass Foundry; Foundry Equipment.

The Walschaerts and Other Modern Radial Valve Gears for Locomotives. By W. W. Wood. 245 pages, 5 by 7½ inches. 50 illustrations and 5 folding plates. Published by Norman W. Henley & Son, New York. Price $1.50.

This book, now in its third revised and enlarged edition, contains, in the first place, a practical treatise on the locomotive valve gear invented by Walschaerts. The book contains the same matter relating to this valve gear as the previous edition; but, as during the last few years the development of other styles of radial valve gears has been considerably stimulated by the adoption of the Walschaerts valve motion, practically to the exclusion of the old link motion on nearly every railroad in America, two of the most successful of the other types of radial valve gears have also been fully described in the present edition. Questions and answers explaining the proper method of procedure in cases of breakdowns of either style of gear, while on the road have been included. The author says in his preface that the question as to how the Walschaerts gear may be "set" is asked so often that it has been deemed advisable to fully answer it in this edition. The contents of the book are divided into five parts, of which the first contains an analysis of the Walschaerts valve gear; the second, a treatise on the designing and erecting of the valve gear; the third, a review of the advantages of this gear; and the fourth, a series of questions and answers relating to the Walschaerts valve gear. The fifth division deals with several subjects, such as the setting of valves with the Walschaerts gear, the Hobart-Allfree valve and valve gear, and the Baker-Pilliod valve gear in its original and improved form. A discussion of the three primary types of locomotive valve motions is also included in this division.

The Steam Engine and Turbine. By Robert C. H. Heck. 631 pages, 6 by 9 inches. 402 engravings. Published by D. Van Nostrand Co., New York. Price $5.00.

The author of this book, who is professor of mechanical engineering at Rutgers College, has intended it primarily as a text-book for engineering colleges, and throughout the preparation of the book its purpose as a guide in the class-room has been kept in mind. Hence the book deals more with the theory of the steam engine than with purely practical consideration, although some attention is also given to illustrating and describing conventional designs of engine details. The book is in no sense elementary, and it is assumed that the student approaches the subject with at least a general knowledge of the working of a steam plant and with a good preparation in the elements of physics and mechanics. An excess of algebraical mathematics has, however, been avoided, preference having been given to graphical methods. Many numerical examples have been included to illustrate the principles explained. A new steam table is presented, differing slightly from that of Marks and Davis, but founded on the same experimental data. While both engines and turbines are dealt with, the former receive much the larger share of the space, although the difference is less than may appear, since several of the chapters in the first part of the book apply to both. The scope and contents of the book will be best appreciated by a list of the chapter heads, which are as follows: A General View of the Subject; Elementary Theory of the Heat Engine; Properties and Behavior of Steam; Ideal Steam Cycles; Action of the Steam in the Engine; Performance and Efficiency of the Engine; Working and Construction of the Engine; Valve Gears and Governors; Action of the Steam in the Turbine; Design and Construction of the Turbine; and Sundry Steam Appliances.

The Gasoline Automobile. Vol. I. The Gasoline Motor. By P. M. Heldt. 506 pages, 5½ by 8½ inches. 314 illustrations. Published by the Horseless Age Co., New York. Price $4.00.

The author of this book, who is editor of the *Horseless Age*, has in this treatise presented a comprehensive work of considerable value to the automobile trade. The matter contained was originally published serially in the *Horseless Age*. Although the automobile industry has developed during the last few years so that it now is one of the leading industries of the country, no books treating comprehensively on automobile design have been published. The books that so far have appeared on this subject have been limited in their scope, and do not fully fill the requirements of the designer and engineer. The author states in the preface that the need for a comprehensive work on the subject has often been strongly impressed upon him from the fact that he himself has frequently been asked to recommend a book of this nature, and being unable to do so, he resolved to make an attempt to supply this deficiency in automobile literature. It is proposed to cover the subject in two volumes. The first volume, here reviewed, deals with gasoline motors, and the second, not yet published, will treat of the running gear and the transmission. Ignition appliances, carbureters and radiators are not dealt with, because these accessories are rarely designed in the automobile factory. Mathematical treatment has been avoided where not entirely necessary. In cases where it has been necessary to give the mathematical analysis, the treatment has been made as clear as possible, and the application of formulas derived have been illustrated by practical examples in most instances. A special folder accompanying the book contains a considerable number of large plates showing sectional views of modern American and European motors of different types. The following list of chapter heads will give an idea of the contents of the book. The Working Media—Gasoline and Air; The Laws of Gases—Thermodynamics; The Otto Cycle; Conversion of Reciprocating Into Rotary Motion; Balancing of the Engines; The Cylinder; Piston, Piston Rings and Piston Pin; Offset Cylinders; The Crankshaft; The Connecting-rod; Valves and Valve Gears; Cam-shaft and Accessories Drives; Crank-case and Oiling System; Starting Crank, Manifolds and Muffler; The Flywheel; Speed Control—The Governor; Power Output and Other Characteristics; Sleeve; Piston and Rotary Valve Motors; Air Cooling; The Two-Stroke Cycle Motor; and Motor Tests.

CATALOGUES AND CIRCULARS

Nappanee Iron Works, Nappanee, Ind. Circular of the Victor combined punches and shears.

Locomotive Equipment Co., Detroit, Mich. Catalogue No. J-1 of bearings for locomotives and cars.

Page Storms Drop Forge Co., Chicopee, Mass. Leaflet illustrating the "Gem" all steel screw driver.

Webster Mfg Co., Tiffin, Ohio. Circular illustrating and describing the Webster coal handling system.

American Blower Co., Detroit, Mich. Bulletin No. 306 descriptive of the "Vento" cast-iron hot-blast heater.

Robbins Conveying Belt Co., Park Row, New York. Bulletin No. 47 illustrating installations of belt conveying apparatus.

Sterling Electric Co., 9 S. Fifth St., Minneapolis, Minn. Catalogue No. 12 of automobile ignition and lighting equipment, and aeronautic supplies.

Simonds Mfg. Co., Fitchburg, Mass. "Simonds Guide for Millmen," No. 2. An imaginative trip through the company's new steel mill at Lockport, N. Y., graphically set forth.

Industrial Instrument Co., Foxboro, Mass. Bulletin No. 58 illustrating and describing the "Industrial" dial type indicating thermometers, and the "Industrial" improved thermometers.

Sprague Electric Works of General Electric Co., 527 West 34th St., New York. Bulletin No. 239 describing full automatic push button control systems for the operation of newspaper presses.

Bosch Magneto Co., 223 W. 46th St., New York. Circular of Bosch products including magnetos for motor cars, motorcycles, motor trucks, motor boats, stationary engines, the Bosch oiler and spark plugs.

H. W. Johns Manville Co., 100 William St., New York. Catalogue No. 112, J. M. sectional conduit for insulating pipes conveying steam, water, gas or liquids underground, giving plans of some of the most important installations.

Hyatt Roller Bearing Co., Newark, N. J. Mailing card illustrating Hyatt flexible roller bearing wheels under a quarry truck which was buried beneath 15 tons of rock. The bearings withstood the shock without suffering material injury.

Vanadium Sales Co., of America, Frick Bldg., Pittsburg, Pa. *American Vanadium Facts*, a monthly publication describing, in the January number, the position of vital importance occupied by vanadium in modern automobile construction.

Richardson-Phenix Co., Hudson Terminal Bldg., New York. Circular illustrating the Richardson-Phenix lubricating system adapted to small power plants. All the various pipes, receivers, filters, pumps, etc., can be located on or close to the engine.

Dooley Smith & Co., 133-137 Front St., New York, importers and exporters, are sending out a pamphlet of information regarding the resources of the island of Porto Rico, of interest to the manufacturers, capitalists and farmers of the United States.

J. Faessler Mfg. Co., Moberly, Mo. Folder illustrating Faessler roller and sectional tube expanders, and flue cutting machines. The flue cutting machines are for cutting out the flues of locomotive boilers, and they have a record of 300 flues cut per hour.

Bourne-Fuller Co., Cleveland, Ohio. Booklet entitled, "Tool Steel and Its Uses," containing complete catalogue of Scott's tool steels with tables of approximate weights, decimal equivalents, etc.; also practical suggestions regarding the treatment of tool steels.

Blaugas Co. of America, 381 Fourth Ave., New York. Circular of Blaugas apparatus for isolated lighting plants and other situations requiring gas for illumination, heating, brazing, welding, or any other purpose to which ordinary illuminating gas is commonly put.

The first BORING, DRILLING AND MILLING MACHINE we ever made was named the

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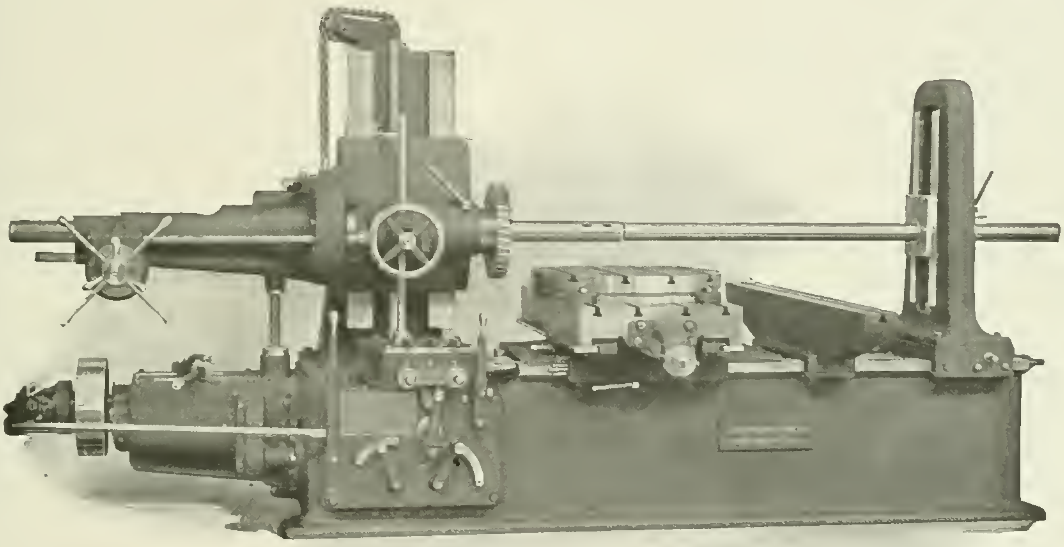

a commercial machine in the present state of the art. "ASK THE MAN WHO HAS ONE" if this is not true; or, better yet, ask the man who has several. We will be satisfied to abide by the decision of the USERS.

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AGENTS—C. W. Burton, Griffiths & Co., London Alfred H. Schutte, Cologne, Berlin, Brussels, Paris, Milan, Barcelona, Bilbao. Donauwerk Ernst Krause & Co., Vienna, Budapest. Prague. Overall, McCray, Ltd., Sydney, Australia. Andrews & George, Yokohama, Japan. Williams & Wilson, Montreal, Canada.

Fowden Gasoline and Electric Rock Drill Co., 1321-23 Real Estate Trust Bldg., Philadelphia, Pa. Catalogue of Fowden gasoline and electric rock drills, illustrating and describing a rock drill that can be operated by an electric motor, gasoline engine, or other motors.

Electro-Dynamic Co., Bayonne, N. J. Data sheets, Nos. 1 and 2, giving wiring diagrams for shunt-wound adjustable, interpole motor with Cutler-Hammer Bulletin No. 24 on 25 controller, clockwise rotation facing commutator end, and counter-clockwise rotation, facing commutator end.

Harvey Hubbell, Inc., Bridgeport, Conn. Catalogue No. 14 of "Hubbell" electrical specialties comprising lamp sockets reflectors, shade holders, lamp guards, pull switches, adapters, socket bushings, candelabra sockets, outlet box adapters, and other interior electric lighting equipment.

Buffalo Forge Co., Buffalo, N. Y. Catalogue No. 199 on "Buffalo" conoidal blowers and exhausters. These exhausters are so designed that the direction of the air current is gradually changed, thus avoiding large losses due to eddies and frictional resistance common to the usual type of exhauster.

Nappanee Iron Works, Nappanee, Ind. Catalogue "A" illustrating and describing a portable cylinder boring bar designed by J. W. Rosburgh. These bars are made for boring engine cylinders, etc., and are constructed in six sizes, the diameter of the boring bar ranging from 2 to 4½ inches inclusive.

General Electric Co., Schenectady, N. Y. Bulletins No. 4912, on General Electric ozonators; No. 4895, on electric fans; No. 4897, on G-E Edison "Mazda" lamps for standard train lighting service; No. 4902, on direct-current switchboards; and No. 4908, on the lighting of hotels, cafes and clubs.

Hamilton-Beach Mfg. Co., Racine, Wis. Circular of the Hamilton-Beach portable electric grinder for grinding dies, reamers, cutters, etc. The circular illustrates the use of the grinder on the milling machine, sharpening cutters in position; on the shaper, grinding dies; and on the lathes, grinding dies.

Grand Rapids Public Library, Grand Rapids, Mich. Bulletin containing a section on vocational guidance with an outline of a course of study in the Central High School and a selected line of books for teachers and pupils. The bulletin will be found of general interest to those concerned in vocational education.

Cleveland Hardware Co., Cleveland, Ohio. Catalogue supplement of drop-forge geared blanks, comprising bevel pinions, spur pinions, bevel gears, spur gears, and sprockets of various style and sizes. The catalogue concludes with tables of useful data on the elements of bevel and spur gearing of value to the drafting-room and shop.

Hyatt Roller Bearing Co., Newark, N. J., is sending out cards giving striking examples of the various uses of Hyatt flexible roller bearings. One of these shows a huge bottle sign, 20 feet in diameter, 50 feet high and weighing 17 tons on the top of a high tower, revolving at a speed of 107 feet per minute upon Hyatt flexible roller bearings.

Chicago Pneumatic Tool Co., Fisher Bldg., Chicago, and 50 Church St., New York. Bulletins No. 34 A, Class "G" steam-driven compressors; No. 34 C, tandem gasoline-driven compressors; No. 34 E, railroad type duplex steam-driven compressors; No. 34 H, general instructions for installing and operating "Chicago" pneumatic compressors.

Ingersoll-Rand Co. 11 Broadway, New York. Twelve-page 6 by 9 pamphlet of the "MC-22" telescope feed hammer drill. This drill is of the valveless type in which the piston itself performs the valve functions by covering or uncovering the ports which control its forward and back movement. This drill is intended for stoping, raising and to a limited extent, drifting.

Safety Air-Brake Hose-Coupler Co., 21 N. Third St., Harrisburg, Pa. Circular illustrating and describing the advantages of a new safety air-brake hose-coupler which permits trainmen to couple and uncouple air-brake hose without going between the cars. The value of these simple and easily used tools in saving human lives and limbs, can hardly be over-estimated.

Reliance Electric & Engineering Co., 1056 Ivanhoe Rd., Cleveland, Ohio. Bulletin No. 7010 on automatic starting control for motor-driven machinery. The bulletin is illustrated with views of motor-driven machine tools provided with automatic starting control which in connection with the descriptive matter will make the bulletin of general interest to machine tool builders, users and operators.

Schumacher & Boye, Cincinnati, Ohio. Circular of Schumacher & Boye double-back-geared engine lathe with variable-speed motor drive. The motor is mounted on the headstock, and the controller, which is on the back of the bed, is operated by a handle on the right-hand end of the carriage. The lathe is furnished with wires carried in flexible tube conduits, and all the electrical apparatus is fitted and wired ready for use.

Hydraulic Sales Co., 1777 Broadway, New York. Matter descriptive of the LaFrance-Manly hydraulic transmission auto-truck for commercial purposes. The hydraulic principle eliminates change gears, clutches, differential gears, service brake, jack shaft, clutch pedal, gear changing levers, etc., incident to the gear drive. The system gives speed variations from zero to the maximum by small increments.

Hess-Bright Mfg. Co., 2111 Fairmount Ave., Philadelphia, Pa. Numerical index to data sheets Nos. 1 A to 86, inclusive. These sheets give practical information upon ball bearings and their correct use, taking up a great number of the various ball-bearing mountings in more or less common use; also folder describing a special ball bearing grease and showing the effect of poor greases upon the surface of balls.

National Tube Co., Pittsburg, Pa. N. T. C. Bulletin No. 5 entitled "Steel Pipe vs. Wrought Iron Pipe in Refrigerating Work." The bulletin takes up the manufacture of wrought iron; manufacture of soft steel; properties of the different materials; pipe welding; corrosion resisting qualities; etc. Also N. T. C. bulletin No. 7 on the National Tube Co.'s regrinding valve. The construction of the valve is shown with line cuts and colored drawings, and data on lifts, sizes, disks, etc., are included.

Cleveland Twist Drill Co., Cleveland, Ohio. Folder No. 32 illustrating the "Paragon Flatwist" drills, and the "Paragon" sleeves, center collet and driving collet; also the Cleveland high-speed taper shank drills. The folder also reproduces the account of the remarkable tests made with Cleveland "Flatwist" drills at the American Railway Master Mechanics' and Master Car Builders' Associations' joint convention at Atlantic City, June 14-21, which was published in the August, 1911, number of Machinery.

Springfield Mfg. Co., Bridgeport, Conn. Catalogue of grinding machines and wheels. Wheels for all classes of service are listed, following which are the illustrations and descriptions of grinding machines, comprising the Springfield-Brandes vertical grinding planer; automatic planer surface grinders in four sizes; automatic oscillating planer surface grinders in four sizes; vertical and horizontal oscillating surface grinders; car-wheel grinders; automatic knife grinders; heavy paper and veneer knife grinders; face and variety grinders; guide bar and variety grinders; tool grinders; swing frame grinders; buffing lathes; roll grinders; special grinders; ring-wheel grinders; etc.

Ideal Case Hardening Compound Co., 1919 Broadway, New York. Treatise on casehardening, pack-hardening and annealing of steel with the "Ideal" casehardening compound. The compound is economical and non-poisonous, and is adapted for casehardening steel articles of every size and shape including battleship armor, armor vault plates, roller and ball bearings, gears, hubs, bushings, shafts, universal joints and a great multitude of machine parts that can be effectively treated by the casehardening process. The divisions of the book are: "Ideal Casehardening Compound"; "Points Worth Remembering"; "Casehardening Carbon Steels"; "Pack-Hardening"; "Annealing"; "Various Applications of Casehardening," etc. The book is sent free to any address.

General Fire Extinguisher Co., 1 Liberty St., New York. Bulletin on the "Grinnell" automatic sprinkler system for shops, mills, factories, offices, stores, institutions, and all large structures containing inflammable materials. The importance of the sprinkler system as the means for reducing fire hazard to a minimum, is becoming more and more generally appreciated as its efficiency is shown. The tremendous fire loss sustained in the United States alone every year is awakening business men generally to the need of providing apparatus that will automatically extinguish flames before they have gained headway. The bulletin illustrates buildings in which the sprinkler system is installed, and contains many testimonials from concerns whose plants are thus protected.

Betts Machine Co., Wilmington, Del. Catalogue No. 24 on vertical boring and turning mills. The catalogue deals with the 5-foot, 6-foot and 7-foot Betts boring mills with worm or spur drive; 5-foot, 6-foot and 7-foot boring mills, extra heavy, with spur drive; 90-inch boring mill, special design, spur drive; 8-foot mill, spur drive; 8-foot mill, extra heavy, double drive; 10-foot mill, spur drive, standard pattern A; 10-foot mill, spur drive, standard pattern B; 10-foot mill, extra heavy, spur drive; 10-foot mill, double drive; 12-foot mill, spur drive; 12-foot mill, extra heavy, spur drive; 12-foot mill, extra heavy, double drive; 14-foot mill, spur drive; 14-foot mill, extra heavy, spur drive; 16-foot, spur drive; 20-foot, spur drive; 20-foot, extra heavy, double drive; also 7 10-foot extension boring mill, spur drive; 10—16-foot extension mill, spur drive; 12—18-foot extension mill, spur drive; 14—20-foot extension mill, spur drive.

Heald Machine Co., 20 New Bond St., Worcester, Mass. Catalogue of Heald grinding machines, 115 pages, 6 by 9 inches, 96 illustrations. This is a complete catalogue of internal grinding machines, giving detailed information of the design and construction. A valuable part of the catalogue is entitled "Suggestions in Grinding," which division occupies fourteen pages of directions and advice to the user of grinding machines, and contains sixteen clearly made line engravings to illustrate the text. The Heald cylinder grinding machine is also described in detail, and directions are given for its use. Another section of the catalogue is devoted to the Heald ring and surface grinding machine, and still another to the American drill grinding machine. In this latter section very thorough instructions are given on drill grinding. The catalogue also shows the works of the Heald Machine Co., with the new addition, covering, in all, a floor space of over 50,000 square feet.

TRADE NOTES

J. W. Wright & Co., dealer in machine tools and accessories, is now located at 1221-1223 North Broadway, St. Louis, Mo.

Henry & Wright Mfg. Co., Hartford, Conn., has purchased the Parker Motor Co.'s plant in Hartford with the view of using it for the manufacture of the Henry & Wright drilling machines

A. J. Smart Mfg. Co., Greenfield, Mass., has just moved into a new three-story brick building having floors 40 by 250 feet. The new building enlarges the company's floor space to four times the former capacity.

Superior Machine Tool Co., Kokomo, Ind., manufacturer of upright drilling machines, has recently added improvements to its shop equipment. The company will erect another large wing to the shop early in the coming spring. Business conditions are reported to be good.

Baird Machine Co., formerly of Oakville, Conn., opened its new factory in Stratford, just over the Bridgeport city line, January 1, which will employ about 200 men at the start. The company manufactures automatic wire bending machines, and builds special machinery to order.

Joseph T. Ryerson & Son, Chicago, Ill., have removed their Minneapolis, Minn., district offices under Mr. Wm. H. Sherwin to larger and more commodious quarters at 501 Third St., South, Minneapolis. The larger quarters will give better facilities for the display and demonstration of the various lines of iron and steel, machine tools, metal-working machinery and specialties.

Taft-Peirce Mfg. Co., Woonsocket, R. I., has opened an office in Chicago at 1038 National Life Bldg., in charge of Mr. A. H. Mitchel. The Chicago office will enable the company to better serve its customers in the Middle West in connection with the manufacture of light high-grade machinery, the redesigning of machines for economical manufacture, and the designing and construction of special tools and machinery.

Dayton Pneumatic Tool Co., Dayton, Ohio, entertained its employes with a banquet and smoker on the evening of December 27. A general discussion followed the banquet, preceded by remarks by the officers, on the future business outlook and methods best adapted for turning out the company's product in the most efficient manner. It is the intention of the company to make the banquet and smoker an annual event.

Joseph T. Ryerson & Son, Chicago, Ill., have opened a district office under Messrs. R. J. Stayman and J. H. Marlotte at 828 Ford Bldg., Detroit, Mich. Mr. Marlotte will act as special representative for machine tools, fabricating equipment, railroad shop machinery, high-speed drills and other tools. The office will facilitate the Ryerson service in the Detroit district on the standard lines of bar, plate, and structural products, and the complete line of rolled steel products.

American Engineering Co., Philadelphia, Pa., is a consolidation of Williamson Bros. Co., of Philadelphia, and the American Ship Windlass Co., of Providence, R. I. The first steps in this consolidation were taken in 1906 when the Williamson Bros. Co. purchased control of the American Ship Windlass Co., with the intention of gradually combining the two concerns into the line of marine production. The American Ship Windlass Co. was founded about fifty-three years ago, and Williamson Bros. Co. about forty-five years ago.

Watson-Stillman Co., 192 Fulton St., New York, manufacturer of hydraulic machines with plant at Aldine, N. J., has been reorganized. The increasing use of hydraulic presses and the steady growth of the business necessitated an immediate extension of the company's facilities. To take care of the increasing scope it was considered advisable to reorganize the board of directors. The new officers elected are: Francis H. Stillman, president (re-elected); F. A. Stillman, vice-president; J. P. Bird, treasurer; A. F. Stillman, secretary and works manager; and Carl Wigtel, chief engineer.

H. W. Johns-Manville Co., 100 William St., New York, has changed the location of its offices in Louisville, Ky., removing them from the Lincoln Bank Bldg., to 205 Paul Jones Bldg. The new and more spacious quarters are much better adapted to the company's requirements. The offices will be in charge of Mr. J. R. Chowning, who is well and favorably known throughout that section, having traveled through it from the Milwaukee office for considerable time. A com-

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MILLING AXIAL TEETH IN CUTTER AND REAMER BLANKS—I

Angle of Fluting Cutter in Degrees	Width of Land, Radius = 1	Number of Teeth to be Cut	Depth of Cut, Radius = 1	Number of Teeth to be Cut	Depth of Cut, Radius = 1	Number of Teeth to be Cut	Depth of Cut, Radius = 1	Number of Teeth to be Cut	Depth of Cut, Radius = 1	Number of Teeth to be Cut	Depth of Cut, Radius = 1
50	0.020	6	......	8	0.8604	10	0.6601	12	0.5310	14	0.4400
	0.040		......		0.8346		0.6351		0.5057		0.4155
	0.060		......		0.8088		0.6101		0.4808		0.3917
	0.080		......		0.7829		0.5851		0.4568		0.3690
	0.100		......		0.7571		0.5601		0.4330		0.3460
	0.120		......		0.7313		0.5351		0.1102		0.3238
55	0.020	6	......	8	0.7640	10	0.5805	12	0.4634	14	0.3820
	0.040		......		0.7403		0.5570		0.4415		0.3603
	0.060		......		0.7167		0.5342		0.4195		0.3385
	0.080		......		0.6928		0.5116		0.3981		0.3141
	0.100		0.9843		0.6691		0.4893		0.3767		0.2900
	0.120		0.9596		0.6454		0.4674		0.3554		0.2785
60	0.020	6	0.9774	8	0.6790	10	0.5102	12	0.4042	14	0.3311
	0.040		0.9543		0.6572		0.4893		0.3830		0.3129
	0.060		0.9312		0.6353		0.4685		0.3630		0.2940
	0.080		0.9081		0.6134		0.4479		0.3438		0.2750
	0.100		0.8849		0.5915		0.4276		0.3252		0.2565
	0.120		0.8616		0.5697		0.4076		0.3072		0.2392
65	0.020	6	0.8824	8	0.6020	10	0.4467	12	0.3504	14	0.2850
	0.040		0.8605		0.5819		0.4283		0.3325		0.2671
	0.060		0.8386		0.5617		0.4090		0.3150		0.2507
	0.080		0.8167		0.5415		0.3906		0.2977		0.2350
	0.100		0.7948		0.5213		0.3720		0.2805		0.2195
	0.120		0.7729		0.5012		0.3538		0.2636		0.2035
70	0.020	6	0.7945	8	0.5311	10	0.3875	12	0.3007	14	0.2420
	0.040		0.7738		0.5125		0.3701		0.2847		0.2271
	0.060		0.7530		0.4938		0.3530		0.2689		0.2122
	0.080		0.7322		0.4751		0.3364		0.2534		0.1980
	0.100		0.7114		0.4564		0.3200		0.2383		0.1842
	0.120		0.6907		0.4378		0.3038		0.2234		0.1708
75	0.020	6	0.7125	8	0.4645	10	0.3332	12	0.2543	14	0.2021
	0.040		0.6928		0.4474		0.3174		0.2400		0.1900
	0.060		0.6731		0.4302		0.3020		0.2262		0.1760
	0.080		0.6534		0.4130		0.2868		0.2125		0.1035
	0.100		0.6337		0.3958		0.2718		0.1990		0.1513
	0.120		0.6141		0.3787		0.2569		0.1857		0.1400
80	0.020	6	0.6339	8	0.4010	10	0.2806	12	0.2099	14	0.1640
	0.040		0.6153		0.3852		0.2770		0.1978		0.1533
	0.060		0.5967		0.3694		0.2533		0.1857		0.1426
	0.080		0.5780		0.3536		0.2396		0.1736		0.1319
	0.100		0.5594		0.3378		0.2259		0.1616		0.1211
	0.120		0.5408		0.3221		0.2128		0.1496		0.1104
85	0.020	6	0.5577	8	0.3394	10	0.2297	12	0.1667	14	0.1271
	0.040		0.5395		0.3248		0.2176		0.1563		0.1180
	0.060		0.5222		0.3098		0.2055		0.1459		0.1090
	0.080		0.5043		0.2953		0.1933		0.1355		0.1000
	0.100		0.4868		0.2811		0.1811		0.1251		0.0910
	0.120		0.4697		0.2673		0.1690		0.1148		0.0820

Contributed by George W. Burley

No. 152, Data Sheet, MACHINERY, March 912

MILLING AXIAL TEETH IN CUTTER AND REAMER BLANKS—II

Angle of Fluting Cutter in Degrees	Width of Land, Radius = 1	Number of Teeth to be Cut	Depth of Cut, Radius = 1	Number of Teeth to be Cut	Depth of Cut, Radius = 1	Number of Teeth to be Cut	Depth of Cut, Radius = 1	Number of Teeth to be Cut	Depth of Cut, Radius = 1	Number of Teeth to be Cut	Depth of Cut, Radius = 1
50	0.020	16	0.3735	18	0.3238	20	0.2847	22	0.2550	24	0.2299
	0.040		0.3505		0.3030		0.2645		0.2347		0.2090
	0.060		0.3281		0.2820		0.2435		0.2132		0.1884
	0.080		0.3054		0.2599		0.2220		0.1920		0.1681
	0.100		0.2840		0.2378		0.2011		0.1724		0.1482
	0.120		0.2635		0.2161		0.1806		0.1526		0.1288
55	0.020	16	0.3250	18	0.2785	20	0.2448	22	0.2191	24	0.1955
	0.040		0.3026		0.2600		0.2264		0.2002		0.1780
	0.060		0.2830		0.2420		0.2090		0.1822		0.1609
	0.080		0.2640		0.2219		0.1906		0.1638		0.1439
	0.100		0.2443		0.2030		0.1721		0.1460		0.1262
	0.120		0.2252		0.1853		0.1540		0.1292		0.1084
60	0.020	16	0.2780	18	0.2395	20	0.2099	22	0.1861	24	0.1672
	0.040		0.2602		0.2230		0.1938		0.1700		0.1520
	0.060		0.2428		0.2062		0.1776		0.1542		0.1371
	0.080		0.2256		0.1891		0.1616		0.1883		0.1220
	0.100		0.2090		0.1732		0.1458		0.1238		0.1071
	0.120		0.1928		0.1578		0.1301		0.1091		0.0925
65	0.020	16	0.2380	18	0.2035	20	0.1780	22	0.1580	24	0.1401
	0.040		0.2222		0.1891		0.1635		0.1435		0.1266
	0.060		0.2066		0.1748		0.1491		0.1293		0.1138
	0.080		0.1915		0.1599		0.1354		0.1161		0.1014
	0.100		0.1770		0.1453		0.1220		0.1031		0.0883
	0.120		0.1630		0.1322		0.1088		0.0908		0.0760
70	0.020	16	0.2010	18	0.1715	20	0.1488	22	0.1312	24	0.1165
	0.040		0.1862		0.1585		0.1363		0.1190		0.1049
	0.060		0.1740		0.1462		0.1240		0.1072		0.0938
	0.080		0.1601		0.1335		0.1123		0.0956		0.0830
	0.100		0.1478		0.1210		0.1010		0.0845		0.0704
	0.120		0.1360		0.1095		0.0890		0.0735		0.0579
75	0.020	16	0.1660	18	0.1400	20	0.1200	22	0.1052	24	0.0933
	0.040		0.1542		0.1289		0.1096		0.0950		0.0836
	0.060		0.1427		0.1180		0.0993		0.0850		0.0741
	0.080		0.1313		0.1072		0.0896		0.0757		0.0650
	0.100		0.1200		0.0970		0.0800		0.0667		0.0562
	0.120		0.1092		0.0870		0.0704		0.0580		0.0480
80	0.020	16	0.1322	18	0.1103	20	0.0950	22	0.0815	24	0.0712
	0.040		0.1228		0.1015		0.0851		0.0735		0.0634
	0.060		0.1130		0.0924		0.0762		0.0654		0.0561
	0.080		0.1035		0.0836		0.0685		0.0577		0.0490
	0.100		0.0942		0.0747		0.0610		0.0503		0.0420
	0.120		0.0848		0.0660		0.0531		0.0430		0.0352
85	0.020	16	0.0991	18	0.0817	20	0.0680	22	0.0580	24	0.0498
	0.040		0.0914		0.0745		0.0615		0.0520		0.0443
	0.060		0.0837		0.0673		0.0550		0.0460		0.0388
	0.080		0.0760		0.0601		0.0485		0.0400		0.0333
	0.100		0.0683		0.0529		0.0421		0.0341		0.0270
	0.120		0.0606		0.0458		0.0357		0.0282		0.0225

Contributed by George W. Burley

No. 152, Data Sheet, MACHINERY, March, 1912

MILLING AXIAL TEETH IN CUTTER AND REAMER BLANKS—III

Angle of Fluting Cutter in Degrees	Width of Land, Radius = 1	Number of Teeth to be Cut	Depth of Cut, Radius = 1	Number of Teeth to be Cut	Depth of Cut, Radius = 1	Number of Teeth to be Cut	Depth of Cut, Radius = 1	Number of Teeth to be Cut	Depth of Cut, Radius = 1	Number of Teeth to be Cut	Depth of Cut, Radius = 1
50	0.020	26	0.2095	28	0.1912	30	0.1745	32	0.1624	34	0.1508
	0.040		0.1884		0.1705		0.1547		0.1426		0.1314
	0.060		0.1681		0.1508		0.1355		0.1232		0.1126
	0.080		0.1482		0.1314		0.1164		0.1040		0.0935
	0.100		0.1288		0.1126		0.0976		0.0852		0.0749
	0.120		0.1095		0.0935		0.0785		0.0667		0.0567
55	0.020	26	0.1780	28	0.1631	30	0.1490	32	0.1382	34	0.1278
	0.040		0.1609		0.1454		0.1321		0.1219		0.1119
	0.060		0.1439		0.1280		0.1150		0.1044		0.0951
	0.080		0.1262		0.1119		0.0985		0.0880		0.0786
	0.100		0.1084		0.0951		0.0822		0.0718		0.0630
	0.120		0.0930		0.0786		0.0665		0.0566		0.0476
60	0.020	26	0.1520	28	0.1390	30	0.1270	32	0.1176	34	0.1086
	0.040		0.1371		0.1238		0.1126		0.1028		0.0945
	0.060		0.1220		0.1086		0.0984		0.0882		0.0803
	0.080		0.1071		0.0945		0.0832		0.0742		0.0667
	0.100		0.0926		0.0804		0.0694		0.0605		0.0533
	0.120		0.0784		0.0668		0.0562		0.0470		0.0402
65	0.020	26	0.1265	28	0.1156	30	0.1053	32	0.0972	34	0.0899
	0.040		0.1137		0.1025		0.0983		0.0850		0.0780
	0.060		0.1013		0.0897		0.0820		0.0725		0.0660
	0.080		0.0882		0.0779		0.0683		0.0610		0.0544
	0.100		0.0760		0.0660		0.0567		0.0495		0.0432
	0.120		0.0642		0.0544		0.0455		0.0386		0.0325
70	0.020	26	0.1048	28	0.0954	30	0.0865	32	0.0797	34	0.0731
	0.040		0.0937		0.0841		0.0761		0.0692		0.0635
	0.060		0.0830		0.0731		0.0663		0.0589		0.0536
	0.080		0.0703		0.0635		0.0556		0.0490		0.0440
	0.100		0.0578		0.0536		0.0460		0.0396		0.0348
	0.120		0.0520		0.0440		0.0368		0.0313		0.0260
75	0.020	26	0.0835	28	0.0754	30	0.0680	32	0.0623	34	0.0567
	0.040		0.0741		0.0660		0.0594		0.0538		0.0493
	0.060		0.0650		0.0567		0.0509		0.0456		0.0113
	0.080		0.0562		0.0493		0.0430		0.0377		0.0336
	0.100		0.0480		0.0413		0.0353		0.0303		0.0265
	0.120		0.0400		0.0336		0.0278		0.0233		0.0197
80	0.020	26	0.0634	28	0.0568	30	0.0509	32	0.0464	34	0.0421
	0.040		0.0561		0.0493		0.0443		0.0400		0.0360
	0.060		0.0190		0.0427		0.0379		0.0332		0.0301
	0.080		0.0421		0.0360		0.0311		0.0272		0.0245
	0.100		0.0355		0.0301		0.0257		0.0215		0.0191
	0.120		0.0288		0.0245		0.0205		0.0154		0.0141
85	0.020	26	0.0437	28	0.0385	30	0.0341	32	0.0308	34	0.0278
	0.040		0.0385		0.0337		0.0296		0.0265		0.0238
	0.060		0.0334		0.0289		0.0251		0.0222		0.0198
	0.080		0.0283		0.0241		0.0206		0.0179		0.0158
	0.100		0.0282		0.0194		0.0162		0.0137		0.0118
	0.120		0.0181		0.0147		0.0118		0.0095		0.0078

Contributed by George W. Burley

No. 152, Data Sheet, MACHINERY, March, 1912

MILLING AXIAL TEETH IN CUTTER AND REAMER BLANKS—IV

Angle of Fluting Cutter in Degrees	Width of Land, Radius = 1	Number of Teeth to be Cut	Depth of Cut, Radius = 1	Number of Teeth to be Cut	Depth of Cut, Radius = 1	Number of Teeth to be Cut	Depth of Cut, Radius = 1	Number of Teeth to be Cut	Depth of Cut, Radius = 1	Number of Teeth to be Cut	Depth of Cut, Radius = 1
50	0.020	36	0.1404	38	0.1314	40	0.1232	42	0.1164	44	0.1106
	0.040		0.1212		0.1126		0.1045		0.0976		0.0917
	0.060		0.1020		0.0935		0.0858		0.0785		0.0731
	0.080		0.0832		0.0749		0.0676		0.0602		0.0548
	0.100		0.0651		0.0567		0.0484		0.0423		0.0370
	0.120		0.0476		0.0387		0.0297		0.0248		0.0196
55	0.020	36	0.1195	38	0.1119	40	0.1044	42	0.0985	44	0.0937
	0.040		0.1024		0.0951		0.0882		0.0822		0.0773
	0.060		0.0862		0.0786		0.0724		0.0665		0.0614
	0.080		0.0702		0.0630		0.0619		0.0507		0.0460
	0.100		0.0546		0.0476		0.0416		0.0360		0.0311
	0.120		0.0393		0.0326		0.0266		0.0207		0.0163
60	0.020	36	0.1013	38	0.0945	40	0.0882	42	0.0832	44	0.0790
	0.040		0.0867		0.0804		0.0745		0.0694		0.0652
	0.060		0.0728		0.0668		0.0610		0.0562		0.0517
	0.080		0.0590		0.0533		0.0480		0.0432		0.0380
	0.100		0.0459		0.0402		0.0348		0.0303		0.0260
	0.120		0.0329		0.0272		0.0222		0.0172		0.0185
65	0.020	36	0.0835	38	0.0779	40	0.0725	42	0.0683	44	0.0647
	0.040		0.0718		0.0660		0.0611		0.0567		0.0530
	0.060		0.0596		0.0544		0.0498		0.0455		0.0420
	0.080		0.0481		0.0432		0.0388		0.0347		0.0312
	0.100		0.0372		0.0325		0.0282		0.0242		0.0210
	0.120		0.0267		0.0221		0.0180		0.0140		0.0109
70	0.020	36	0.0681	38	0.0635	40	0.0589	42	0.0556	44	0.0525
	0.040		0.0577		0.0536		0.0494		0.0460		0.0429
	0.060		0.0481		0.0440		0.0402		0.0368		0.0338
	0.080		0.0387		0.0348		0.0312		0.0275		0.0249
	0.100		0.0298		0.0260		0.0225		0.0192		0.0166
	0.120		0.0211		0.0174		0.0142		0.0111		0.0085
75	0.020	36	0.0530	38	0.0493	40	0.0456	42	0.0430	44	0.0405
	0.040		0.0444		0.0113		0.0380		0.0353		0.0330
	0.060		0.0370		0.0336		0.0307		0.0279		0.0258
	0.080		0.0296		0.0265		0.0236		0.0205		0.0189
	0.100		0.0225		0.0197		0.0169		0.0141		0.0125
	0.120		0.0160		0.0131		0.0106		0.0083		0.0064
80	0.020	36	0.0390	38	0.0360	40	0.0332	42	0.0311	44	0.0293
	0.040		0.0331		0.0301		0.0280		0.0257		0.0242
	0.060		0.0273		0.0245		0.0225		0.0205		0.0191
	0.080		0.0216		0.0191		0.0172		0.0154		0.0142
	0.100		0.0161		0.0141		0.0122		0.0104		0.0092
	0.120		0.0110		0.0090		0.0073		0.0055		0.0043
85	0.020	36	0.0253	38	0.0231	40	0.0212	42	0.0196	44	0.0183
	0.040		0.0215		0.0195		0.0178		0.0166		0.0151
	0.060		0.0177		0.0159		0.0143		0.0130		0.0119
	0.080		0.0138		0.0122		0.0108		0.0096		0.0087
	0.100		0.0100		0.0086		0.0073		0.0063		0.0055
	0.120		0.0062		0.0050		0.0039		0.0030		0.0023

Contributed by George W. Burley

No. 152, Data Sheet, MACHINERY, March, 1912

MACHINERY

March, 1912

SPECIAL TOOLS USED IN THE MAKING OF DENTAL CHAIRS

By CARROLL ASHLEY

IN order to more clearly explain the special tools to be described in this article it will be necessary to briefly describe the construction of the dental chair for which the tools are used. A dental chair is rather a complicated piece of mechanism, which perhaps is best proved by the fact that in case repairs are necessary, even skilled mechanics, inexperienced in this class of work, are usually unable to remedy the defects, and the chair has to be sent back to the factory. Some parts of the chair described in the following, in fact, are so complex that only a trained expert can assemble them.

At first thought it may be assumed that a dental chair is no more complicated than a barber's chair. However, there is a vast difference between the two. The barber's chair must be made to rise and fall easily for two or three reclining positions, and perhaps rotate clear around. The dental chair must meet a great many more requirements. It must be perfectly rigid, and its levers must be easily accessible to the operator, making it possible to adjust it to any position; the chair must be built to fit the tall and the short, the stout and the thin. Sometimes it is necessary to etherize the patient, in which case the back of the chair must be placed lower than the front, so as to drop the patient's head. This necessitates a "compensating back," that is, a back which will lengthen out as the patient is lowered to the reclining position.

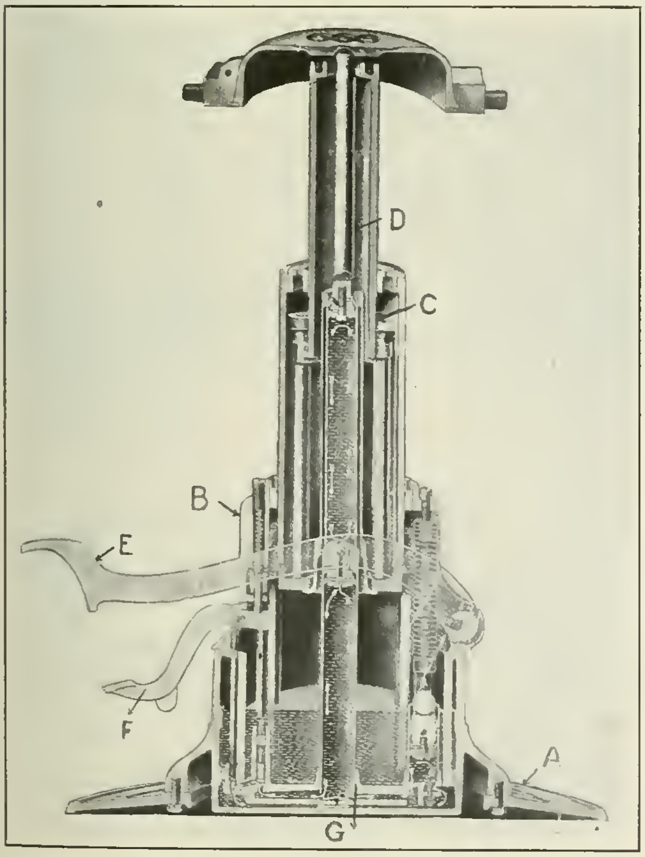

Fig. 1. Section of Base of Dental Chair

Fig. 1 shows a section of the lower part of a dental chair, this part being termed the base. The principal parts are the floor plate *A*, the cylinder *B*, and the outer and inner tubes *C* and *D*, which are all of cast iron. The main raising and lowering levers *E* and *F* are also made of cast iron. The part *G* at the very bottom of the reservoir is a brass casting carrying the different valves. The center of this casting carries the telescoping tubes into which oil is pumped for the operation of the chair.

The base ring is sufficiently large to support the chair without fastening it to the floor, although holes are provided for this purpose. It also serves as a reservoir for the oil used in the pump for raising and lowering the chair. This raising and lowering mechanism consists of a pump and plunger operated by the foot by means of the main lever *E*. The operation of this lever forces the oil from the reservoir into the telescopic tubes and against the lower end of the rod and plunger, as indicated in Fig. 1. The plunger is provided with leather packing, fitting the tube closely. Due to the telescoping construction a large range of vertical positions can be obtained. When the chair is to be lowered, lever *F* is pressed, which opens a valve and allows the oil to flow out of the telescopic tubes back into the reservoir. The sudden closing of the valve by withdrawing the foot ordinarily has a tendency to give the patient a jolt. In this particular construction this is obviated, however, by a retarding device which causes the chair to come to rest in so smooth a manner that it is hardly possible to notice the exact moment when motion ceases. Several round guide-rods are provided to prevent the telescopic tubes from turning and to give strength and rigidity to the mechanism. The lower ends of the cast-iron tubes slide on these guide-rods, the tubes being provided with lugs for this purpose.

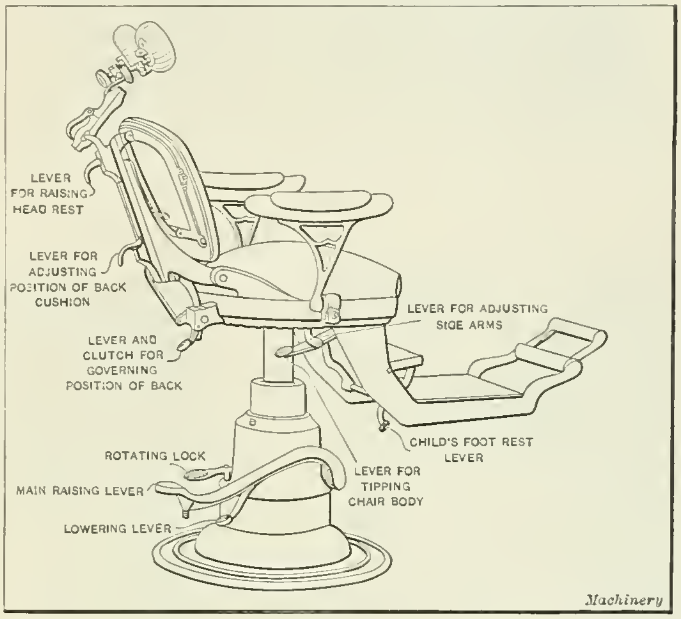
LEVER FOR RAISING HEAD REST
LEVER FOR ADJUSTING POSITION OF BACK CUSHION
LEVER AND CLUTCH FOR GOVERNING POSITION OF BACK
LEVER FOR ADJUSTING SIDE ARMS
CHILD'S FOOT REST LEVER
ROTATING LOCK
MAIN RAISING LEVER
LOWERING LEVER
LEVER FOR TIPPING CHAIR BODY
Machinery

Fig. 2. General Outline of Dental Chair

Fig. 2 shows the general features of a dental chair in outline, and Figs. 3 and 4 show the main parts of the base as they appear immediately before being assembled.

Tools used in the Making of a Dental Chair

A number of interesting tools which the writer has designed for building the chair described will now be dealt with. Figs. 5 to 13, inclusive, illustrate drilling and reaming attachments for drilling and reaming two to four holes simultaneously.* The attachments are used on a J. E. Snyder & Son drill press. The shafts and spindles of the attachment are of tool steel with ball thrust bearings. The line engravings Figs. 10 to 13 show the principal arrangements. These attachments differ in their details on account of the location of the holes to be drilled. In the four-spindle arrangement shown in Fig. 8, for example, there is just room enough for the train of driving gears, while in Fig. 9 there is ample room for the gearing. In all cases, however, the spindles in the attachments have about the same speed as that of the main spindle of the drill press.

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* Address: 625 Esperanza St., Los Angeles, Cal.

* See also MACHINERY, October, 1906, "Three-Spindle Drilling Attachment."

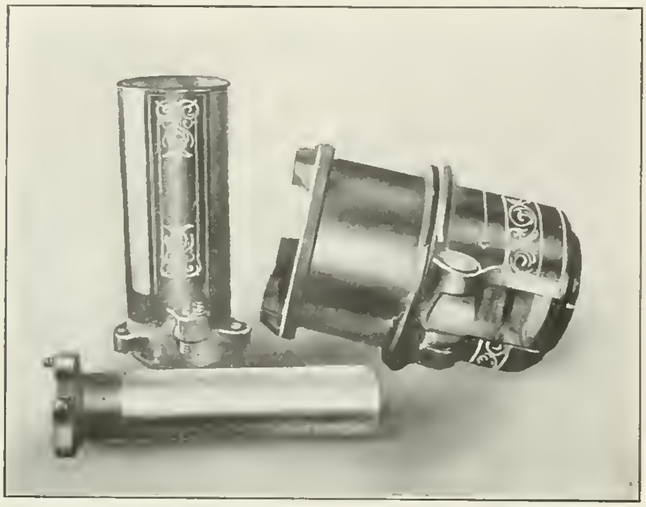
Fig. 3. The Cylinder, Outer and Inner Tube of Chair before assembling

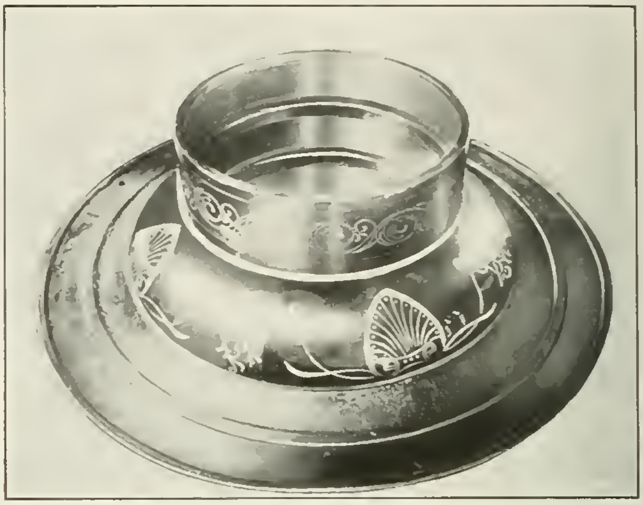
Fig. 4. Floor-plate of Chair, showing Bearings on Inside

It is not altogether essential that the drills or reamers be of the same length, except in the case of the two-spindle attachment, Figs. 5 and 10, where it was found necessary to sharpen them to the same length, because otherwise the drills and reamers would cause the jig holding the work to wind or twist. It is understood, of course, that the work operated on by these drilling attachments is held in jigs, and the drills are guided by bushings. On all the spindles of these attachments a spiral oil groove is cut the full length of the bearing, so that when the spindles revolve, the oil is driven upwards, and thorough lubrication of the bearing is obtained.

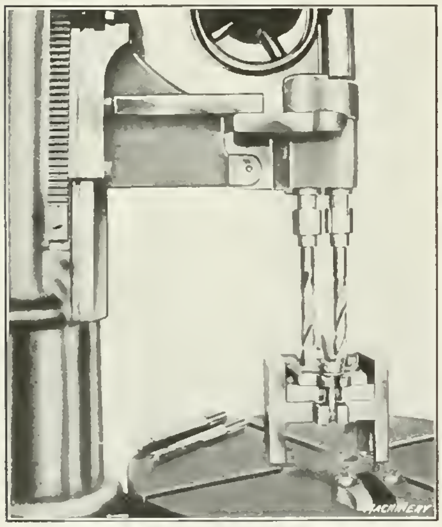

Fig. 5. A Two-spindle Drilling Attachment

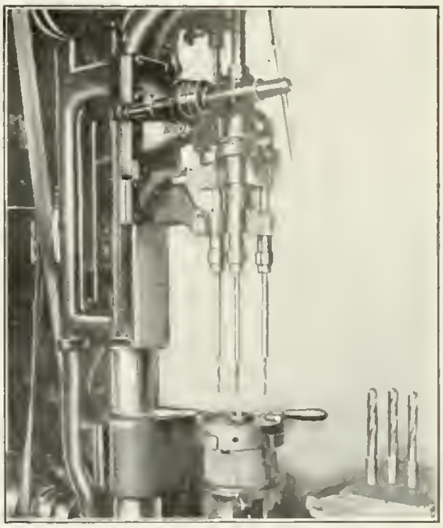
Fig. 6. Three-spindle Drilling Attachment

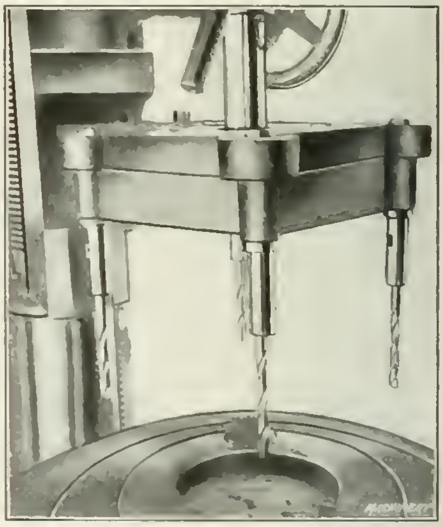

Fig. 7. Four-spindle Drilling Attachment

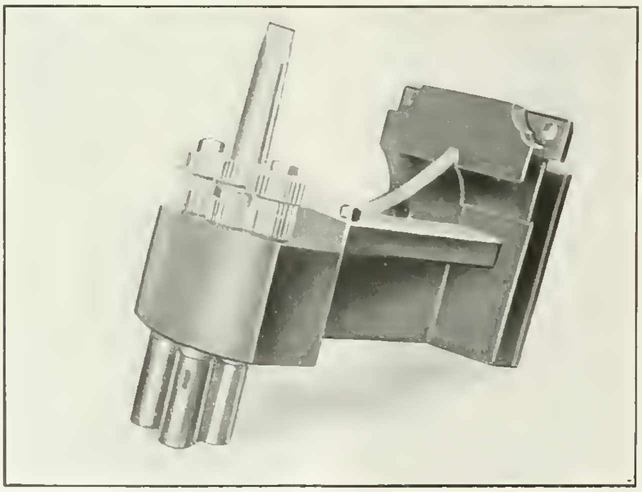
Fig. 8. Compact Four-spindle Drilling Attachment

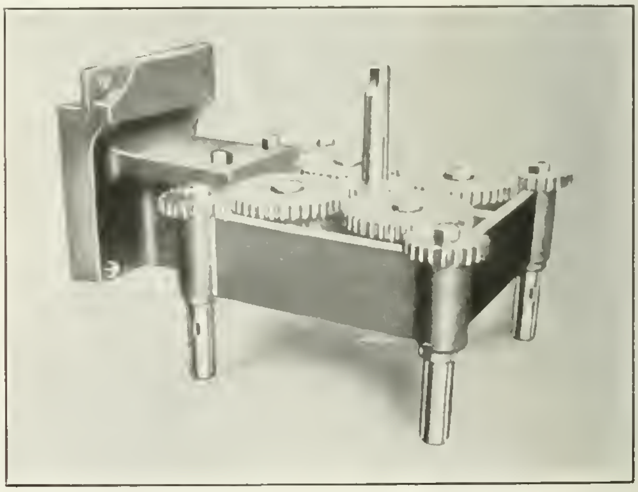
Fig. 9. Attachment shown in Fig. 7 with Gear Covers removed

These attachments were not all designed to fit one drill press, but as several machines of the same make were available, each press had its own attachments which could easily be removed when the drill press was to be used for other work. The bracket *A* and the carrier *B* shown in the line engravings Figs. 10 and 12 are of cast iron, and when bolted together provide a very stiff construction. The bracket is not, as might be supposed, bolted fast to the drill press head, but is fastened by two cap-screws which take the place of the regular tie-bolts that hold the lower ends of the gibs to the head. The holes for these screws are shown in Fig. 8 at the upper end of the bracket. The bracket is gibbed to the column.

It will be seen in Fig. 12 that the thrust of all four spindles is taken by a ball bearing at *C* seated in the center of the spindle carrier *B*. The idler gears shown at *D* are separate gears pinned together, thus practically making a solid gear. The pitch circles of the gears only are indicated in the illustrations.

When removing the attachments from the drill press, the cap-screws *E*, Fig. 11, are taken out, permitting the attachment to slip off the ways. The driving gear and shank remain in the drill spindle after the removal of the attachment, and are driven out the same as a drill.

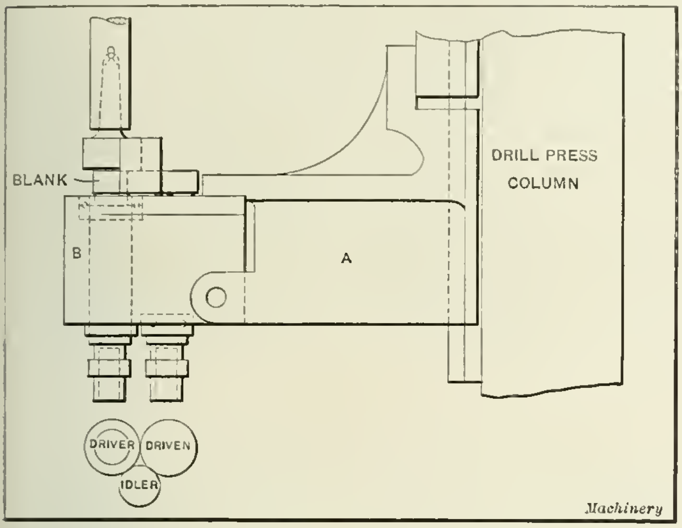

Fig. 10. General Design of Attachment in Fig. 5

Fig. 5 shows the two-spindle attachment in use drilling two pieces at one time, the pieces being shown in the foreground. It will be noted that the gears are properly encased to prevent accident to the operator. In Fig. 11 a three-spindle attachment is shown. There are two sets of lugs on the pieces which are drilled with this attachment which necessitates two sets of drills and reamers, one set being about 16 inches long. As indicated in Fig. 11, the lower part of the driving spindle *F*, in this instance, has to be unscrewed to separate the shank that is held in the drill press spindle from the fixture itself. Fig. 6 shows another three-spindle attachment constructed especially for "extension" drilling. Figs. 8 and 12 show an especially powerful four-spindle drilling attachment. Fig. 7 shows a four-spindle attachment which drills the four holes in the base ring for bolting it to the floor. As there is no reaming to be done in this case, the spindles are arranged to carry taper shank drills. The drills are not removed except when sharpened. In Fig. 9 the gear guard is removed showing the gear arrangement. The main casting is not as heavy as it appears to be in the illustration, as it is designed with webs as indicated in Fig. 13.

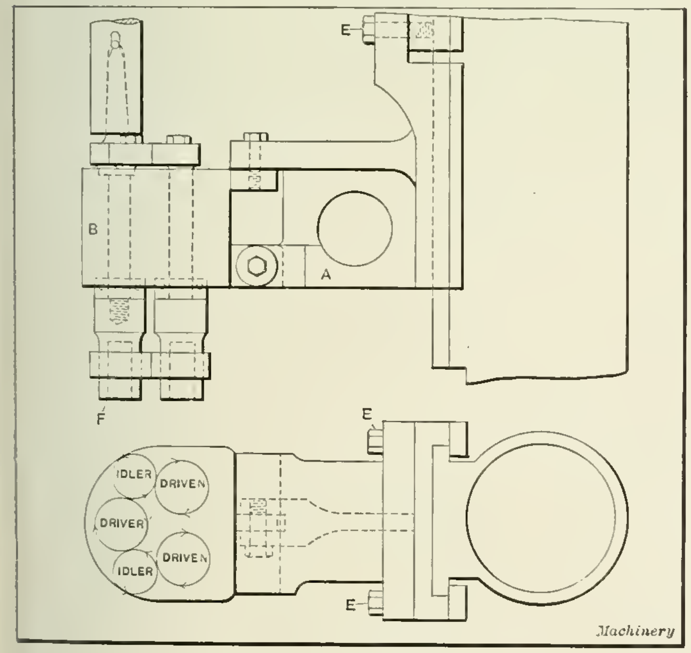

Fig. 11. Three-spindle Drilling Attachment

A Reaming Attachment

In the outer tube mentioned in the description of the chair, there are three lugs which must be reamed for the guide-rods. This reaming operation has been done by hand for years, a good sixteenth inch of metal on the diameter having been removed in lugs ⅞ inch thick. Naturally this was slow work, and the fixture shown in Fig. 14 was therefore designed by the writer. By means of this device the time is cut down to one-quarter of that previously required. A countershaft, not shown in Fig. 14, is hung in the ceiling and carries on the end of the shaft a pair of miter gears which drive the vertical universal telescopic shaft shown. This shaft, in turn, drives a pair of miter gears in a cast-iron box or cage having a handle on each side. In reaming the tube, the operator places it in a vise, inserts the reamer, swings the fixture in front of it, attaches the "ball-chuck" on the end of the projecting horizontal shaft to the reamer, as shown, and puts his foot on a lever under the bench which shifts the belt on the countershaft from the loose to the driving pulley. This starts the reamer, and the operator merely has to push it right through the work. When the hole is reamed through, he lifts his foot from the lever and a spring pulls the belt back to the loose pulley.

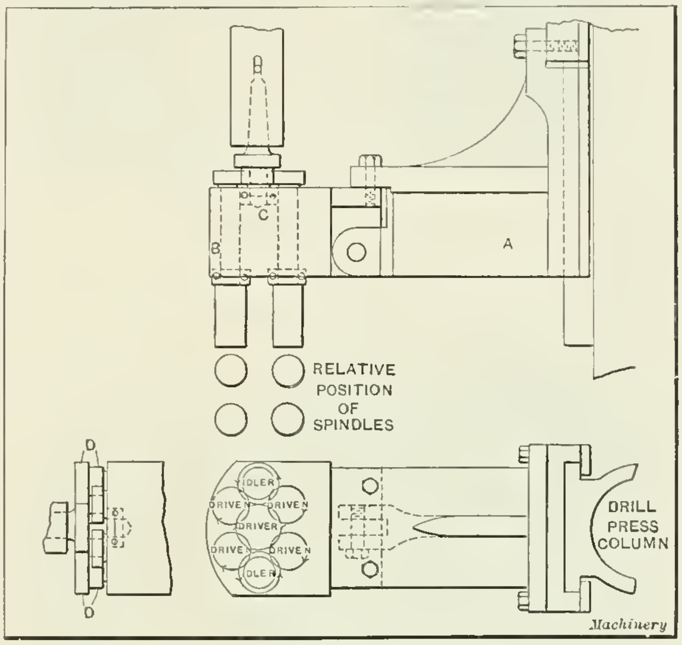

Fig. 12. Design of Four-spindle Attachment shown in Fig. 8

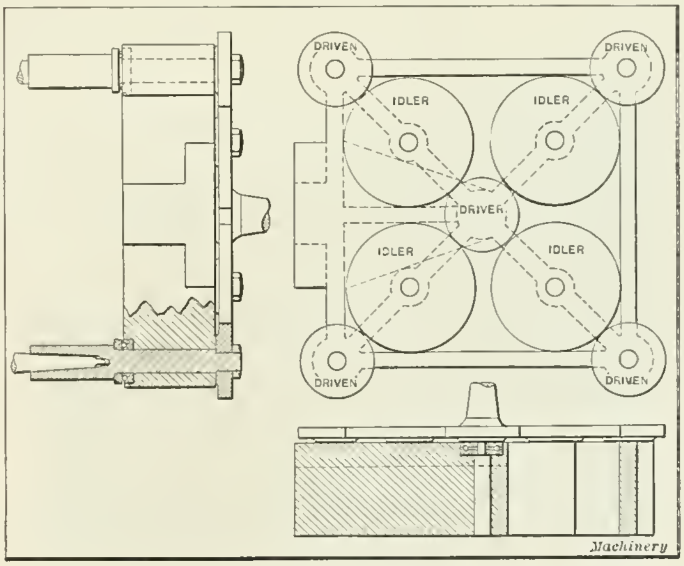

Fig. 13. General Design of Attachment shown in Figs. 7 and 9

A Compound Lathe Tool

Figs. 15, 16 and 17 show a tool for a turning operation in the lathe. As shown in Fig. 3, there are two bearings on the cylinder which are machined to size and must be true. The bearing near the center of the cylinder is faced to a square shoulder. This operation was originally done on a vertical milling machine, but too much time was consumed and the results were unsatisfactory. To improve this method, the toolpost slide of an old lathe that stood idle was removed, and the fixture shown in the illustrations was permanently dovetailed in its place. The body *A*, Fig. 17, is of cast iron and on it are mounted three pairs of Novo high-speed steel tools. The two roughing tools shown at *B* are stationary and are clamped in slots on the sides of the body. The second roughing tools *E* are mounted in a hinged holder *C*, which is thrown in when the carriage has been moved back after the first roughing tools have finished their cut. The locking device *D* holds these tools in position. After the roughing tools *E* have finished their cut, the finishing tools *F* are thrown in and the two bearings finished simultaneously.

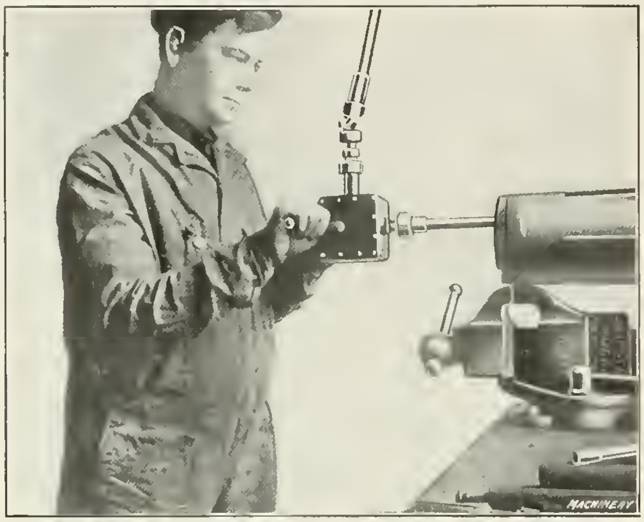

Fig. 14. A Reaming Attachment

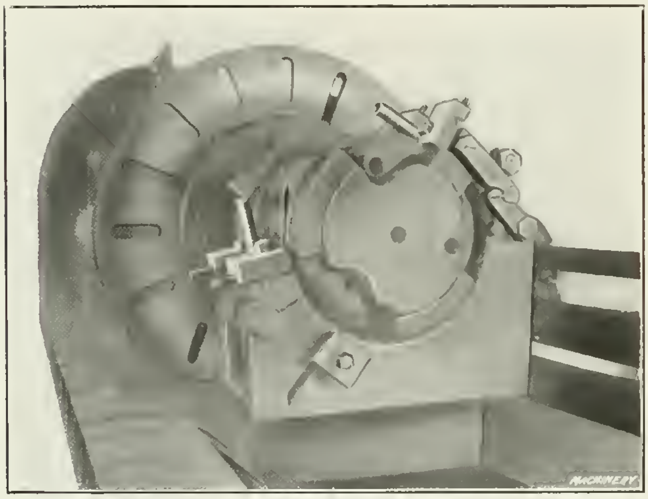

Fig. 15. Turning Tool for Cylinders of Dental Chair with Cylinder in Position for Turning

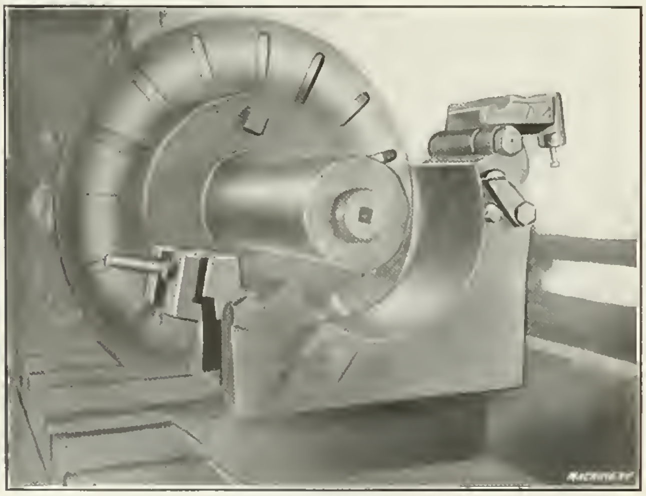

Fig. 16. Turning Tool for Cylinders of Dental Chair with Cylinder removed

Fig. 16 shows the cylinder removed and the second roughing tools and the finishing tools thrown out. The cylinder is securely held on the holder or arbor shown bolted to the faceplate of the lathe. One end of the cylinder fits the tapered shoulder near the faceplate and the other end is held central by three conical plugs driven out together by the socket screw shown in the center of the outer end of the arbor. The end of this screw is pointed to a 60-degree angle and the ends of the three plugs are correspondingly tapered.

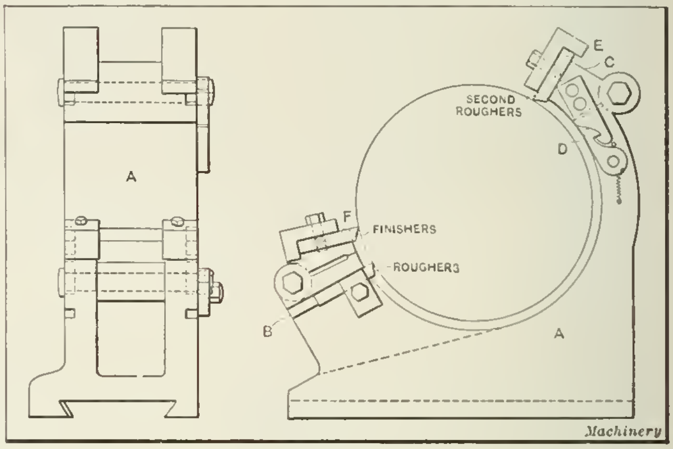

Fig. 17. General Design of Tool shown in Figs. 15 and 16

Fig. 15 shows the cylinder in position with the tools thrown in, and with a piece held onto the bottom of the cylinder into which the tailstock center is forced. When the turning was done on the vertical milling machine nine or ten pieces only could be completed in a day. With the arrangement shown, eighteen or twenty pieces constitute an average day's work.

A Special Boring Tool

As shown in Fig. 4, the base ring of the chair has three ribs on the inside. The top and lower one of these ribs constitute bearings for the cylinder, and it is on these bearings that the chair rotates. The central rib is for the locking device to bear upon. All three of these bearings had been milled out with a gang mill until the boring tool shown in Fig. 18 was designed. In this illustration the general outline of the tool is shown. The body *A* is of cast iron, having a hole in the center bored and threaded to fit the spindle of a large Becker vertical milling machine. On the four wings of the tool are mounted four shafts, each carrying three cutting tools *B*. The shafts are held in their seats by the covers *D*, the retaining screws of which are not shown. The

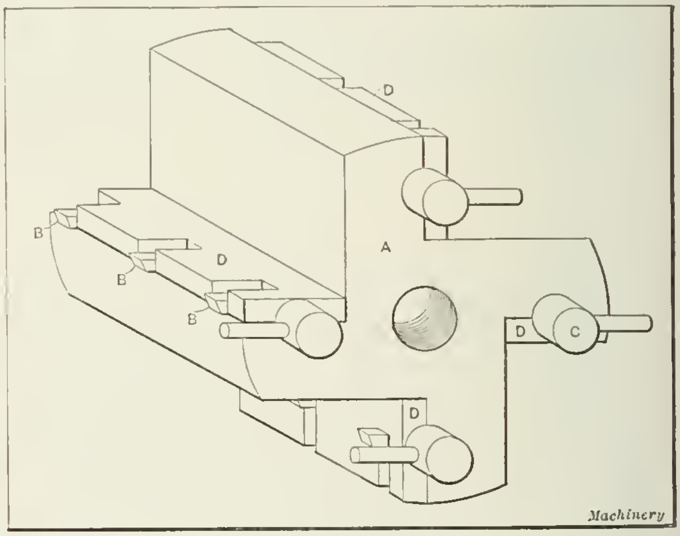

Fig. 18. A Multiple Boring Tool for Roughing and Finishing

shafts are free enough in their bearings to be turned by the small levers shown at their ends; this turning motion, limited by the depths of the slots in the covers *D*, throws the tools in or out of their working position, as desired. Two sets of these tools are roughing tools and two are finishing tools.

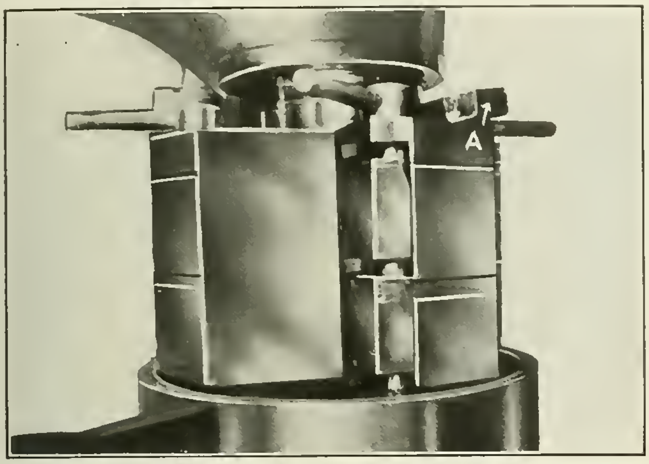

Fig. 19. General Appearance of Tool in Fig. 18

When in operation, both the roughing and finishing tools are turned in and the whole tool is lowered into the work to a point where the tools are just above the respective bearings to be machined. The two sets of roughing tools are then turned outward and the tool is fed downward while rotating. After having roughed all three bearings at once, the tool is withdrawn a little more than the thickness of the bearings, the finishers are thrown outward, and the tool is again fed down until the two facing tools, not shown in Fig. 18, but indicated at *A* in Fig. 19, face off the top edge of the casting. When the tools are taken out to be ground, a gage is used in re-setting them. This tool works very smoothly and quietly.

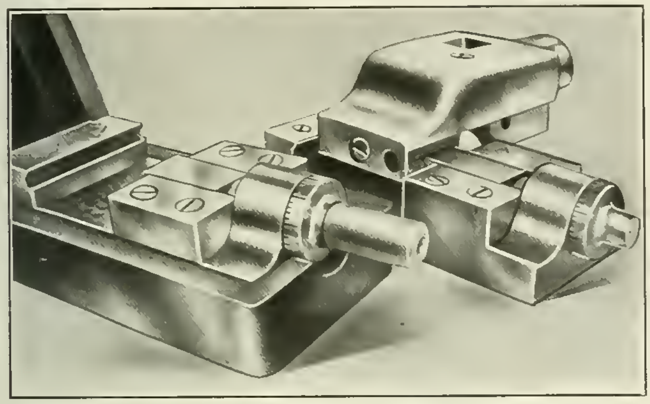

Fig. 20. The Device in Fig. 21 in its Case, and in Use

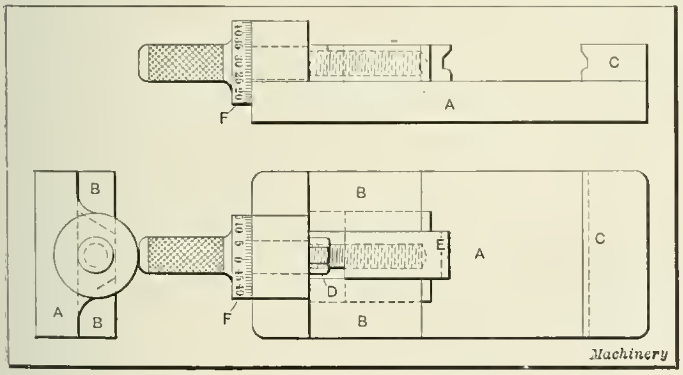

Fig. 21. A Micrometer Measuring Device

A Micrometer Measuring Device

The tool shown in Fig. 21 was made to caliper the beveled edges of the slides used on the back of the dental chair. This device is much more satisfactory than a solid gage because the proximity of the pieces to the correct size can be determined, the size of the piece being read off in thousandths of an inch. On the casting *A* are fastened gibs *B* in the opening between which is a sliding member *E*, notched as shown to fit the piece to be calipered. The member *C* is the anvil of the tool, the same as in a micrometer. The lock-nut *D* prevents end motion of the screw while driving part *E* in or out. The thimble *F* has fifty graduations and the lead-screw twenty threads to the inch, thus giving readings to 0.001 inch. Fig. 20 shows the finished gage in its case and also with a slide to be calipered in it.

Inner Tube Frosting Device

In Fig. 23 is shown a frosting device which was pronounced by both the superintendent and the manager as one which could not be made to work. The experiments with the device were, therefore, carried on in secret, and after a "try-out" a tube was presented to the authorities which was frosted even better than could be done by hand. Fig. 22 shows a sectional view of the arrangement. A cast-iron bracket *A* is fitted to a Landis grinder, near the spindle which carries the emery wheel. On this bracket is mounted shaft *B* which carries a worm-wheel on one end and a member *C* on the other, the latter being connected to the shaft by a

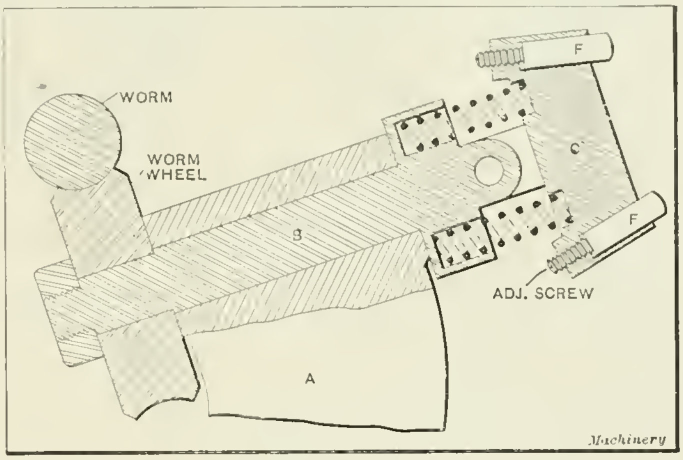

Fig. 22. A Frosting Device

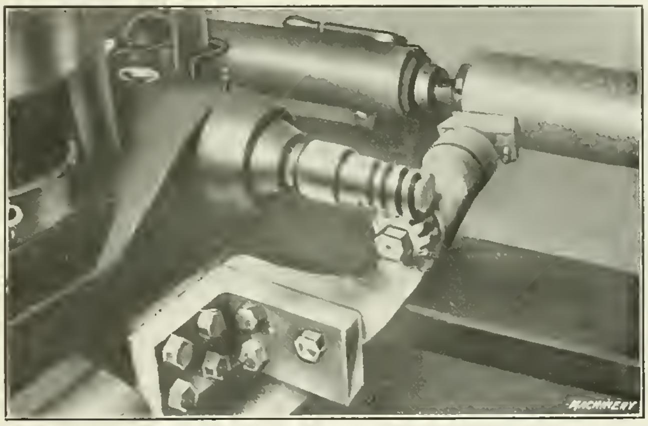

Fig. 23. Frosting Device in Operation

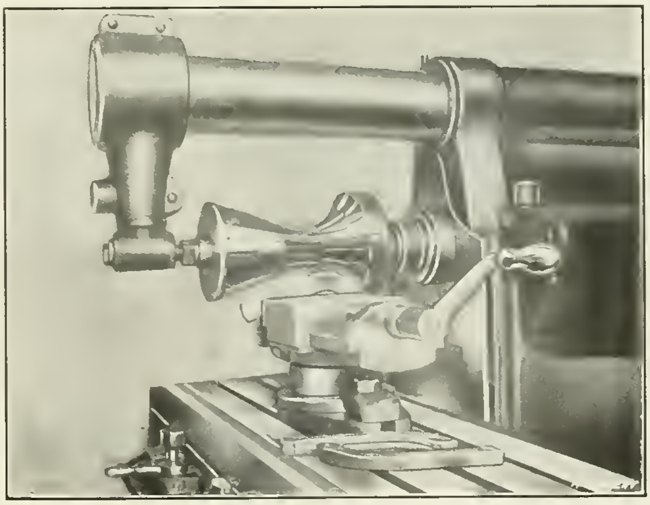

Fig. 24. A Special Built-up Milling Cutter

knuckle-joint as shown. This member is held central in relation to the shaft by springs. Diametrically opposite each other are placed two oilstones *F* which operate upon the work to be frosted. The screws behind the oilstones provide for adjustment as the stones wear away. The work is rotated and travels back and forth the same as if an emery wheel were working on it. The spindle *B* and head *C* carrying the oilstones are also rotated, being driven by a worm connected to the emery-wheel spindle of the grinder. The worm-wheel has eleven teeth, so that the speed of the shaft carrying the oilstones is reduced to one-eleventh of the regular speed of the grinding-wheel spindle. The work is rotated at the maximum speed. The grinder head is set over fifteen degrees so that only one oilstone bears on the work at once. The work, of course, is first ground very smooth. It then travels once across and back and is then completed. Kerosene is used as a lubricant. In Fig. 23 the device is shown at work.

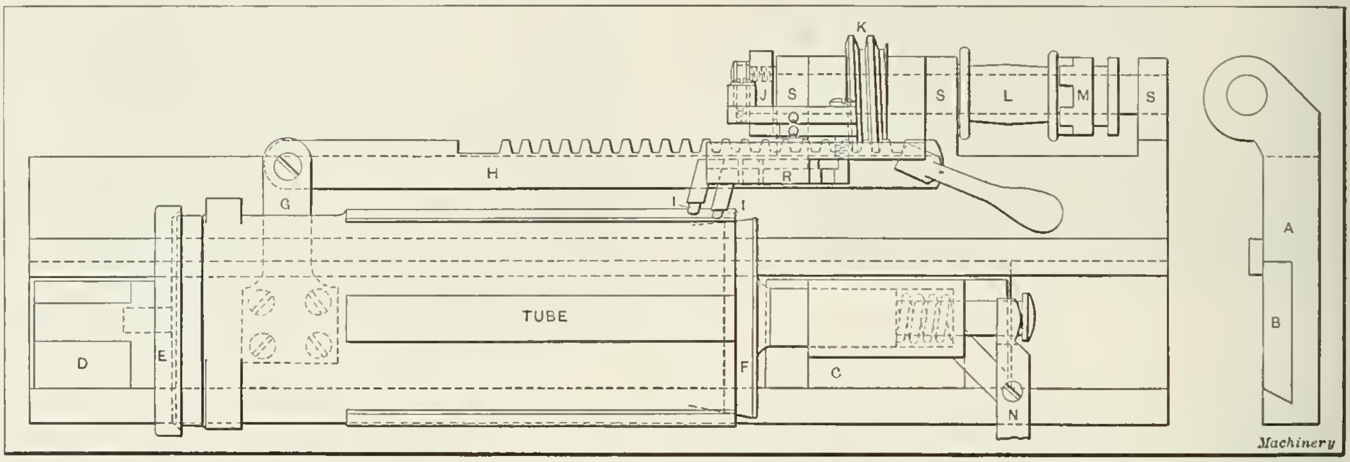

Fig. 25. Plan View of Automatic Frosting Device

A Large Formed Milling Cutter

Fig. 24 shows a large inserted tooth milling cutter for milling one edge of the "back-bar" of the chair. This cutter is constructed in five sections and is keyed onto a special arbor so that all the teeth are staggered. The cutter blades are made of Novo steel and are held in their respective seats by tapered pins in slots between all the blades. In making this cutter, the various sections were first keyed on a mandrel so that the rows of teeth were even, and were then backed off the same as a formed tooth cutter, after which the teeth were removed and hardened. In this way it is possible to take out the teeth at any time and sharpen them on their faces. The cutter bodies are of cast iron, except the center one, which is made of Novo steel and without inserted teeth. An idea of the size of the cutter may be obtained by noting that it is shown in Fig. 24 on a No. 4 Cincinnati milling machine.

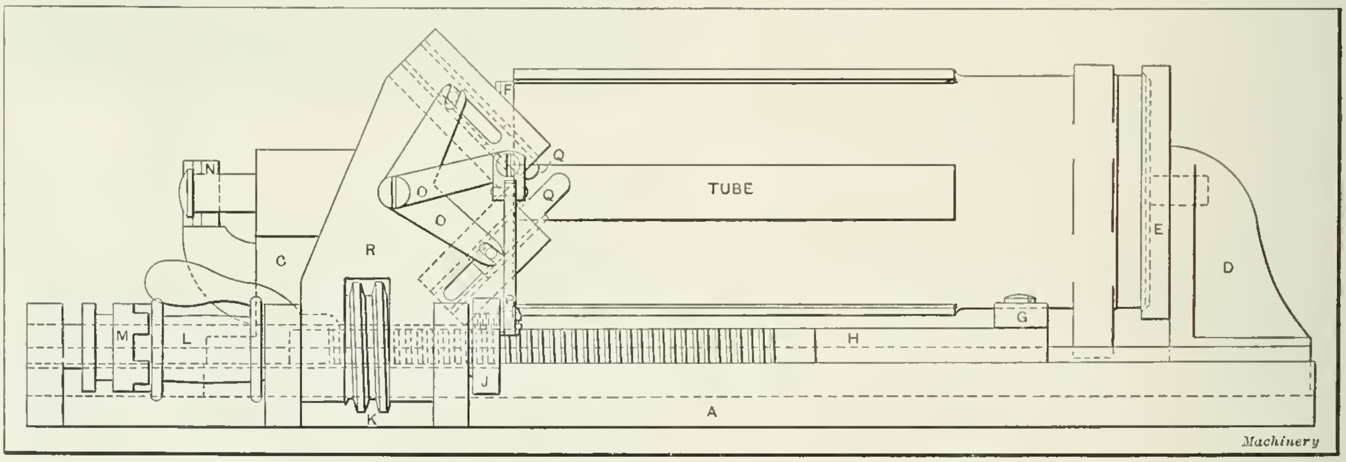

Fig. 26. Elevation (Back View) of Device shown in Fig. 25

Another Frosting Device

The outer tube shown in Fig. 3 has four bearings on its periphery. Just before the tubes are assembled these bearings are frosted. Previous to the time when the writer designed the device shown in plan and side elevation in Figs. 25 and 26, respectively, this frosting was done by hand. The mechanism operating the different members, which makes this device semi-automatic, is not shown. The end view shows simply the form of the base casting. The bed *A* has three lugs *S*. A sliding member *B*, nearly as long as the bed, carries a headstock *C*, footstock *D* and bracket *G*. On the footstock is a disk *E*, and on the headstock a disk *F*, which serve as centers for swinging the outer tube. The spindle of the headstock is fastened to the center *F* and is released by the hand lever *N*. The coil spring shown holds the tube on the centers while the device is in operation. Lugs *S* carry a shaft on which is keyed a clutch *M*, worm *K*, and crank disk *J*. The driving pulley *L* is loose on the shaft. On each side of worm *K* are the lugs of the swinging bracket *R*, which carries the mechanism governing the action of the oilstones *I*. In Fig. 26 the bracket *R* is shown more clearly. The slides *Q* travel in T-slot openings on the inner side of *R*, these slides carrying the oilstones. The two members that form the quadrant *O* are fastened together to make one unit. As the shaft is turned, the crank disk *J* drives crank *P* and imparts a reciprocating motion to the quadrant *O*, which, in turn, moves slides *Q* back and forth.

Assume that a tube is to be frosted. After placing the tube on its centers, the operator pulls a lever, throwing in clutch *M*. The oilstones simultaneously begin to reciprocate, and slide *B* will move lengthwise of the bed, operated by worm *K* meshing in rack *H*. When the stones have reached the end of the bearing of the tube, bracket *R* moves outward and away from the tube, rack *H* flies out of mesh, and slide *B* returns to its starting place by the action of a weight. As the slide returns to its starting place, it strikes a bellcrank under the bed, not shown, throwing out the clutch. Bracket *R* remains away from the work until the clutch is pulled in again, which the operator does after having indexed the tube for the next track. In designing a device of this kind, the writer found it good practice to merely draw an outline and make separate sketches of the different mechanisms, as sometimes the whole character of the machine must be changed.

DRAWING A FLANGED AND TAPERED CYLINDRICAL SHELL*

By JOSEPH V. WOODWORTH†

In the production of cylindrical shells from flat stock, the construction of the tools and the number of operations or steps in their development depend entirely upon what the ultimate shape is to be. Thus, when it is desired to produce a straight cylindrical shell of a depth not exceeding, say, twice the diameter, the first operation may be accomplished in a combination blanking and drawing die, which will cut the blank and draw it to a height almost equal to the diameter.

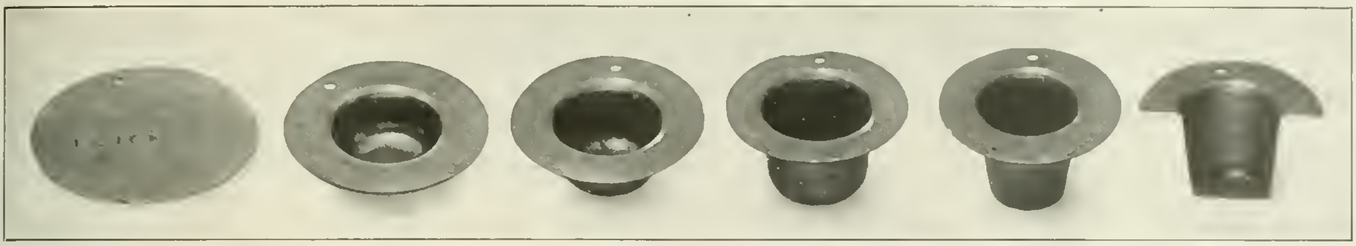

Fig. 1. The Successive Operations in the Production of a Flanged and Tapered Cylindrical Shell

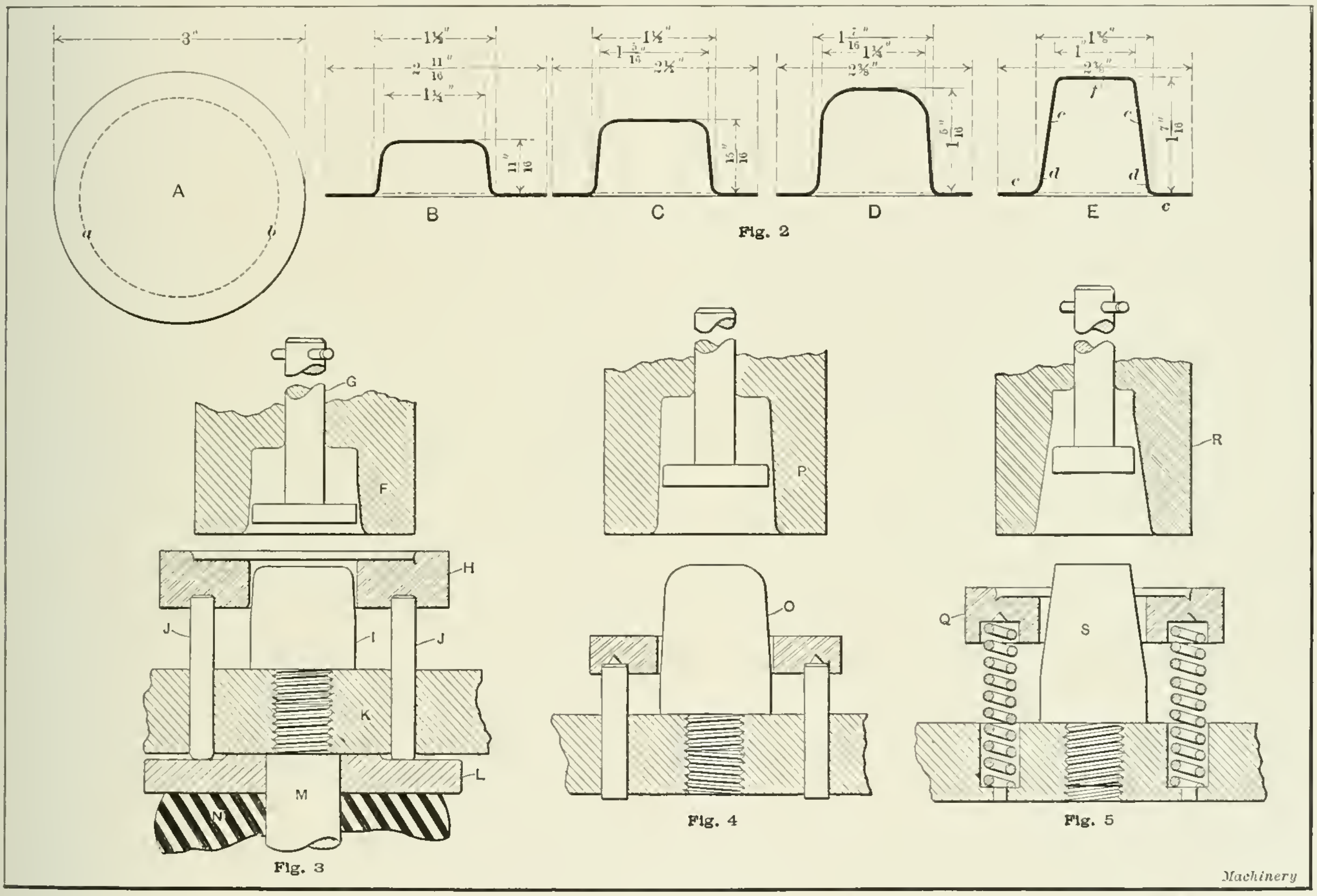

Fig. 2. Development, Evolution and Dimensions of a Flanged and Tapered Cylindrical Shell. Fig. 3. The Drawing Punch and Die for the Cups shown at B and C, Fig. 2. Fig. 4. Redrawing Punch and Die for Operation shown at D. Fig. 5. The Finishing Punch and Die for Operation shown at E

If a flange is left around the shell, the die can be used in a single-action press, a rubber spring barrel being used to create pressure on the blank. If no flange is left on the shell, a double-action press is used and all of the blank area worked into the shell, the metal being drawn through the die, and the shell stripped on the under edge of the drawing die at the commencement of the return stroke. After this first operation, two, or at the most, three redrawing operations, each accomplishing an approximately equal reduction in diameter and increase in depth, will attain the desired result. In such work, the evolution of the shape and the dimensions can usually be planned accurately without trouble before starting the construction of the tools, and the blanking die can be made to size with the certainty that just the right amount of stock will be contained in the blank to produce a shell of the required form, diameter and depth.

When the shell height does not exceed the shell diameter, only a slight variation will take place in the thickness of the wall, and the final thickness will not differ materially from the original blank thickness, that is, if the metal drawn is perfectly soft to commence with and the product of each drawing operation is annealed before reducing. If the holes in the drawing dies are lapped, the punches fitted properly and given just sufficient taper to allow the shell to be stripped without collapsing the rim, an elegant surface will be attained and the shell diameter will be true.

In drawing tapered cylindrical shells with flanges, the requirements for the construction of the dies and the evolution of the shell shapes are different. When the taper in the finished shell is considerably acute in comparison with the height and diameter, the desired result can only be accomplished as shown in Figs. 1 to 5 inclusive. To attain these results, it is first necessary to bring the blank into a cylindrical shape, the area of which will just equal that of the metal required in the finished shell. When trouble is experienced in drawing tapered shells, it is almost invariably caused through the die-maker endeavoring to generate the acute taper in the first operation, or to draw it directly from the flat blank. When this practice is followed the shell is either split at the bottom, or waves and wrinkles are formed in the wall of the shell which cannot be removed. Another frequent cause of trouble lies in having a surplus of metal in the shell, and the consequent inability to distribute it in the finishing operation or to return it to the flange from which it was drawn.

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* For additional information on drawing dies and kindred subjects, see the following articles previously published in MACHINERY: "Dies for Drawing a Deep Steel Shell," January, 1912; "Drawing Rounding Covers in One Operation," November, 1911; "Press Tools for an Aluminum Shell," October, 1911; "The Multiple Plunger Press," August, 1911; "A Wiring Die," June, 1911; "Drawing a Cold-Rolled Steel Shell," "Shape of Drawing Edges in Sheet Metal Drawing Dies," April, 1911; "Cartridge Making—1 and 2," March and April, 1911; "Drawing Deep Cylindrical Shells," February, 1911; "Drawing Deep Cylindrical Shells," December, 1910; "Tools for Drawing Seamless Automobile Lamp Hoods," February, 1910; "Dies and Methods for Making Watch Crowns," December, 1909, engineering edition; "Drawing Dies for Hollow Rivets," October, 1909; "Sheet Metal Drawing," August, 1908; "The Drawing of Cartridge-Cases for Quick-Firing Guns," January, 1906; "Dies for Making Tin Nozzles," May, 1905; "A Combination Cutting, Drawing and Knurling Die," January, 1905; "A Quintuple Combination Die for Producing Five Drawn and Embossed Tin Shells in One Operation," March, 1904; "Some Suggestions for Die Making," January, 1904; "Dies for Square Tin Boxes," February, 1901; "A Combination Die and a Piercing Die," November, 1900; "Combination Drawing and Forming Die," October, 1900; see also MACHINERY'S Reference Book, No. 26, "Modern Punch and Die Construction."

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When the proper amount of metal is contained in the shell form as shown at *D*, Fig. 2, with slightly tapering walls, a succeeding operation of reforming—not drawing or reducing through friction—will shape the cylindrical shell to the desired taper. The reason for this practice is that in drawing a straight cylindrical shell or even one slightly tapering, the metal is confined at all times during the process of drawing, between the die and punch surfaces, making the inception of wrinkles impossible and the flow of metal equal and constant during the entire operation. When the depth to be drawn is quite shallow as compared with the shell diameter, even acute tapers can sometimes be accomplished in one operation.

Fig. 1 shows clearly the result of each operation, while Fig. 2 illustrates the various steps necessary to develop the final form completely. In Fig. 2, *A* is the blank, 3 inches in diameter by 0.032 inch thick—No. 20 Brown & Sharpe gage. The blank was cut in a plain blanking die in an automatic press. *B* is the result of the second operation, and is accomplished in the die shown in Fig. 3, as is also the redrawing operation *C*, the die remaining unchanged, except that a thinner locating pad and blank-holder was substituted for the one shown at *H*. In Fig. 3, *F* is the drawing die, *G* the shell ejector, *H* the blank-holder and locater, *I* the drawing punch, *J* two of five spring barrel pins, *K* the die-bolster, *L* one of the two spring barrel-washers, *M* the barrel stud, and *N* the rubber spring barrel, only a section of which is shown, it being circular, 4 inches in diameter by 6 inches high with a 1-inch hole through it.

At *C* in Fig. 2, it will be noticed that an increase of ¼ inch in height and 1/16 inch in top diameter is attained. At *D* the height is increased to 1 5/16 inch—a gain of 3/8 inch—and at *E* the shell is completed to a height of 1 7/16 inch, the smallest diameter being 1 inch and the largest 1 3/8 inch with a flange diameter of 2 3/8 inches. The dotted line *a b* at *A* in Fig. 2, shows the amount of metal drawn from the blank to form the entire cone of the shell at *E*.

Fig. 4 shows the tools used for accomplishing the operation shown at *D* in Fig. 2. A spring buffer, not shown, is used as in Fig. 3, and the cup *C*, Fig. 2, is located on the punch *O*, the die *P* descending and drawing the cup to the shape shown at *D*.

In the finishing punch and die shown in Fig. 5, no drawing of the metal takes place, the displacement of the wall of the shell and reshaping alone being accomplished. Only a slight description is necessary to understand the operation of the die shown in Fig. 5. The shell *D* is located in a seat in the holder *Q*, and the die *R* descends, holding the flange of the shell tightly between the faces of *Q* and *R*, while the punch *S* forms the shell into the tapered shape shown at *E*. At the bottom of the stroke, pressure occurs on all surfaces of the shell, shaping it to a tapered and cylindrical form.

In the evolution of the finished shell the following changes take place in the wall and flange thickness: At *c* (see *E* Fig. 2) the metal is reduced to 0.030 inch, at *d* to 0.022 inch, at *e* to 0.018 inch, and at *f* to 0.021 inch. It was necessary to anneal the shell twice, after the first draw and after the third or redrawing operation. To secure satisfactory results the annealing has to be accomplished without producing a surface scale, as the scale would prevent the attainment of smoothness and accuracy in the finished product.

Thin lard oil was used as a lubricant during the first two drawing operations, and then the shells were run dry and clean through the last two operations. No fractured shells came through, and the tools produced a large quantity of the shells which were used in molding fixtures for brass articles reinforced with cement. The drawing pads, punches and spring buffer pins used in the dies shown in Figs. 3 and 4, were made of steel, the other parts being made of cast iron. For the finishing die, Fig. 5, steel was used throughout for all the working parts, and the pad and die surfaces were hardened and lapped to a finish.

In drawing tapered shells of the type shown in Figs. 1 and 2, in which a uniform thickness of wall throughout is not demanded, a slight insufficiency of metal in the product of the next to the last operation is best, as the finishing tool can then stretch the metal so as to bring the surface and diameter perfectly smooth and true.

* * *

EFFICIENCY IN CYLINDRICAL GRINDING[*]

By F. B. JACOBS[†]

Anyone who has followed the progress made in cylindrical grinding for the last ten or fifteen years, will admit that the present-day grinding machine, which owes a large part of its success to the modern grinding wheel, has been one of the prime factors in cutting down the cost of production, by furnishing a rapid and efficient method for accurately finishing the component parts of high-grade machinery. To follow the development of the grinding machine from the crude toolpost grinder of the early sixties, to the present-day self-contained grinder capable of finishing such work as chilled rolls for steel mills, piston-rods for marine engines, and an endless variety of work of like nature that heretofore was finished by the slow process of turning, would without doubt be very interesting. For the present, however, let us merely consider a few of the methods employed by up-to-date concerns for obtaining the maximum output from the grinding machine.

The thoroughly up-to-date machinist who looks over the advertisements in the leading trade papers has probably noticed that the manufacturers of grinding machines are not at all bashful in their claims for the efficiency of their machines, and that several makers of grinding wheels play a close second. But notwithstanding all that has been published concerning the efficiency of grinding machines and grinding wheels, the average shop foreman seems to be perfectly satisfied as long as the operator of the grinding machine turns out work that is nicely finished, in just a little shorter time than it could be done by obsolete methods.

There are several reasons for this condition of affairs: One is that the average shop foreman served his time before the introduction of modern grinding; another is that the majority of grinding machine operators have made themselves believe that because they are employed on accurate work, they should be a long time in doing it. Among other reasons are the improper selection of wheels, slow traverse speeds of work, running the wheel too far over the ends of the work, grinding long work without backresting, setting the reverse dogs for each individual piece, and neglecting to use the automatic cross-feed. These are by no means all of the reasons for curtailed production. However, they are the most important to be considered at present, and for the sake of convenience they will be taken up one at a time.

The average shop foreman who served his time long before the introduction of modern grinding methods, has had no practical experience concerning them. For this reason he is satisfied with results that otherwise would be more closely investigated. The makers of grinding machines and grinding wheels are at the present time getting excellent results and high efficiency with their products, and there is no good reason why the average shop foreman cannot get the same results, if local conditions will permit.

As mentioned, the average grinding machine operator seems to have the idea that because he is employed on accurate work, he should be a long time in doing it, feeling his way along carefully, and at the end obtaining the finish by the slow and out-of-date method of letting the wheel "grind out." In justice to the thousands of operators employed on grinding machines, it should be stated that the amount of time "killed" on the grinding job by "soldiering" is insignificant when compared to the time wasted through lack of knowledge concerning modern methods. In nine cases out of ten, the grinding machine operator did not have a competent man to "break him in" on the job. He had to work out his own salvation. It was a case of making good or getting fired. Therefore, he is not wholly to blame if he chose what seemed to be the easiest way of doing his work accurately. Another mistake, and one which is quite common in some localities, is to have the operator run two cylindrical grinding machines at once. The result is that one of the machines is running on a "blind" feed about half of the time. This may look all right, but it must be remembered that overhead expenses are going on while production is at a standstill. The practice recommended by the most successful makers of grinding machines, is that one operator should run but one machine at a time, in order that the machine may produce the maximum of work.

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[*] For additional information on this and kindred subjects, see the following articles previously published in MACHINERY: "The Field for Grinding—A Comment," July, 1911; "Rough Turning vs. Rough Grinding of Crankshaft Pins," March, 1911; "The Field for Grinding," January, 1911; "Precision Grinding," January, 1911; "Grinding Economy," July, 1910; "Grits and Grinding Chips," June, 1910, engineering edition; "Economy in Grinding," May, 1910; "Cylindrical Grinding," May, 1909; "Helps and Don'ts for Grinding," August, 1908; "Grinding and Grinding Machines," April, 1908; "Precision Grinding," September, 1907, engineering edition.

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It seems to be a common error in the majority of shops to have a large variety of grinding wheels for one machine, whereas a few would be sufficient. For the ordinary plain grinding machine four, at the most, are enough, *viz.*: one for cast iron, one for very low carbon (cold-rolled) steel, one for 30-point and up carbon and crucible steel, and one for hardened steel. For the universal grinding machine, which is generally used for finishing tool work such as jig bushings, reamers, cutters, etc., one wheel will often suffice, provided it is of the proper material, and of the right grit and grade.

Wheels of too fine grit are another source of curtailed production. Many operators are of the opinion that a fine grit is necessary for producing a fine finish. This is an erroneous idea. A mediumly coarse wheel, provided it is of the proper grit combination, will produce as good a finish as a fine wheel of a straight grit, if used under the proper conditions. Wheels finer than 60 in a straight grit are practically useless for the majority of precision grinding operations. They cut slowly, call for a fine traverse feed, heat the work, glaze, and are the source of various other troubles.

The average grinding machine operator knows but little concerning the selection of wheels for various classes of work, the shop foreman less, and the purchasing agent, who generally selects the wheels, still less. For this reason, the majority of the progressive concerns leave the selection of wheels to the maker, describing the work, the kind of material to be ground, and the finish desired. It must be remembered that the makers of grinding wheels have a wider experience than any one operator or concern can ever hope to get, and for this reason are more competent to select wheels, provided the proper data are submitted to them. To be sure, they make mistakes once in a while, but before condemning a wheel as useless for a certain class of work, the operator should make sure that it is run at the proper speed. A good rule, followed by many, is to speed up the wheel if it wears out too readily, and to reduce the speed if it glazes. Many operators condemn wheels that would show high efficiency if run at the proper speed. They seem to be under the impression that the wheel should show the highest efficiency under any and all conditions.

Some ten or fifteen years ago—in the days of the fine-grit and hard-grade wheels—it was necessary to use a fine traverse feed to overcome the tendency of the work to chatter. For the same reason three-quarters of the face of the wheel was often cut away with the diamond. This practice, which in many shops has been handed down to the present time, is a fruitful source of curtailed production. The modern grinding wheel with its wide face and open bond is very free-cutting, and for this reason the traverse feed can be greatly increased. In roughing, the traverse feed should be very nearly the width of the wheel for each turn of the work. In other words, if the wheel has a one-inch face, the work should move past the wheel about seven-eighths inch for each turn. For the finishing cuts, the feed can be much finer, depending on the quality of the finish desired. If a fast traverse feed causes the work to chatter, this should be overcome by proper back-resting.

Many operators waste much time in permitting the wheel to feed way past the end of the work before reversing. This is especially true in grinding work like bushings, where the wheel can run off both ends of the work. The reason for this is the belief that the wheel, if dwelling in one spot during the reversal, will wear this place under size. Modern practice has proved this belief to be wholly erroneous; the outside edge of the wheel should pass the end of the work about one-eighth inch, but no more.

Long or slender parts should always be backrested when it is desired to turn out accurate work free from chatter marks. The improved rests supplied with grinding machines, possessing the advantages of both the solid and spring rest, can be used to advantage on the majority of cylindrical work. A good rule for spacing the rests is to place one for every foot of work of about one inch in diameter. Larger work does not call for such a close spacing of the rests. In placing rests, the following method is often employed with good results: Suppose the operator has a shaft to grind four feet long and one inch in diameter. First grind a spot and locate a rest one foot from the footstock. In grinding this spot, feed the wheel directly into the work, bringing the diameter to within 0.002 inch of the finished size. Next, locate a rest one foot from the headstock in the same manner, and then one in the center. While taking the roughing cuts the rests should be used "solid," that is, with the jaws fastened. For the finishing cuts the springs can be used to keep the jaws against the work, care being taken to see that they do not bear hard enough on the work to throw it out of alignment.

Another common error that causes waste of time is the setting of the reverse dogs for each individual piece to be ground, when the operator has several pieces of the same length to grind at a time, and when the wheel has to be fed quite close to a shoulder. If the pieces were all centered alike this individual setting would, of course, be unnecessary. However, as they never are centered alike, care has to be exercised as otherwise the wheel will be likely sometimes to gouge the shoulder of the work. A safe and efficient way is to proceed as follows: First bring the wheel to within 1/32 inch of the shoulder and feed directly into the work, bringing the diameter to within, say, 0.002 inch of the finished size. Then proceed to grind in the usual way, setting the reverse dog to reverse the wheel when within 1/4 inch of the shoulder. This will answer for all the pieces and will take care of the irregularities due to errors in centering. When the work is ground to the desired size, feed the wheel by hand over the small portion near the shoulder not yet ground.

For the majority of cases of cylindrical grinding, the automatic cross-feed should be used. The knock-off should, of course, be adjusted, as otherwise the piece will be ground undersize. The cut should be as deep as the wheel and machine will permit, without unduly heating the work. When a number of pieces are to be ground it is good practice to first rough-grind all of them, bringing the diameter to within 0.002 inch of the finished size, and keeping the wheel sharp and free-cutting meanwhile. The wheel should then be trued off, using for this purpose a diamond which is fed past the wheel with a slow feed. This gives the wheel the proper cutting edge to produce a nice finish without any waste of time. Many operators rough and finish pieces one at a time. This is very poor practice, and should be discouraged, as it is not only a waste of time, but shows a lack of knowledge of the first principles of commercial grinding. Working under these conditions, the wheel has not the proper cutting face for either operation.

In conclusion, it can safely be stated that no one person "knows it all" when it comes to cylindrical grinding. The field is large, and in a few years practical results will be attained along these lines that are hardly dreamed of at the present time. The grinding machine operator should endeavor to gain all the knowledge he can concerning his work, by study and observation, ever bearing in mind the fact that the man who knows "how" does not have to depend on a labor organization to secure the maximum wages paid in his locality.

THE MANUFACTURE OF STEEL BALLS*

ROUGH GRINDING, HARDENING, AND FINISH GRINDING

By ROBERT H. GRANT†

In the article on ball making in the February number of MACHINERY, the methods of making the blanks and preparing them for the dry grinding were explained. In the present article the grinding and hardening operations will be dealt with. The old English method of grinding the balls was mentioned in the previous article, the balls being ground between two circular plates, the upper one of which was revolved by hand. The increased demand for balls in the bicycle industry soon brought about improved methods for grinding, the first step being to fasten the top plate to the spindle of a drill press, while the bottom plate rested on the table of the machine. In this way work was produced very much faster but no better quality was obtained than formerly.

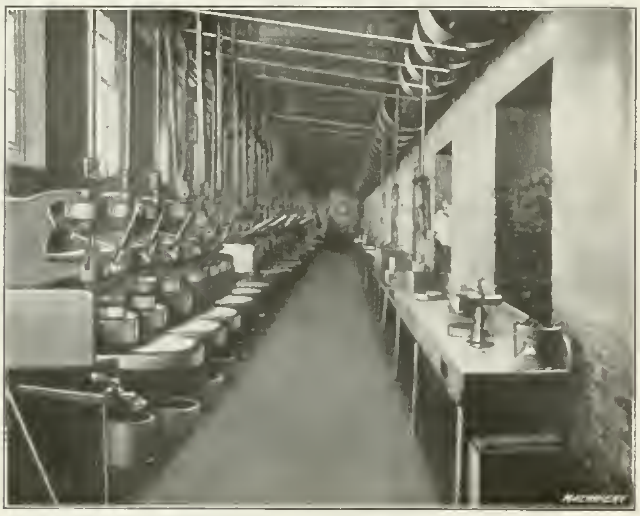

Fig. 1. Battery of Early Type of Ball Grinding Machines

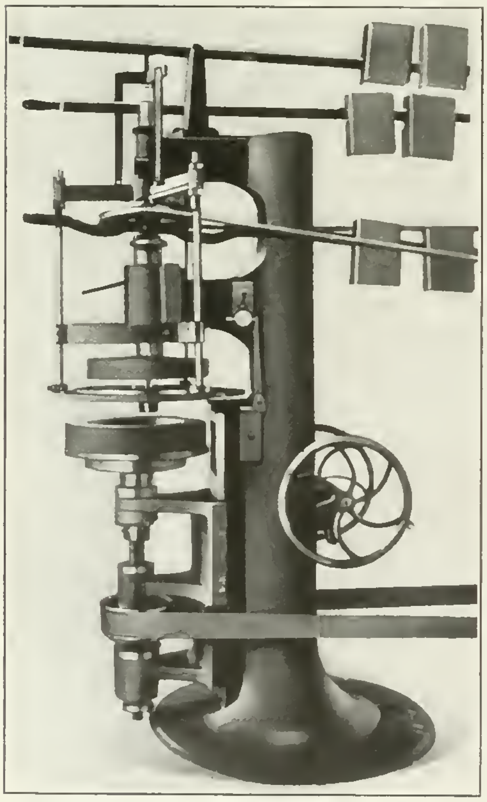

Fig. 2. Richardson's Ball Grinder

About the time when the first steel balls were manufactured in this country, special grinding heads of a much more substantial character were devised. Fig. 1 shows a row of oil grinders, such as were first made in this country. The head is made in the form of a goose neck, and has three bearings. The lower, or main, bearing has a quill the same as a drill press, with a rack cut in it. A lever with pinion teeth cut on the end meshes with this rack and provides the means for raising and lowering the head. The spindle, which has a large faceplate fastened to the lower end, carries the upper grinding ring, which is fastened to the faceplate by three screws. The main drive is through a set of bevel gears on the countershaft directly over the spindle of the machine. A vertical shaft transmits the power from the countershaft to the spindle. As all the blanks at this time were either pressed or forged, instead of being turned, the amount of stock to be removed was considerably more than it is when turned ball blanks are used. For this reason the time required for grinding ¼-inch balls was from one-half to three-quarters of an hour, and if the rings were badly worn the balls would come out of the grinder considerably out of true. It was, therefore, necessary to devise a better and quicker process—a rough grinder—for removing the surface of the balls. It is especially necessary to remove the surface to some depth when the balls are forged, as the outside is then apt to be decarbonized.

The Richardson Rough Grinder

The first rough grinder for balls, as far as the writer knows, was made by Mr. Henry Richardson, president of the Waltham Emery Wheel Co., Waltham, Mass., in 1877. Mr. Richardson, in speaking of this machine, has mentioned a few interesting facts about his experiments along this line. He took a regular 16-inch bastard file and ground a 90-degree groove in the center, almost the entire length of the file. The groove was ground clear through the file so that it would allow a 5/16-inch ball to project through to such an extent that the ball could be ground by a wheel without the latter touching the file. An emery wheel was then fastened to the faceplate of a lathe, and the file was clamped to the carriage in a vertical position. A plate with an elongated slot, which could be moved up and down on the tailstock spindle, was then made. The file with the balls was now placed against the emery wheel, and the plate on the tailstock was placed against the balls. The lathe was then started. The balls at once began to move in the V-groove in the file, and by moving the plate on the tailstock spindle up and down, the balls were turned in all directions, producing in a very short time a blank which was a comparatively true sphere.

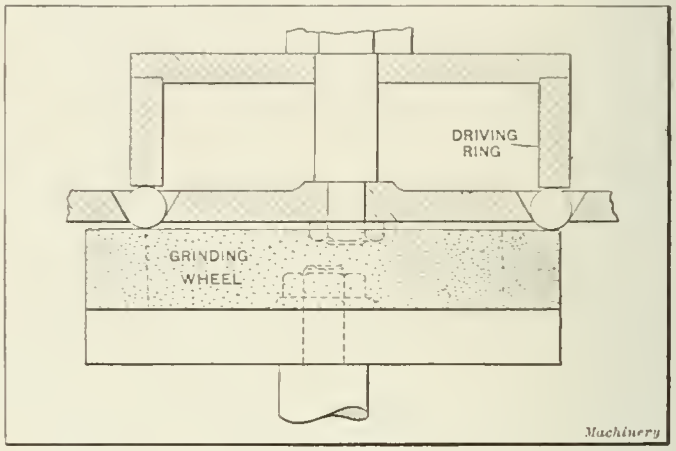

Fig. 3. Diagrammatical View of Principal Arrangement in the Richardson Ball Grinder

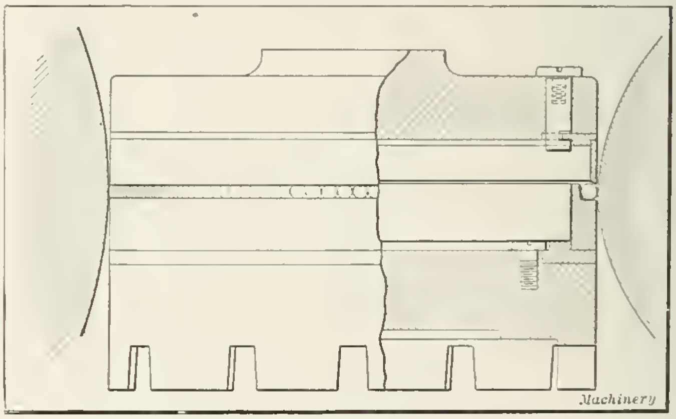

Fig. 4. Principle of the John J. Grant Rough Grinder—U. S. Patent No. 535,794

Mr. Richardson then made a trial machine which worked very satisfactorily, but as a photograph of this machine was never made, no record of its appearance is preserved. In 1878 he went to England and sold the English patents to Mr. Wm. Bown. A sample machine, as shown in Fig. 2, was made at this time. The patent held by Mr. Richardson did not, however, properly cover the invention, so that he was unable to get full returns for his efforts. The only claim of any importance which he held was as follows: a ring of balls in a V-groove, revolved by a driving ring and exposed to an emery wheel. This claim was the direct result of his experiments, and by itself was very far-reaching. It gave the ball makers, who soon began to spring up all over the country, a great deal of trouble in their efforts to "go around" it.

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* See MACHINERY, February, 1912: "The Manufacture of Steel Balls—Making the Blanks."

† Address: 912 Oakland Ave., Ann Arbor, Mich.

As shown in Fig. 2, the emery wheel is placed on the lower spindle which is mounted in the movable head; this head is operated by the handwheels at the rear of the machine. The emery wheel is eccentric with the top ring, so that the whole surface of the wheel will successively come in contact with the balls. This keeps the wheel in perfect shape. The V-groove in which the balls rest is formed by two annular rings or plates (see diagrammatical view in Fig. 3); the outer one is held and adjusted by three long bolts (shown in Fig. 2), while the inner plate is fastened to a rod which passes through the drive shaft to the top of the machine. This inner plate is operated by the middle lever shown, so that the balls thus can be "dropped" when finished. The driving ring which revolves the balls is adjustable in an up and down direction by means of the lower lever, and is clamped in the proper position by the small lever on the main bearing. This driving ring runs in the opposite direction to the emery wheel; the latter is run at a peripheral speed of approximately 5000 feet a minute.

On account of the fact that the outside of the balls run faster than the inside, as they are driven around by the drive ring, the balls assume a spiral motion, thereby exposing all sides to the emery wheel. An approximately accurate sphere is thus produced.

The John J. Grant Rough Grinder

In 1888 when the Simonds Rolling Machine Co., of Fitchburg, Mass., was grinding balls by the old English method, it could only produce balls which were true within 0.003 inch. This accuracy was considered sufficient at that time. Mr. John J. Grant, who was at that time employed by this company, and who had improved the Simonds rolling machine, proceeded to devise a machine which made it possible to produce balls far superior to any ever made. The principle of his first machine, which was a rough grinder, is shown in Fig. 4. This machine produced excellent work, but was very slow in its operation, as the balls had to travel one-half of the circumference of the groove in the ring without coming in contact with the emery wheel. On balls of smaller sizes, the upper or driving ring was so thin that it was possible to grind but a few balls before the emery wheel would wear it away. As shown in Fig. 4, the balls were held at the periphery of the stationary ring in a V-groove. The drive ring was extended over the balls far enough to drive them, and was driven by a pulley on the spindle which held the drive ring. The speed was not over 60 revolutions per minute. A saddle, which was stationary on the base of the machine, carried the emery wheel heads, each head having two wheels, so that the surface coming in contact with the ball would be as wide as possible. The driving pulley was placed between the emery wheels, all being driven from the same countershaft. The upper or drive ring could be raised by a lever at the top of the machine, and the lower ring could be revolved by throwing out a latch with a foot lever. This allowed the machine to be loaded and unloaded very rapidly. Notwithstanding the fact that this machine was very slow, as compared with the Richardson machine in which the emery wheel was on the balls at all times, it was successful, and it was possible for the Simonds company to produce a ball better than those produced by any other manufacturers, and the company, therefore, soon controlled the ball trade.

In 1891, the Grant Anti-Friction Ball Co. was formed by Mr. J. J. Grant, and a great many experiments in the dry grinding of balls without the V-path and drive ring were undertaken, but the experiments were not successful. It was, therefore, necessary to buy Mr. Richardson's patent, and around this was built the most successful dry grinder ever produced.

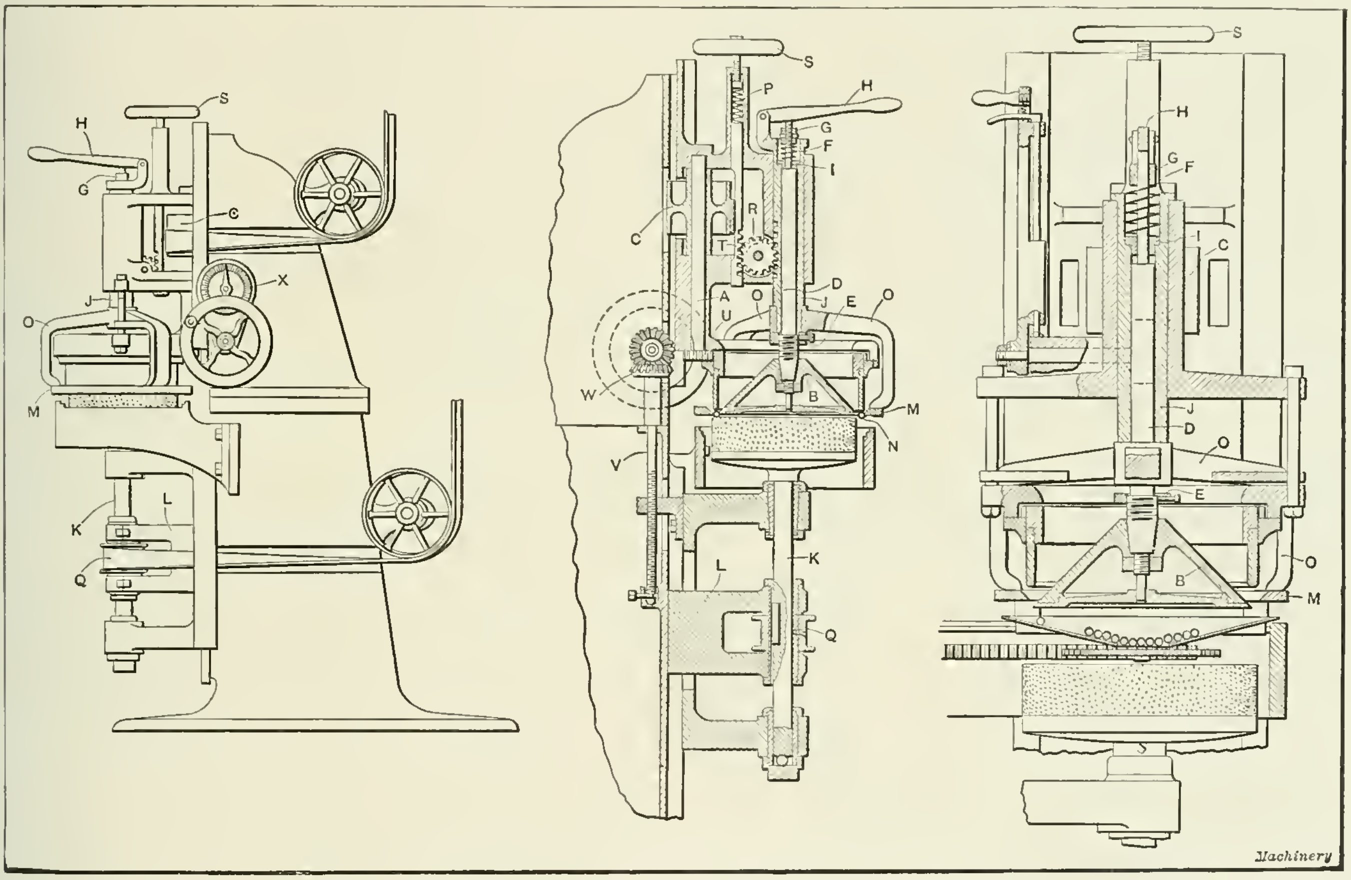

Fig. 5. Robert H. Grant Dry Grinding Machine—U. S. Patent No. 520,019

The Robert H. Grant Dry Grinder

In Fig. 5 are shown general and sectional views of the grinding machine designed by the writer, as originally made. It will be seen that the Richardson path is used in a modified form. The drive ring is driven through a gear on the drive ring holder, this gear, in turn, being driven by pinion *U* which is fastened to the shaft *A*. This shaft carries pulley *C* at its upper end. The cone *B* has a plate with hardened segments screwed to its lower end which form the inner part of the race *N*. The cone is fastened to the shaft *D* which is adjustable by collar *E*. On the upper end of the shaft is a spring *F* which is compressed between the collar *I* and the adjustable sleeve *G*. By means of the lever *H*, the shaft *D* can be lowered, thereby allowing the balls to drop into a receptacle after being ground, as shown in the view to the right. On the rear of the quill *J*, which carries the shaft *D*, is cut a rack in which pinion *R* works. The shaft *T* which operates pinion *R* is adjusted by the spring *P*, controlled by the handwheel *S*. On the lower part of the quill *J* is fastened the spider *O* which carries the ring *M*, to which are screwed the hardened segments forming the outer path.

It will be seen that when the rough forgings are placed in the V-path, the driving ring is stationary, but the inner ring can vibrate on account of the action of the spring *F*. The outer ring *M* is permitted to vibrate slightly through the means of the spider *O*, quill *J*, pinion *R* and spring *P*. In this way the rough forgings will be ground only on the high spots until the balls become round.

The loading and unloading is done without stopping. When the balls are finished, the emery wheel is lowered and a pan is pushed under the path of the balls. The handle *H* is pulled down, thus allowing the balls to fall into the pan. The spider *O* is then lowered by means of the lever on the end of the shaft carrying pinion *R*. This allows the balls to be ground to be fed into the path *N*, and permits the grinding to commence without interruption.

The emery wheel, which is eccentric with the path of the balls, so as to allow the balls to successively cover the whole surface of the wheel, is carried by the lower head. The spindle *K* carries the pulley *Q* which is driven by a belt running over idlers to the countershaft above. Head *L* is raised and lowered by the screw *V* and the bevel gears *W*. The indicator *X*, having a pointer as shown, is connected to this mechanism, and shows the operator how many thousandths inch more he must remove from the balls. With the introduction of this machine the cost of making balls was cut in two, and the quality obtained was far superior to anything which had so far been produced.

The Hawthorne Method of Rough Grinding

About the time when the writer had designed the machine just described, the Hawthorne Mfg. Co., of Bangor, Me., decided to enter into the manufacture of steel balls. This company originally manufactured boot calks and other lumbermen's supplies. Some articles were manufactured for this concern by the Simonds Rolling Machine Co., and representatives of the company frequently visited the Simonds plant. They observed the great number of balls that were beginning to be used in this country, and hence concluded to enter into this field. The first grinder employed by this company made use of sand instead of emery. A bed of sand had been found in which the grit was so hard that it would cut the surface of a ball and last for a considerable length of time before being pulverized. The grinding was done in a closed path in which water and sand were used freely. The sand was fed from bins overhead, and washed out by water when pulverized. This was a very cheap process, as far as the grinding material was concerned, but did not produce a perfectly spherical blank. The oil or finishing grinders had to be relied upon to round up the balls, and a great many seconds and thirds were produced. The process was applicable, however, to the small balls mostly used at that time, nearly all balls being employed in bicycles. For larger balls, such as are now used in automobiles and other machines of the present day, these machines would have been useless.

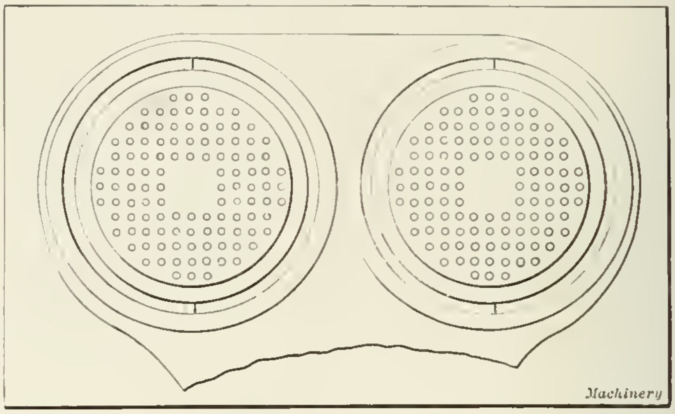

Fig. 8. Arrangement of Balls in the Putnam Grinder

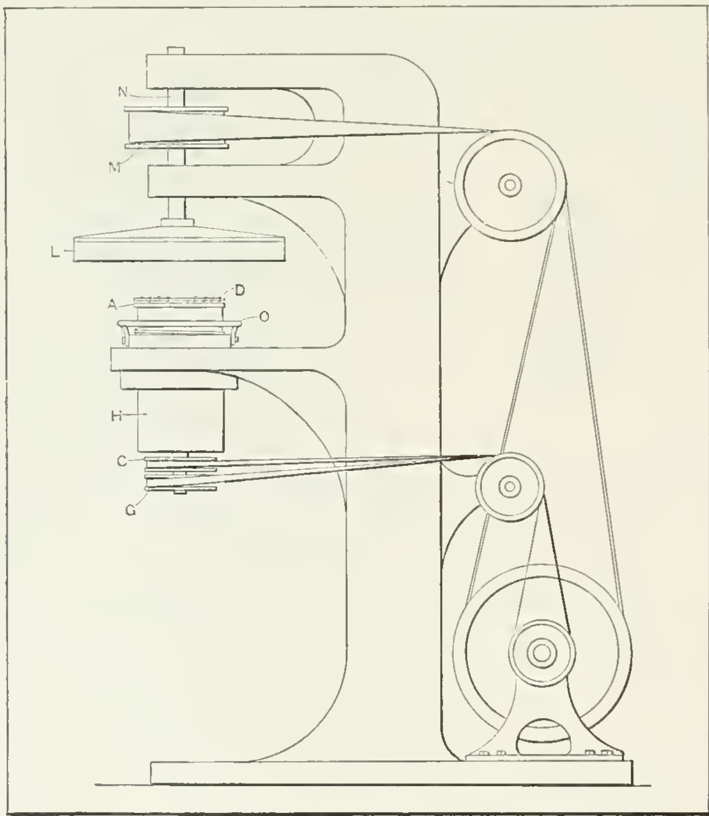

Fig. 6. The Putnam Dry Grinder—U. S. Patent No. 664,823

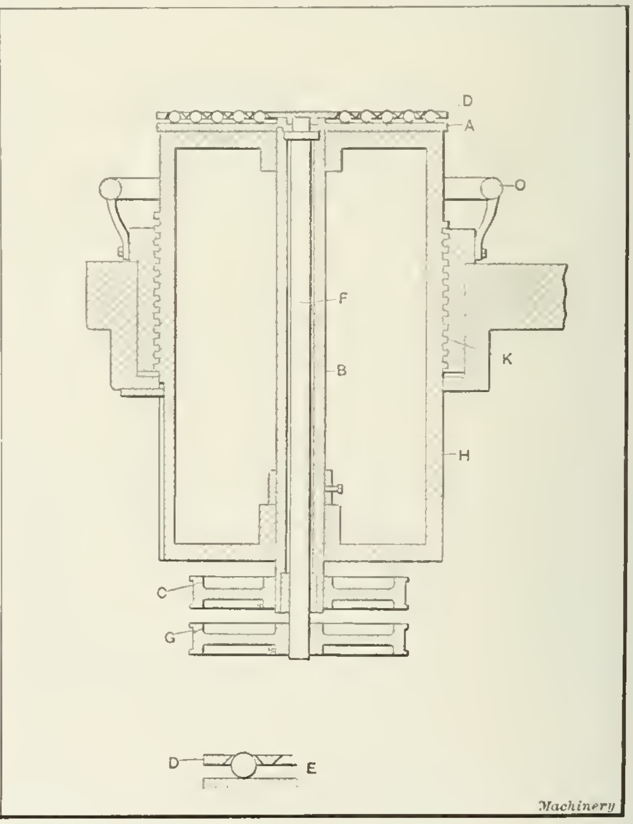

Fig. 7. Details of Principal Parts of the Putnam Grinding Machine

The Putnam Ball Grinding Machine

About 1899, Mr. H. M. Putnam, who for several years was connected with the Simonds Rolling Machine Co., started the Fitchburg Steel Ball Co., and invented a dry grinder, as shown in Figs. 6, 7 and 8. This machine, which had to be constructed without the Richardson path, was made in the following manner: The lower plate *A* which corresponds to the drive ring, was driven through the tube *B* which carries the pulley *C*. The plate *D* which is countersunk as indicated at *E*, Fig. 7, (see also Fig. 8) is made from saw steel and hardened; it is then forced onto spindle *F* which carries pulley *G*. The cylinder *H* is adjustable by means of the screw thread *K*, and can thus, by means of handwheel *O*, be raised or lowered by the operator so that the balls will come in contact with the emery wheel *L*. This wheel is fastened to the upper spindle *N*, which is driven from pulley *M* by a belt passing over two idler pulleys to the countershaft on the floor, as shown. This machine is very simple, but it does not grind an accurate ball on account of the balls being at various distances from the center, thereby giving them different rates of speed. The outer balls are ground faster than those at the center, and thus balls of all kinds of diameters and degrees of accuracy are produced. The balls are not held firmly in the path as in the Richardson grinder, but are simply confined in the countersunk holes so that they will not be thrown from the plate. This allows the ball to take its own course, and it becomes badly out of round during the grinding process. The writer is of the opinion that this machine might have been improved, but the company discontinued business soon after the machine was built.

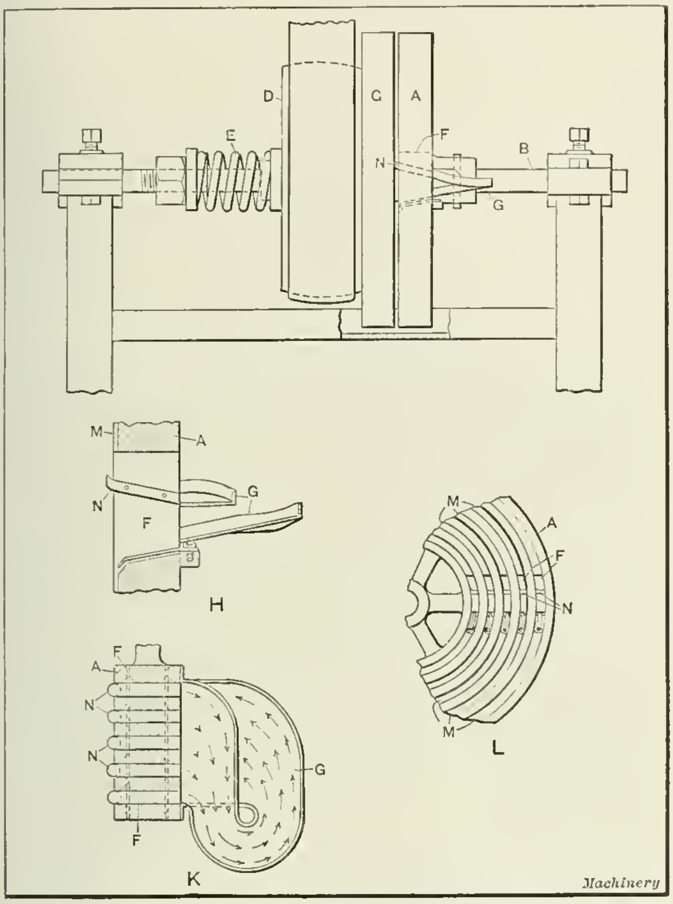

Fig. 9. The Hoffmann Ball Grinding Machine—U. S. Patent No. 803,164

The Chicago Steel Ball Co.'s Grinder

About the same time the Chicago Steel Ball Co., of Chicago, Ill., brought out a dry grinder which had several good features, and which was somewhat similar in operation to the well-known Hoffmann machine which will be described in detail in the following. The Chicago Steel Ball Co.'s machine had the emery wheel and the drive wheel placed in a vertical position. There were several concentric circular paths on the drive ring, and the balls were transferred from one into another, thus giving the balls a different spiral motion on account of being at various distances from the center. This machine ground a very accurate ball, but on account of its poor construction and the poor method used for transferring the balls from one path to another, it was but little used, and, therefore, had no particular influence on ball manufacturing methods.

The Hoffmann Grinder

What may be considered as one of the best ball grinding machines constructed was invented in 1905 by Mr. E. G. Hoffmann, who was at that time connected with the Hoffmann Ball Co., in England. This machine required several years for its development, but when completed it produced a very accurate ball, and is greatly appreciated by ball manufacturers.

In the article on ball manufacture published in the February number of MACHINERY, the Hoffmann ball turning machine was described. The blanks produced by this machine are accurate, and but little grinding is required on them. These balls, therefore, are especially suited for grinding in the Hoffmann grinder, as this machine is very slow, and cannot be used to advantage on pressed blanks or forgings, unless they have been previously rough ground by some other process. The machine is automatic, and requires little or no attention, except for gaging the balls at intervals during the grinding. The machine requires from three to five hours for removing 0.001 inch on a ½-inch ball.

In Fig. 9, diagrammatical illustrations of the Hoffmann machine as originally designed, are shown. Pulley *D* is driven by a belt from the countershaft, and revolves upon a stationary shaft *B*. The pulley is fastened to the disk *C* which has a series of grooves in its face. Plate *A*, which also has a series of concentric grooves to correspond with those on disk *C*, is stationary and is fastened to shaft *B*. The balls are placed in the machine so as to fill all the concentric grooves, spring *E* forcing disk *C* against plate *A*, thus holding the balls in place. The machine is then started, and the balls, by means of the mixer and interchanger shown in two views at *H* and *K*, are changed from one groove to another.

As indicated at *H*, *K* and *L*, slots *F* are cut through the stationary disk, a slot being directly opposite each of the grooves *M*. In each slot is placed a finger *N* which projects slightly beyond the bottom of the groove into the corresponding groove in the rotating disk *C*. The function of the finger is to stand in the path of the balls so as to positively dislodge each ball from the groove as it reaches the point where the finger is located. Each finger discharges the ball from the corresponding groove upon a table *G* which affords a surface upon which the balls may roll, and which also directs the balls back toward the grooves below the fingers, the table being slightly inclined toward the lower portion of the slots *F*. It will be seen that this keeps the balls moving from one groove to another so as to place them at different distances from the center at each revolution of plate *A*. This results in the grinding of a very accurate ball.

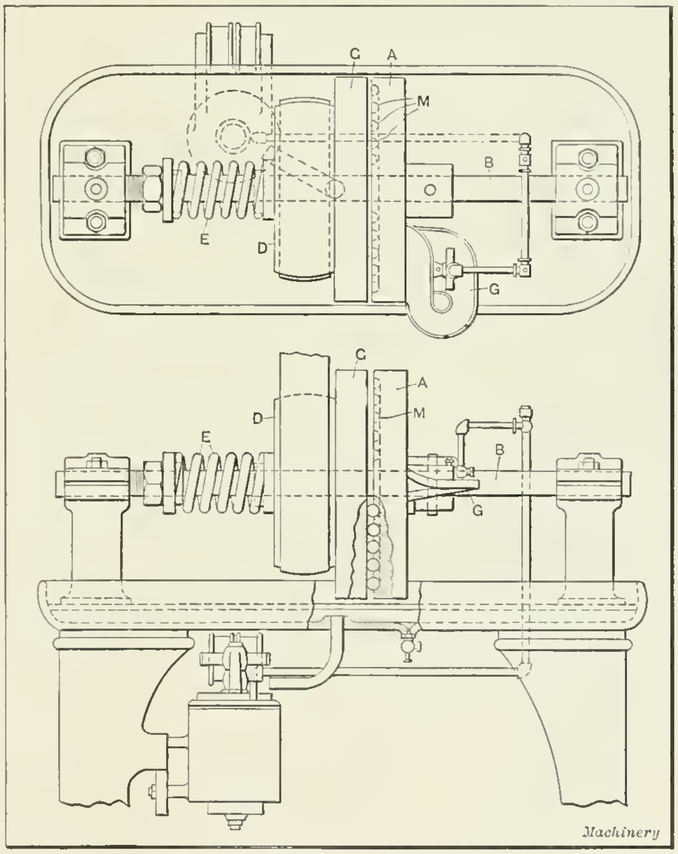

Fig. 10. Improved Hoffmann Ball Grinding Machine—U. S. Patent No. 868,926

The grinding is done with oil and emery introduced in the required quantities upon the table *G*, and fed into the machine by the balls. This machine was further improved by the introduction of an emery wheel in place of the grinding ring *C*. The improvement was very marked, as the grinder *C*, when made of cast iron, was apt to be spongy, and softer in some spots than in others; it would, therefore, quickly wear out of shape. The replacing of this disk by the emery wheel overcame these difficulties. Kerosene oil is used to keep the grooves clear of the loose particles of abrasive material, and prevents the balls from being badly scratched or cut. A very peculiar fact about this grinder is that the emery wheel is run at only 75 revolutions per minute, instead of at the peripheral speed of 5000 feet, generally required by emery wheel manufacturers.

Annealing and Hardening

After the balls have been rough ground so as to remove all scale and decarbonized surface resulting from the forging operation, they are taken to the hardening room where they are first annealed. This annealing removes any internal stresses caused by forging or other methods of blanking. The process, as indicated in Fig. 11, is automatic. The balls are fed into the hopper *B* which is revolved by a worm and worm-wheel placed at the opposite end of the machine. From this hopper the balls are fed into the spiral *E* which they follow until they reach the opposite end, where they drop into the outer spiral *H*, which is revolved in the opposite direction. Finally the balls fall out of the cylinder at *I* into the funnel *K*. The machine is heated by gas with burners at *R*, thus preventing the heat from coming into direct contact with the balls and decarbonizing the surface.

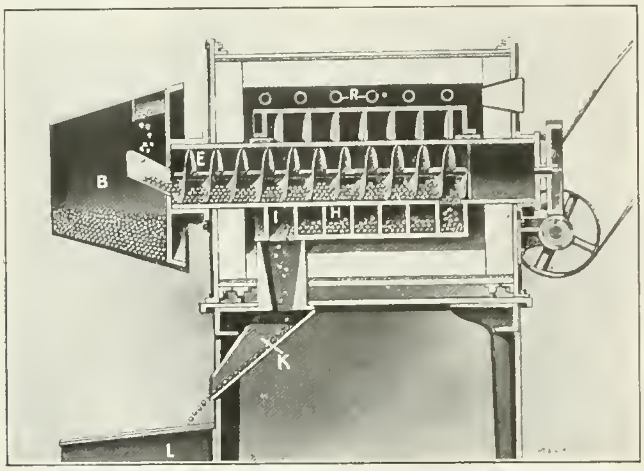

Fig. 11. Section of Ball Heating Furnace, made by the American Gas Furnace Co.

After being annealed, the balls are put through the same machine to be heated for the hardening. They are heated to exactly 1275 degrees F., the temperature being determined by a pyrometer. The thermo-couple is placed near the point where the balls leave the cylinder.

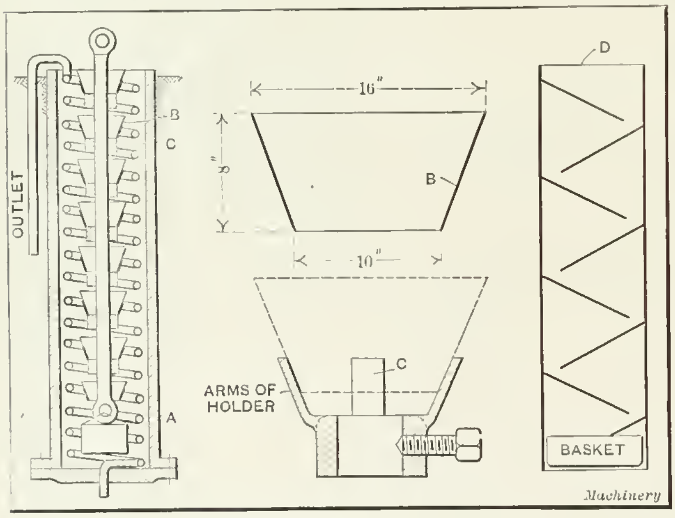

Fig. 12. Tanks used for Quenching Balls

The smaller balls are dropped into a reservoir of oil, while the larger ones are immersed in brine. The oil reservoir, shown at *A* in Fig. 12, consists of a length of 30-inch water pipe, one end being provided with a head strongly bolted to it so that it is water-tight. The pipe is sunk into the ground so that the top can receive the balls, as indicated at *L*, Fig. 11. Inside of this cast-iron pipe is placed a coil of 1¼ inch water pipe, in which cold water is circulated in order to keep the bath cool. A rod with a number of inverted galvanized iron cones *B*, adjustably fastened onto the rod by the holders *C*, is then placed in the bath. (Parts *B* and *C* are also shown in detail in Fig. 12.) When the balls drop into the bath in the pipe, they strike the side of the upper cone, which shoots them off at an angle until they strike the opposite side of the next cone; this reverses their direction of motion, so that they reach the basket at the bottom in a zigzag path, thoroughly cooled off. When the balls are thus cooled off, the rod with the basket at the lower end is pulled out, and the balls in the basket are allowed to drain, the oil draining back into the pipe.

The best oil for the hardening of balls is cotton-seed oil; while it is very expensive, it has sufficient body to cool the balls thoroughly, and it does not need to be replaced. It is only necessary to add to it, from time to time, due to the loss from evaporation.

The larger balls are hardened in brine. The machine shown in Fig. 11 is placed at the edge of a tank of the type shown at *D*, Fig. 12. This tank has a series of shutters made in the form of steps overlapping each other as indicated. These steps force the balls to traverse in a zigzag path through the brine in the tank for a considerable time before dropping into the basket at the bottom.

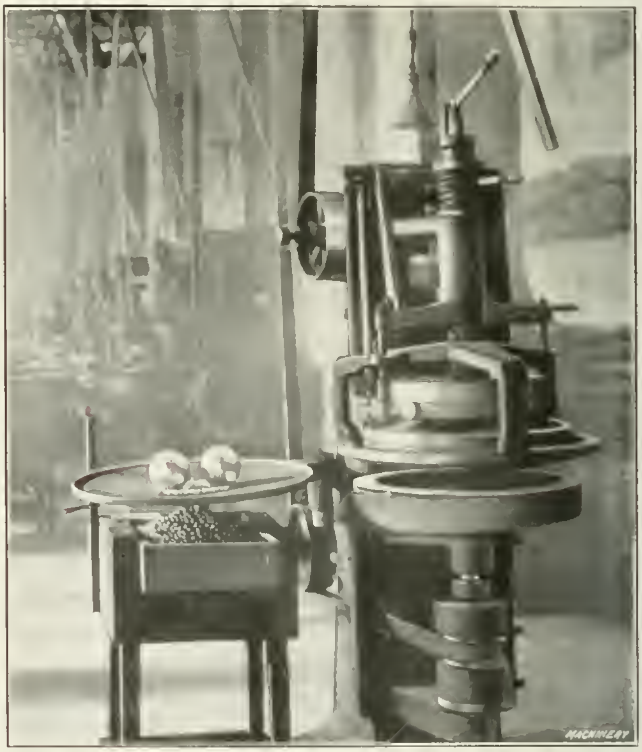

Fig. 13. General View of the Grant Dry Grinding Machine, with Samples of Largest and Smallest Balls ground in it

The largest balls are heated for hardening by being placed on the tiling of a regular casehardening furnace, similar to that made by the Brown & Sharpe Mfg. Co., and are allowed to heat slowly through to the center, the balls being revolved gradually. Two or more balls, according to size, are then placed in a wire basket and rapidly swung to and fro in the brine tank until thoroughly cooled off. All balls, as soon as they are taken from the hardening tanks are placed in a kettle of boiling soda, not only for the purpose of washing them, but also to prevent the air from coming in contact with them at a time when they are extremely hard. The balls are then placed in the drawing kettles, which are filled with oil heated to 325 degrees F.

Finish Grinding

The balls are now ready to return to the finish dry grinding department, where the same machine as shown in Fig. 5 is used (except that a finer grade of emery wheel is employed) to reduce the balls to the proper size for the oil grinders. For this finish dry grinding the inner and outer segment are ground true, so that the path formed is a perfect track for the balls.

In Fig. 13, the improved Grant machine (Fig. 5) is shown, with the two extremes in size of balls which this machine will grind. In Fig. 14 is shown the special grinding machine which is used for grinding the segments that form the path for the balls. These special grinders are very simple in construction, the wheel head being solid and the spindle on which the segment plate is fastened being driven by a worm through a shaft from a pulley in the rear. The two adjustments up and down and in and out are operated by the shafts which project in the front. By this grinding, the segments are made absolutely true, and by grinding the drive ring by the emery wheel on the machine on which it is used, the balls will make contact on three points absolutely true with each other, and hence the balls produced will be absolute spheres, ready for the final oil grinding.

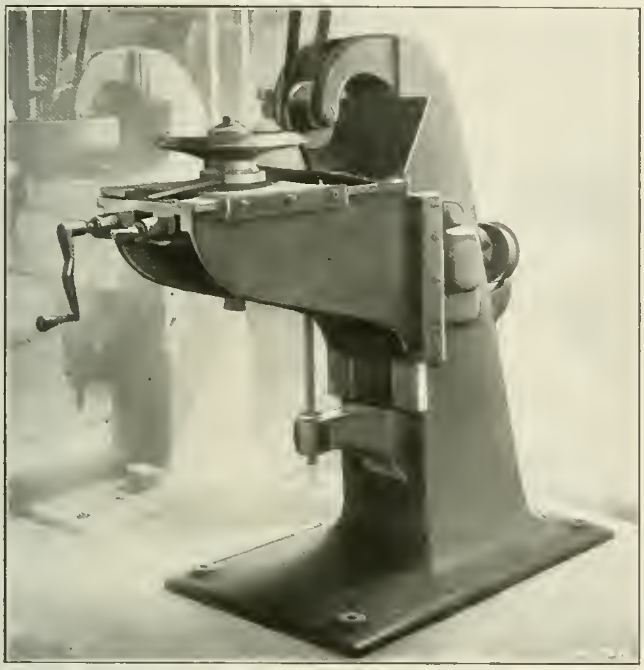

Fig. 14. Special Grinding Machine used for Grinding the Segments for the Path of the Balls in the Machine shown in Fig. 13

Fig. 17 shows the ordinary type of oil grinders. These are usually placed in groups of three. The machines are provided with a quill, on which a rack is cut for raising and lowering the head by means of the lever shown projecting at the front of the machine. The machines run about 450 revolutions per minute. The oil grinding constitutes the final finishing operation, and requires considerable skill. The operator must know just how much oil and emery to use, and how long to run the rings so as to make the balls round up.

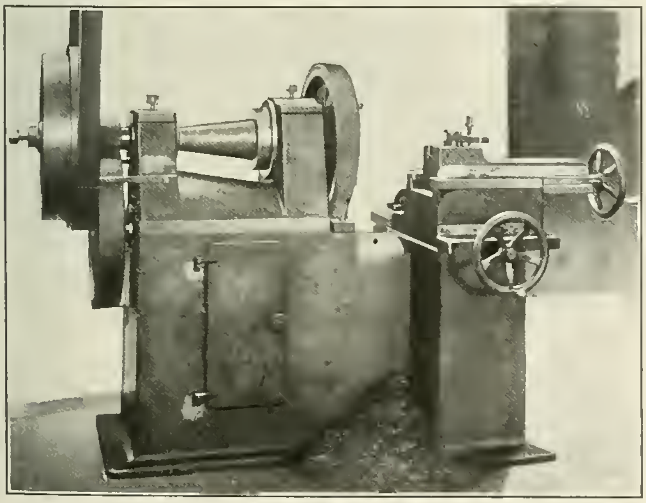

Fig. 15. Ring Turning Lathe for Dressing the Oil Grinder Rings

Assume, for example, that a man is to finish grind balls ¼ inch in size. In Fig. 16 is shown a diagrammatical section of the grinding rings. The circular path of the balls is usually 16 inches in diameter. A half circular groove is cut in the bottom ring, as indicated, and a small channel is cut at the bottom of the groove to allow the oil and emery to reach the bottom of the ball. The top ring is simply a cylinder shrunk onto a plate. This plate can be used over and over again, by merely breaking off the cylinder when used up and shrinking a new ring in place. The upper cylinder has a shallow groove in it for the balls. After the balls have been placed in the ring, the oil and emery are poured in, and the upper ring is lowered onto the balls, the machine then being ready to start. The ¼-inch balls should have 0.006 inch left for the finishing operation. The operator gages the balls and sets his clock on the head of the machine as many minutes ahead of the clock in the room as he knows will be required to obtain very nearly the final size. At this time he must stop the head and again measure the balls. The operator runs three heads, and as each head finishes its work at different intervals, he has ample time to stop any one head and take out three or four balls from different parts of the ring. After washing them in benzine, he measures them with his micrometer, testing both the size and roundness; if not to size, he replaces them and applies the required amount of oil, emery and speed, until he obtains a ball that is as nearly perfect as possible in all respects.

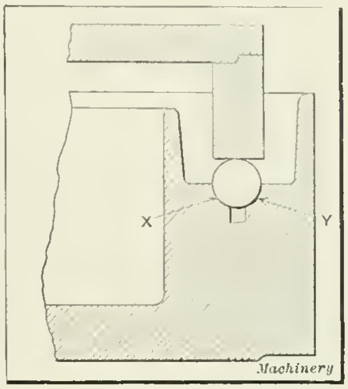

Fig. 16. Illustration of Principle of Action of Oil Grinders

The grinding ring should be of porous medium soft cast iron, as the oil grinding is merely a lapping process, and the ring must wear away to allow the balls to round up. On account of the larger diameter at the outside Y than at the inside X of the balls, Fig. 16, there is a greater peripheral speed at the outside. This causes the balls to move in a spiral path as they revolve, so as to bring all points of the surface in contact with the ring. The operator, when using a new ring for the first time, must make allowance for the ring not having become penetrated with emery, and also for its being cold. Later the output can be greatly increased. The heads on the grinders must be kept in perfect alignment, so that the balls will be ground on the entire circumference of the rings.

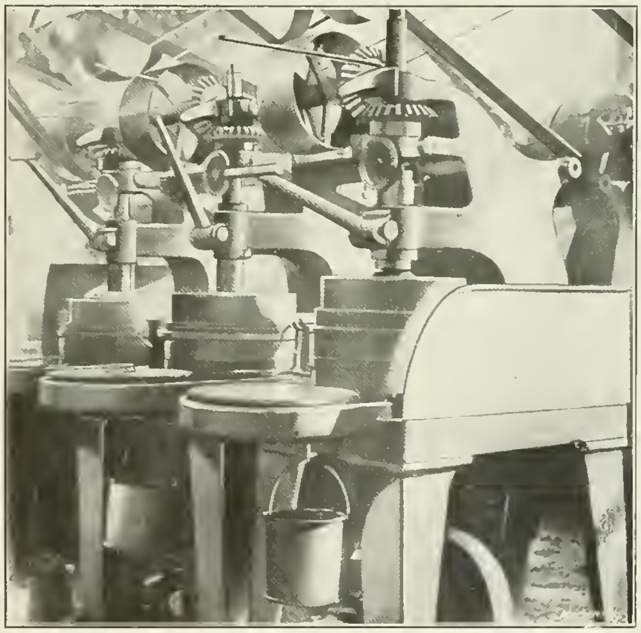

Fig. 17. The Oil Grinders

Fig. 15 shows a special ring turning lathe for dressing the oil grinder rings. It is necessary that these rings be free from chatter marks and imperfections of any kind, so that even the first sets of balls ground by them will be perfect; otherwise the first balls would have to be classified as seconds or thirds on account of poor grinding.

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MARCH, 1912

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MACHINERY is published in four editions. The practical work of the shop is thoroughly covered in the Shop Edition, $1.00 a year, which comprises approximately 700 reading pages. The Engineering Edition—$2.00 a year, coated paper, $2.50—contains all the matter in the Shop Edition, about 300 pages a year of additional matter and forty-eight 6 x 9 Data Sheets filled with condensed data on machine design, engineering practice and shop work. The Foreign Edition, $3.00 a year, comprises the same matter as the Engineering. The Railway Edition, $2.00 a year, is a special edition including a variety of matter for railway shop work—same size as Engineering and same number of Data Sheets.

SHOULD ENGINEERING SOCIETIES PAY FOR CONTRIBUTIONS?

The papers read before American engineering societies are of two main classes. One class describes installations of machinery and apparatus, and the considerations that had to be taken into account by the engineers in charge. These papers are generally valuable and unobjectionable, notwithstanding their advertising nature. The advertising that the concerns and engineers get from the presentation of papers is the incentive that causes them to be prepared. The other class comes from college professors, and chiefly describes tests conducted by students for their theses. The professor advertises himself and his college with little effort by giving the results of his students' investigations in a paper. These papers are legitimate and commendable when the investigations have led to results of practical value. Both classes of papers are contributed at little or no cost to the authors and mean little or no personal sacrifice.

A third class of contributions, of which there are entirely too few examples, comes from men who give their personal time and energy to the subjects of their papers. They give freely to the engineering world that which has cost them much thought and time to reduce to a form that can be generally understood and appreciated. Great credit is due them for their generosity and enterprise. But, is the brief recognition accorded these able men adequate compensation? Is not the American Society of Mechanical Engineers losing many valuable contributions that would be offered by individuals if they could afford to give the time and labor to their preparation? How can the difficulty be met except by offering compensation for the results of investigation made by men who cannot afford to give their work freely?

The society's sub-committee on machine shop practice is required to present those details of practice that can be collected and described only by the men in daily contact with the conditions of manufacturing. These men are generally paid wages much lower than the salaries of engineers, yet we ask them to contribute their time and energy for the benefit of the mechanical engineering world. Their reward is the honor of having their papers read before the society, which is probably highly appreciated, but which may be of little actual value to the individual. Will the ethics of engineering societies prevent doing what seems necessary to secure the records of the most advanced practice?

* * *

HARDENING VS. TEMPERING

A contributor to MACHINERY has written a letter in reference to the tool tempering furnace described in October, 1911, taking exception to calling it a tempering furnace when it is clearly a hardening furnace.

The exception is well taken. Every reader of MACHINERY who knows anything about hardening steel is well aware of the distinction between hardening and tempering. To harden a piece of carbon steel, we must heat it to a "cherry red," then quench it in a bath which is usually pure cold water. In the state produced by cooling in the bath the steel is too hard for use, being brittle and liable to chip or crack. The hardness is reduced by heating the piece to the temperature which experience has demonstrated to be sufficient to reduce the hardness to that consistent with the use of the tool.

Heat treatment of carbon steel almost invariably consists of two operations, first hardening and then "drawing" the hardness or tempering it to the required degree. The definition of "tempering" in the Standard Dictionary, edition of 1899 is: "To bring (a metal) to a certain degree of hardness by heat and suddenly cooling. In tempering steel, the metal is usually heated until it assumes a color, as yellow, brown, purple, or blue, and then plunged into water. The degree of heat (as shown by the color) at which the cooling takes place determines the degree of hardness."

This definition clearly shows a lack of understanding of the distinction between hardening and tempering, but in justice to the lexicographer it may be said that tempering is a term that is often loosely used to mean both hardening and tempering, that is, both operations necessary for the proper heat treatment of carbon steel, although it should not be so used by those who know and understand the true meaning of the term.

* * *

THE GROWTH OF THE MOTOR TRUCK INDUSTRY

The recent automobile shows held in New York City were startling revelations to many business men of the importance of the motor truck industry, from both the manufacturers' and users' standpoints. For several years it has been the fashion of editors, economists and others to deplore the fact that the inventive genius and manufacturing enterprise of the country apparently was almost exclusively concentrated on the improvement and construction of automobiles for pleasure. It seemed that the more useful and enduring business of commercial car building was practically neglected. While these strictures were in the main true, the developments of the past two or three years show that a substantial body of designers and builders was planning and making commercial vehicles that are satisfactorily meeting the exacting demands of business in large cities and towns.

Commercial trucks have arrived at the practical stage, and although they still have defects and undesirable complexities, the men capable of operating them are becoming available, and business concerns are using them. The expense of keeping horses in large cities grows greater every year. Stables must be located where rents are low, and this means in sections generally remote from business centers. The time lost in traveling between the stables and the warehouses is a serious item which becomes still more serious in Manhattan where stabling is available mostly in Brooklyn and Jersey City. Ferriage and bridge tolls are added costs of daily operation.

In times of weather stress, horses are subject to accidents and the ills incident to exposure. Loads must be reduced or teams doubled to move normal loads. The motor truck is subject to mechanical troubles, but its practically unlimited power, great capacity, speed and short overall length are advantages that will become more and more apparent as drivers become trained to operate trucks efficiently.

To secure greater efficiency of men and trucks, power loading and unloading facilities will be developed. These will not only accelerate the moving of freight, but will make the operation of power trucks more attractive to a desirable class of men. One of the existing difficulties is getting men competent to drive motor trucks who are willing and able to handle heavy boxes and parcels. Cranes that will lift a box from the sidewalk to the truck will make the loading quicker, easier and safer for men and merchandise.

It is interesting to reflect on the change that will inevitably develop in the personnel of truck drivers. As a class they are now known as ignorant, "horsey" and abusive men, more familiar with saloons than churches. When they become largely a class of men trained to efficiently control powerful road locomotives, the discipline of mind and body necessary to the understanding of machinery and its control must necessarily produce in them the characteristics of a more desirable class of citizens. A drunken driver of a power truck will be too dangerous to tolerate, and he must disappear.

* * *

STANDARDIZATION WORK OF THE S. A. E.

The work of standardizing the characteristics of automobile elements undertaken by the Society of Automobile Engineers is preceeding satisfactorily, notwithstanding the many difficulties that beset it. The general method followed is adjusting shapes, center distances, dimensions and capacities of accessories to common standards that will insure interchangeability, and thus make possible variations of the equipment without necessitating changes in the construction of the basic structure to accommodate them.

Standardization will enable the manufacturer and the user of automobiles to change from one make of motor car element to another at pleasure. Take for example the magneto. To secure interchangeability of magnetos, it is essential that the distance from the base to the shaft center of all magnetos shall be a standard dimension; also that the distance from the bolt holes to the end of the taper shaft, the taper of the shaft and the overall height, length and width, be common. Within these restrictions, each maker will be free to express his ideals of construction and design without interference. The advantages that should accrue from this standardization work, carried on as it is under the direction of representative automobile engineers, can hardly be overestimated.

The work of the committees also includes fixing the physical and chemical characteristics of aluminum and copper alloys, iron and steel, etc. Committees have been appointed on the following subjects: aluminum and copper alloys, ball and roller bearings, broaches, carbureters, frame sections, gear tooth shapes, iron and steel, leaf and coil springs, lock washers, miscellaneous parts, automobile nomenclature, seamless steel tubes, sheet metals, truck standards, wheel dimensions and fastenings for tires. The secretary of the society in alluding to the difficulties of the work says:

> The old-fashioned practice of wrapping a given process up in mystery, or surrounding it with a halo of secrecy still persists. Trade secrets still exist and petty jealousies still continue, and all of these prevent frankness and the accumulation of complete committee knowledge. It is not fair to ask that all trade secrets be laid before committees, nor is it necessary that trade secrets should be exposed in order to give sufficient knowledge to a committee to enable it to proceed intelligently. It is fair to ask that all personal feeling and all trade jealousy be laid aside for the benefit of all concerned. The work of our society in adopting standards has received hearty recommendation from many outside sources, and only a few comments to the effect that the society was attempting the impossible. It is probably a safe statement to make that even these unfavorable comments would not have been made had the writers of them been familiar with what the committee were really trying to do. The adverse critics have been universally those who have not come forward, attended the meetings or even read any of the material placed before them.

* * *

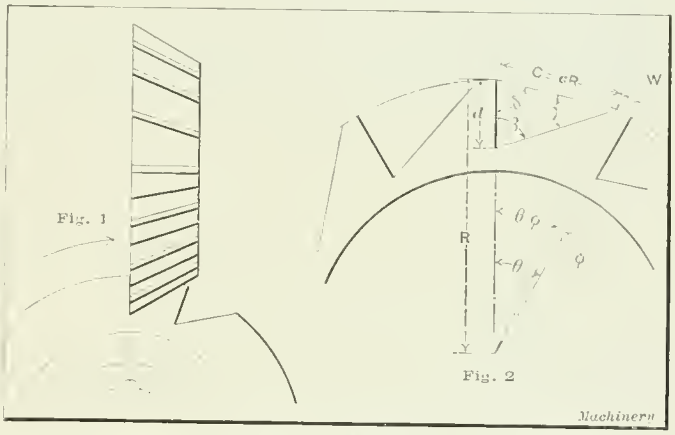
Practically all the vanadium used in the United States is obtained from Peru, South America. Extensive deposits of vanadium ore are located there and are controlled by American interests.

MILLING AXIAL TEETH IN CUTTER AND REAMER BLANKS*†

By GEORGE W. BURLEY‡

The ordinary method of setting the fluting cutter when milling axial teeth in cutter and reamer blanks, parallel to the axes of the blanks, is a cut-and-try method which, while it may give fairly good results in the hands of a skilled operator, is nevertheless rather wasteful of time and, in the majority of cases, indefinite in its results. The first part of the operation is to set the fluting cutter central with respect to the axis of the blank. In other words, where the fluting cutter is a single-angle cutter—as is usual for this class of work—it is arranged so that the vertical face is in the vertical plane passing through the axis of the blank, as is indicated in Fig. 1. The next step in the operation is to arrange the cutter so as to obtain the correct depth of flute. This is done by raising, in the first place, the knee, table, and blank an amount which, under any given circumstances, experience has indicated to be approximately correct.

With the blank in this position, two consecutive grooves are milled, the movement of the blank when indexing being in the direction represented by the arrow in Fig. 1. If the width of the land formed between the two grooves is about right, the position of the blank is assumed to be correct, and all the teeth are cut with the blank in this position. If the width of the land appears to be too great, the blank is further elevated so as to deepen the grooves, the amount of additional elevation being left entirely to the judgment of the operator. If the width of the land is too small, then the blank is lowered slightly to reduce the depth of the cut and increase the width of the land. This is obviously an inexact method and one not calculated to produce satisfactory results.



Figs. 1 and 2. Diagrams illustrating Method of Finding Formula for Depth of Tooth Space

An exact method of determining the depth of the cut required for any given conditions in regard to the number of teeth to be cut in the blank, the diameter or radius of the blank, the angle of the fluting mill, and the width of the land to be formed, can, however, be adopted, the result of applying such a method always being satisfactory. The following is a consideration of the case. The conditions are shown in Fig. 2.

Let

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* With Data Sheet Supplement.

† The following articles relating to the design and manufacture of milling cutters and reamers have previously been published in MACHINERY: "Setting Angles for Inserted-tooth High-speed Milling Cutters," December, 1911; "Face Milling Cutters for Finishing," December, 1911; "Milling Radial Teeth in Cutter Blanks," November and December, 1911, engineering edition; "Recutting Milling Cutters without Annealing," December, 1911; "Method of Setting Cutter for Fluting Spiral Mills," September, 1911; "Fluting Spiral Mills," August, 1911; "Fixture for Backing off Milling Cutters in the Lathe," June, 1911; "The Making of Reamers," July, August, and September, 1911 (see also the articles referred to in a note with the July installment); "Relief of Teeth of Cutters and Reamers," May, 1911; "Milling Cutters and Their Efficiency," May, 1911, engineering edition; "Reamers for Cutting Brass," April, 1911; "Spacing the Cutting Edges of Reamers," February, 1911; "Spacing of Cutting Edges of Reamers," November, 1910; "Apparatus for Hardening Milling Cutters," June, 1910; "Nicked Tooth Milling Cutters," April, 1910; "Milling Cutters with Inserted Teeth," December, 1909; "Length of Recess in the Bore of Milling Cutters," December, 1909, engineering edition; "Lathe Attachment for Backing off Teeth of Stepped Reamers," November, 1909; "Fixture for Grinding Radius Cutters," November, 1909; "Clearance on Milling Cutters," March, 1909. (See also the references to additional information given in a note with this last mentioned article.)

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N = the number of teeth (assumed to be equally spaced) to be cut in the blank.

W = the width of the land to be formed on each tooth.

β = the angle of the fluting or grooving cutter.

θ = the angle subtended at the center of the cutter or reamer by each tooth.

Then

$$\theta = 360 \div N$$

and may be called the tooth angle of the cutter or reamer. Let the radius of the finished (*i. e.* ground) cutter or reamer be R; θ is the angle subtended at the center of the cutter or reamer by the circular arc from which is formed the land of width W. This land may be either flat (as when formed by a cup-wheel) or concave (as when formed by a disk-wheel), but, in each case, the width of the land is measured in a straight line. The difference between the actual width of the land ground and the arc length (Fig. 2) is exceedingly small (though, other things being equal, it will depend upon the clearance), and, therefore, in this connection negligible. As the arc W subtends an angle ϕ at the center of the cutter or reamer, the angle $(\theta - \phi)$ is the angle subtended by a chord C. The angle $\delta = 90 - \dfrac{(\theta - \phi)}{2}$, and

$$\gamma = 180 - \left(90 - \frac{(\theta - \phi)}{2} + \beta\right) = 90 - \left(\beta - \frac{(\theta - \phi)}{2}\right)$$

The angle ϕ in degrees is obtained from $W \div R$, which is ϕ in circular measure. The chord C is, obviously, a function of radius R; hence its value is $c\,R$, where c is a constant for any particular values of θ and ϕ (from which it can be calculated) and, therefore, of N and $\dfrac{W}{R}$.

Let d = the depth of the cut required. Then, from Fig. 2,

$$\frac{d}{\sin\gamma} = \frac{c\,R}{\sin\beta},$$

from which we get

$$d = \frac{c\,R\sin\gamma}{\sin\beta} = \frac{c\,R\sin\left\{90 - \left(\beta - \dfrac{\theta - \phi}{2}\right)\right\}}{\sin\beta}$$

$$= \frac{c\,R\cos\left(\beta - \dfrac{\theta - \phi}{2}\right)}{\sin\beta} \qquad (1)$$

Recapitulation

It will be seen that by means of this formula, the depth of cut required for any given set of conditions can be calculated, the steps in the calculation being as follows: ϕ is obtained from $W \div R$ (the value of which is selected according to whether it is a milling cutter or a reamer which is to be fluted, and according to the kind of work which it has to perform. For medium-sized milling cutters, the quotient $W \div R$ varies from 0.020 to 0.060, while for reamers and small cutters its value lies between 0.040 and 0.120; θ is calculated from $360 \div N$; $c\,R$ is taken from a table of chords, it being the chord corresponding to $(\theta - \phi)$; and $\cos\left(\beta - \dfrac{\theta - \phi}{2}\right)$ and $\sin\beta$ are taken from the trigonometrical tables. Substituting the latter three values in Equation (1), we determine the depth of cut required.

It should be noted here that the very slight rounding which is usually given to the extreme angular point of the fluting cutter has been neglected in this consideration of the problem. This is because it is not possible to deal with it in a simple manner, and also because the amount of rounding is, in the majority of cases, not sufficient to affect materially the results of our calculations.

For practical purposes, the above formula is cumbersome, and, therefore, almost useless. To make it useful and of practical value, it has been converted into another formula, namely:

$$d = x\,R \qquad (2)$$

in which x is the depth of cut for a cutter or reamer of unit radius, and is equal to

$$\frac{c\cos\left(\beta - \dfrac{\theta - \phi}{2}\right)}{\sin\beta}$$

This is a constant for any given set of conditions, since, in such a case, W, N, and β, and, therefore, $W \div R$, θ, ϕ, and c will have fixed values. In the accompanying Data Sheet Supplement are given the values of x for a large number of different combinations of $W \div R$, N, and β; $W \div R$ ranging from 0.020 to 0.120 by increments of 0.020; N ranging from 6 to 44 by steps of 2; and β varying from 50 to 85 degrees.

Since the radius of the cutter or reamer blank is invariably made greater than the required radius of the finished cutter or reamer—the usual allowance on the diameter being about 0.008 inch per inch of diameter*—it is necessary to modify Formula (2) in order to fit it for application to conditions actually prevailing in practice. Obviously, in this case, to $x\,R$ must be added the difference between the radius of the blank and that of the finished cutter or reamer. Hence, the formula is:

$$d = x\,R + (R_1 - R) \qquad (3)$$

where R_1 = the radius of the blank. Another form is this:

$$d = R_1 - (1 - x)\,R \qquad (4)$$

Either of these two formulas may be used in practice, the value of x being taken from the accompanying tables in the Supplement.

To illustrate the use of this method, we will take the case of the fluting of a 5-inch cutter, which is to have 36 teeth, and a land-width ratio (*i. e.*, $W \div R$) of 0.020, the angle of the fluting cutter being 60 degrees. The blank, we will suppose, has been turned to a radius of 2.520 inches. Then, by consulting the accompanying tables, we find that $x = 0.1013$, and, therefore $x\,R = 0.2532$ inch; but $(R_1 - R) = 0.020$ inch; hence, $d = 0.2532 + 0.020 = 0.273$ inch, which is the required depth, and is an amount which can be easily read off the micrometer dial of the elevating screw of the milling machine.

It may sometimes be necessary to determine the value of x for a set of data not included in the accompanying tables. In such a case, this value can be calculated sufficiently accurately by the "simple proportion" method. To exemplify the use of the tables for this purpose, let us take the case of the fluting of a cutter involving the following data:

$N = 40$ teeth;
$\beta = 70$ degrees; and
$W : R = 0.050$.

From the tables we find that when $W \div R = 0.040$, $x = 0.0494$, and when $W \div R = 0.060$, $x = 0.0402$. Therefore, when $W \div R$ equals 0.050, $x = \dfrac{0.0494 + 0.0402}{2} = 0.0448$ inch.

When there are differences in regard to two of the data, the determination of x is a more complicated problem than the above. Take, for example, the case where $N = 31$ teeth, $\beta = 65$ degrees, and $W \div R = 0.030$. In this case, the values of x for 30 and 32 teeth when $W : R = 0.030$ are first calculated as above, and then their mean is taken as the required value of x. Thus, x for 30 teeth = 0.1018 (by above method); for 32 teeth, $x = 0.0911$; and for 31 teeth, $x = \dfrac{0.1018 + 0.0911}{2} = 0.0964$ inch.

This method of determining the value of x for intermediate combinations is sufficiently close for all numbers of teeth above 12, and all the angles of fluting cutters in general use.

* * *

The invention of a new kind of armor-plate is reported from Germany. The peculiarity of the new armor is its extreme lightness as compared with the Krupp armor, while it is said to have equal, if not greater, resisting power. The armor is made of an aluminum alloy faced with a thin hardened steel plate. The naval authorities have made tests and reported favorably upon the new armor, and gun shields made from it have been ordered for one of the new German cruisers.

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* This allowance is rather too liberal for large diameters. The allowances for grinding should not be in exact proportion to the diameters, as this gives too large values for cutters of large size. However, the assumption made has no influence on the formulas or on the tables. Anyone who prefers to use a smaller allowance for grinding can do so, and yet make use of the tables.—EDITOR.

MANUFACTURE OF LINCOLN-WILLIAMS TWIST DRILLS

By CHESTER L. LUCAS*

Twist drills are such common tools about a machine shop that it is surprising how little is generally understood about the methods employed in their manufacture. Any machinist can tell how a tap is made and any good toolmaker can make one, but we seldom hear of a twist drill being made in the average shop. This no doubt is due to the special machinery necessary to mill and relieve the flutes properly; therefore the manufacture of twist drills is almost exclusively in the hands of specialists.

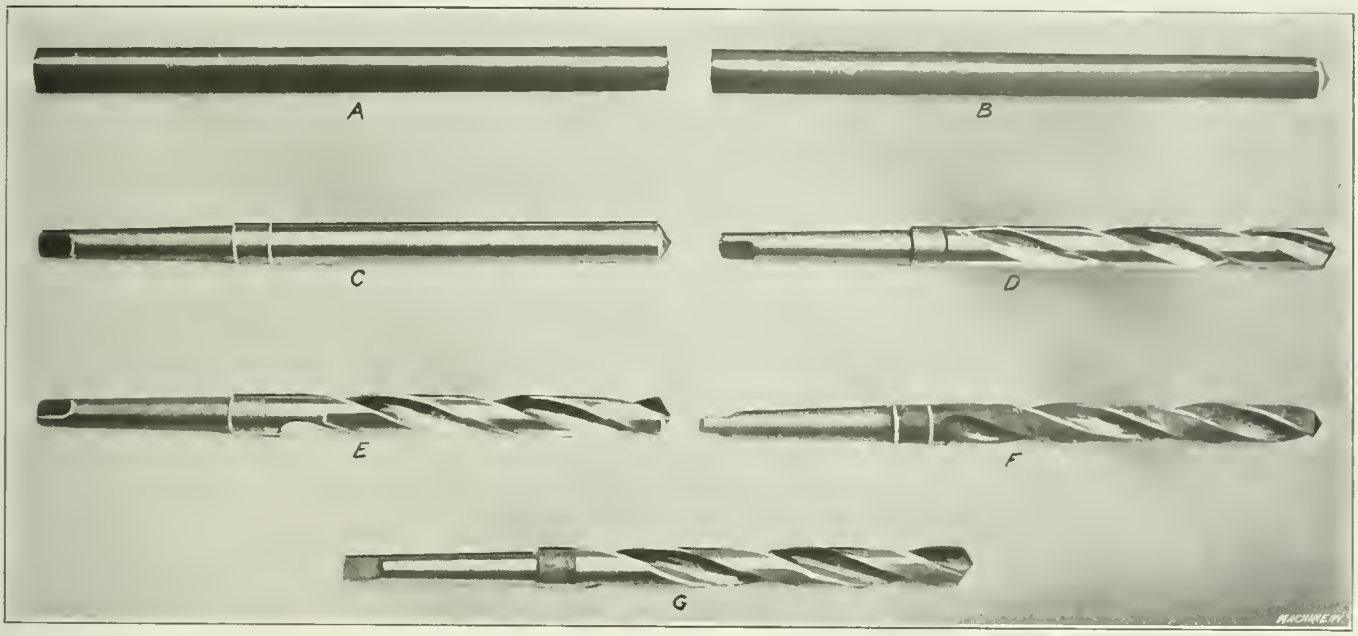

Fig. 1. Results of the Important Operations in Making a Twist Drill

One of the well-known firms in this line is the Lincoln-Williams Co., of Taunton, Mass. The company has moved into a new brick factory of modern design that is well equipped for the manufacture of twist drills. The entire factory is devoted to making this one product, involving the use of much special machinery. Through the courtesy of the management, the writer was allowed to photograph and describe some of the interesting operations connected with the work.

Preparation of the Steel

The stock room in which the steel is stored is kept locked all of the time, and access is permitted to very few men.

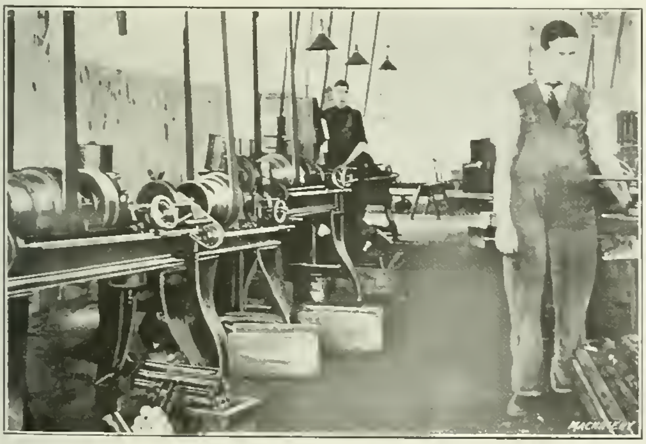

Fig. 2. Cutting off the Stock

The reason for this is to prevent the different brands of steel from getting mixed. As both high-speed and carbon steel are employed in making the various standard and special drills, and as the smaller sizes of drill rod vary but a few thousandths of an inch between sizes, the importance of this precaution is apparent.

Fig. 2 shows the cutting-off department, where the bars are cut to lengths, one of which appears at *A*, Fig. 1. At the left are the cutting-off machines that cut the larger sizes of steel to length. The operator at the right is sharpening a saw for the cold-sawing machine that is used for cutting up some of the steel. For all drills, the steel is selected enough larger than the finish size to admit the turning off of all the "skin" from the outside of the stock.

The lengths of steel are next centered on one end and pointed on the other end to an included angle of 121 degrees. This end of the blank is used as the blade end of the finished drill and obviates the wasting of ¼ inch of steel that would be necessary if centered in the usual way. The blank, centered and pointed, may be seen at *B*, Fig. 1. The smaller sizes of drill blanks are cut off and centered in screw machines, as illustrated in Fig. 3, and the very small drills are cut off and pointed only, no center being required. This work is done in Brown & Sharpe automatic screw machines.

Forging, Annealing and Straightening

A good many drills of the smaller sizes are made with taper shanks that are much larger than the body of the drill, usually with either No. 1 or No. 2 Morse tapers. After being cut off, the stock for such drills is forged down, reducing the blade section approximately to size. This operation is shown in Fig. 4, and of course it is obvious that this treatment improves the steel and results in a better drill.

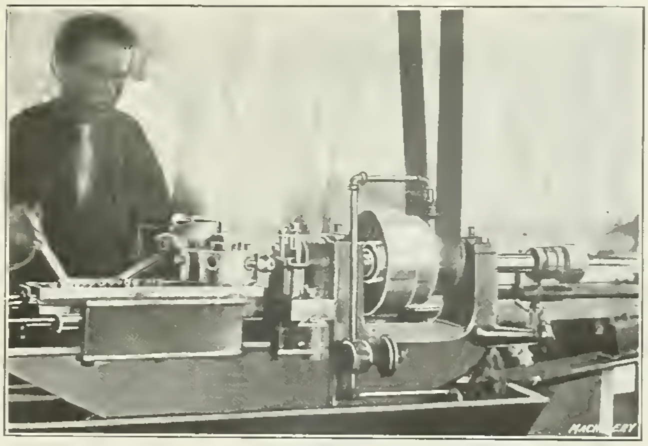

Fig. 3. Pointing and Centering the Drill Blanks

The blanks must now be annealed to facilitate the turning. Fig. 5 shows one of the large oil furnaces in which the blanks are heated. Cast-iron boxes, one of which may be seen being taken from the furnace, are filled with the lengths of steel, covered and sealed and placed in the furnace. Here they are heated slowly for a number of hours and allowed to cool very gradually.

The straightening operation is illustrated in Fig. 6. Here the operator is shown straightening forged blanks. These blanks have been centered and pointed. He places a blank between the centers of the bench fixture *A*, gives it a twirl, at the same time noticing the high points with relation to the adjustable rest *B*. To facilitate the work, a screen *C* is placed so as to diffuse the light; when artificial light is needed, it is placed behind this screen. After locating a high point, the operator takes the drill from the centers, places it across the supports of the straightening press *D*, and bends it slightly to straighten it. In view of the fact that the work depends wholly upon judgment, it is surprising how well and how quickly the blanks are straightened. A straightening stand is used for the larger blanks. The stand is surmounted with an iron surface plate upon which the blanks are rolled. This operation shows up the high places and the blanks are straightened in a larger screw press not shown.

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* Associate Editor of MACHINERY.

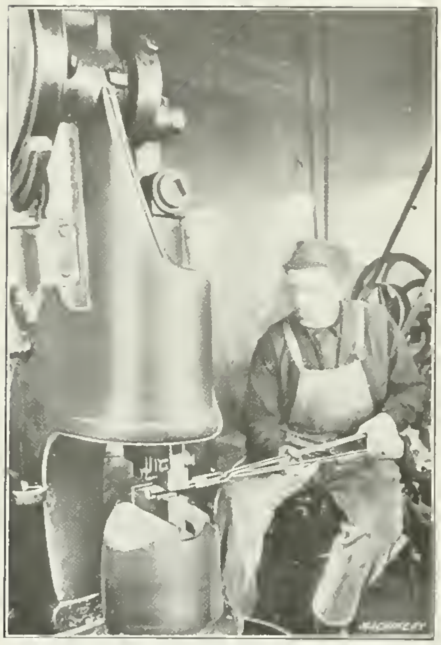


Fig. 4. Forging the Blanks for Special Drills

Rough- and Finish-turning

The small and medium sized drills are turned on lathes like that shown in Fig. 7. The work is held on male and female centers and driven by a dog in the usual way. The tools are made of high-speed steel, and for every turning operation in drill-making in this factory tool-holders with high-speed steel bits are employed. Each lathe performs but a single operation. One lathe rough-turns the shank; the next lathe rough-turns the blade; a third lathe finish-turns the shank and the fourth lathe finish-turns the blade. In turning, an allowance of from 0.005 to 0.007 inch is allowed for the grinding on this small and medium sized work. At *A*, Fig. 7, is a gage for testing the size from time to time. These lathes are fitted with automatic feed-releasing mechanism so that one operator may attend to four machines without trouble. This mechanism consists of a bracket *B*, bolted to the carriage; through this bracket a pin extends downward, coming in contact with arm *C* at the proper time to throw the internal half-nut out of mesh with the lead-screw at the end of the cut.

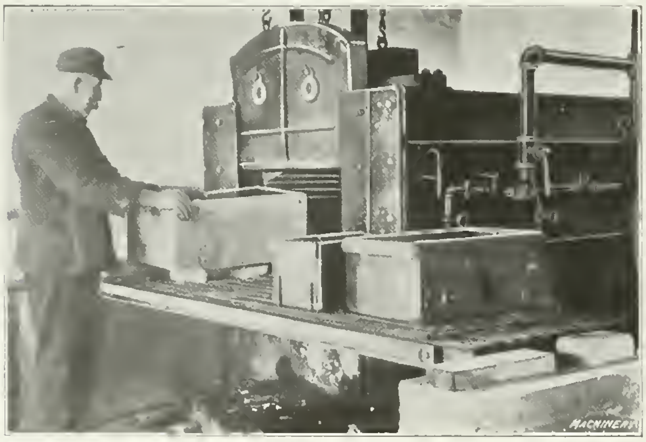


Fig. 5. Annealing the Blanks

The operation of turning the large blanks is essentially the same as the smaller work, except that the limits allowed on drills up to $1\frac{1}{4}$ inch range from 0.008 to 0.012 inch. In a good many instances, the drills are simply rough-turned, and, as shown in Fig. 8, are ground to within the limits allowed for hardening and final grinding. This is quicker than turning and leaves a good surface for the succeeding operations.

Milling the Tangs and Finishing the Ends

Fig. 9 illustrates the method of milling the tang. The drill blank *A* is held in clamp *B*, while the two cutters *C*, which are mounted at the proper distance apart, mill the tang. At *D* may be seen the worm and worm gear that are disengaged automatically at the end of the cut. It takes about half a minute to cut the tang of a $\frac{1}{2}$-inch drill. The partly completed drill now appears as at *C*, Fig. 1.

Another simple operation, shown in Fig. 10, is that of rounding the shank end of the drill. This is done to remove corners and edges that might otherwise become bruised, thus interfering with the fit of the taper shank. The drill blank *A* is held in the clamp *B* and fed into the box-tool *C* that shapes the end of the shank. Both tool and holder are very strong.

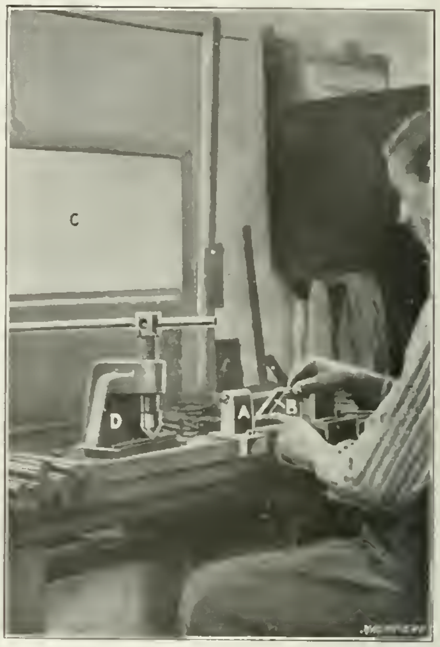


Fig. 6. Straightening the Blanks

Milling the Grooves

One of the most interesting operations connected with the making of twist drills is the milling of the flutes. Fig. 11 shows a small section of the department where the flutes in the large drills are milled. The drill blanks are fed downward to a pair of cutters that simultaneously mill the two grooves. Of course, it is obvious that the drill must turn while the milling operation is being performed, so as to obtain the spiral flutes. These machines are semi-automatic in their operation, so that one operator can keep several of the machines in operation without difficulty. The result of the milling is shown at *D* in Fig. 1.

The method of grooving the small drills is essentially the same, although the machines are of the horizontal type. Fig. 12 shows a row of the machines that are used in milling the grooves in drills under $\frac{1}{4}$ inch in diameter. By means of the same automatic feed-releasing mechanism as is used on the turning lathes and tang-milling machines, the feed is thrown out at the end of the milling operation. While being milled, the drill is automatically turned to give the spiral cut to the grooves. As the small drills have straight shanks, they may be held by chucks while being milled. In milling, a cutting compound, of borax, lardoleum and water, is used.

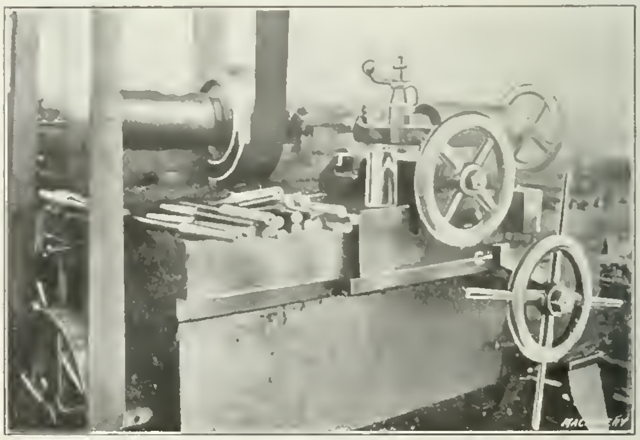


Fig. 7. Turning the Blanks

Increase Twist

To many men, the meaning of "increase twist" as applied to twist drills is not clearly understood. A drill with increase twist is grooved at a constantly increasing angle of spiral, commencing at the point. This variation in the angle of the groove is brought about by the gradual decreasing of the rate at which the drill blank turns while being fed to the grooving cutters, the forward movement of the drill remaining constant. Thus the "twist" steadily increases. The reason for cutting the grooves with increase twist is to increase the area of the groove as it progresses towards the shank, thus allowing the chips more room to work out of the grooves.

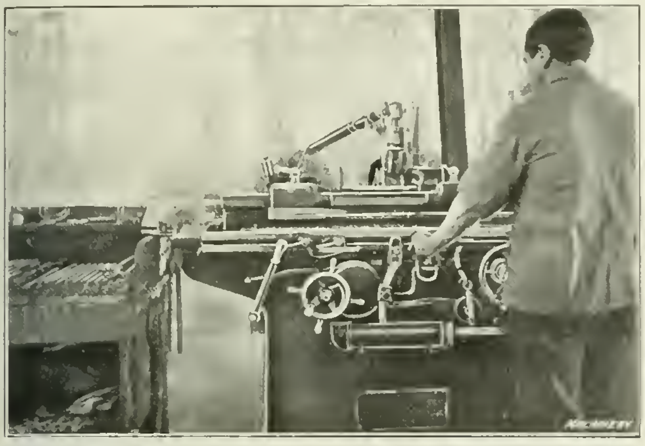


Fig. 8. Grinding the Blade Section, preparatory to Milling

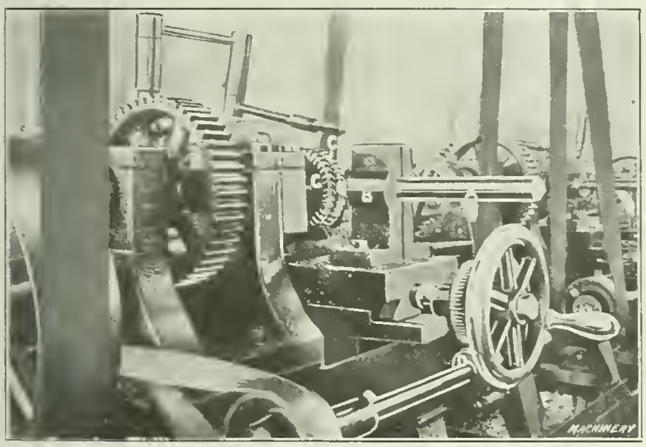


Fig. 9. Milling the Tangs

At first thought it is not quite clear how the increasing of the angle of spiral, or twist, increases the area of the groove. Suppose, to take the extreme view, there were no turning of the drill while being grooved; in such a case it is apparent that the resulting straight groove would be much wider than a spiral groove of any angle. To increase the angle of spiral is to approach the straight line; therefore any increase in the angle of spiral or twist, increases the width of the groove and consequently its area.

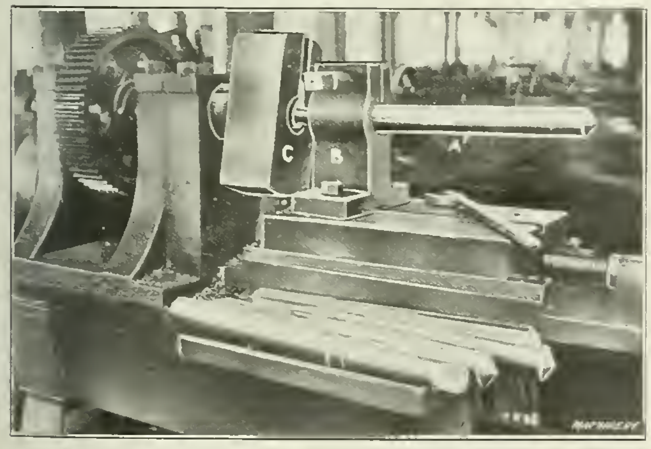


Fig. 10. Rounding the Ends of the Shanks

Milling the Clearance to the Grooves

The edges of the cutting lips of twist drills must be given clearance the same as any other metal-cutting tool. The clearance on Lincoln-Williams drills is milled with cutters; "cutter-cleared" they are termed in the trade. One of the machines for milling clearance may be seen in Fig. 13. The drill is held in the sleeve *A* that runs loosely in tailstock *B*. From the point, it is drawn through bushing *C*, at the same time being slowly turned. Cutter *D* works through an opening in this bushing, removing the clearance. The amount of metal removed for clearance depends, of course, upon the size of the drill, varying from approximately 1/32 inch on the large drills to a few thousandths inch on the smallest drills.

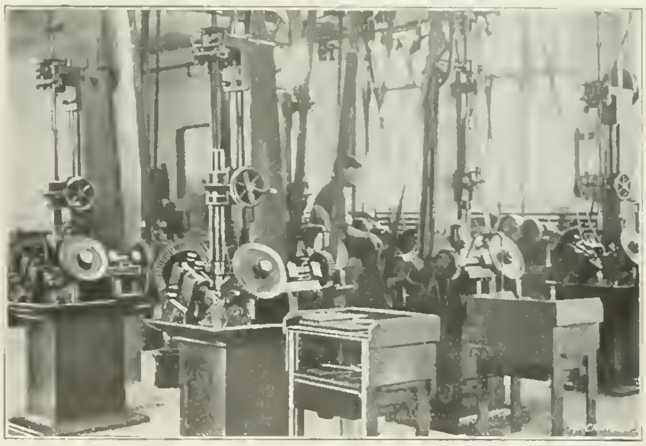


Fig. 11. Milling the Grooves

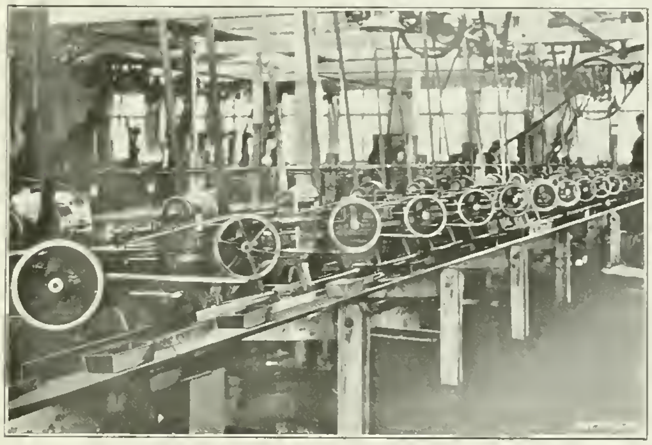


Fig. 12. Milling the Grooves in the Small Drills

The illustration Fig. 14 shows the principle that is followed in "clearing" drills by milling. In a cutter-cleared drill, the stock is milled away in a straight cut, commencing a short distance from the cutting side of the lip and extending parallel to the length of the drill into the groove behind. The result is a clean, even clearance throughout the length of the drill, as may be seen at *E*, Fig. 1.

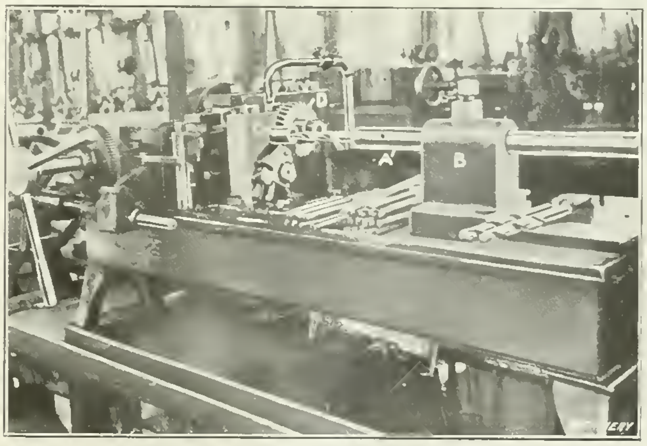


Fig. 13. Clearing the Drills

The ends of the blades of the drills are next relieved, or sharpened, as we would call it if the drills were ready for use, and then another equally simple operation follows: that of marking the name upon the recess between the shank and blade. The size is also stamped on at this time, and the drills are ready for hardening.

Hardening the Drills

After the clearance has been given to the ends of the lips of the drills they are ready for hardening. Fig. 15 shows a section of the department where the high-speed drills are hardened. The furnaces are all gas furnaces and are of several sizes so as to accommodate the different sizes of drills that must be heated. One of the hardeners is shown heating a drill preparatory to hardening in the oil tank behind him.

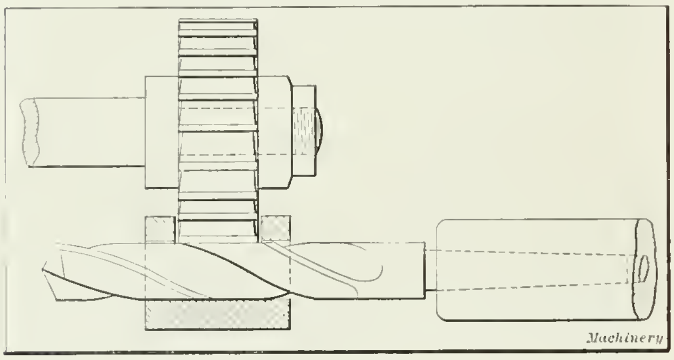


Fig. 14. Details of Clearing Operation

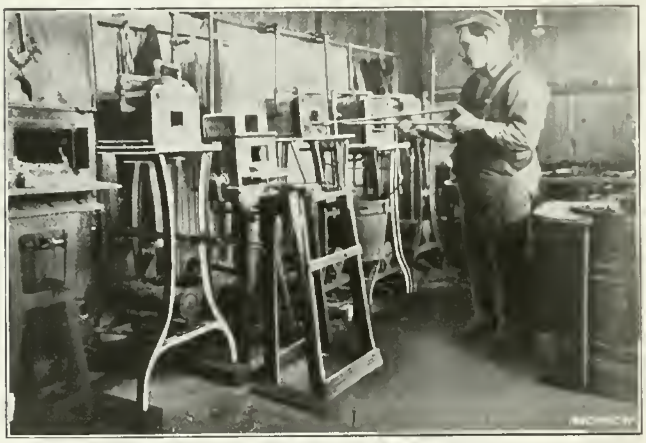


Fig. 15. Hardening High-speed Drills

For hardening these high-speed steel drills the furnaces are regulated to control the heat at approximately 2300 degrees.

In hardening the carbon steel drills, lead pots are used for heating the drills. Fig. 16 shows one of the hardeners at work hardening carbon steel drills. The tank for quenching is an ordinary hogshead filled with brine. The brine is kept cool and at a constant temperature by means of a circulation of cold water that passes through a coil of pipe within the brine barrel. This cold water is pumped from the cistern that may be seen in the right foreground of Fig. 16; thus the continuous stream of cold water circulating through the coil maintains an even temperature in the hardening tank.

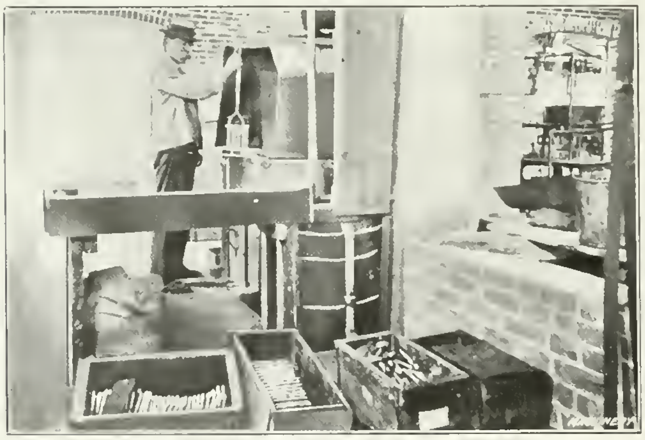


Fig. 16. Hardening Carbon Steel Drills

The special tongs used in hardening small drills may be seen in the background of Fig. 17. These tongs will hold twelve drills so they may be hardened at once. One jaw of the tongs is grooved with twelve parallel grooves, while the other jaw holds a flat spring that has twelve "fingers" that bear upon the drills, compensating for any unevenness in the other jaw. The smaller pair of tongs is for holding small drills, as shown. At the right of this illustration may be seen two lots of small drills that are ready for hardening, and in the foreground is a lot of drills that has just been hardened. Fig. 18 is shown to illustrate the way in which the small drills are hardened. The lead pot is heated from beneath by fuel oil. The surface of the molten lead is kept covered with broken charcoal to prevent the formation of dross. It takes but a few seconds to heat up a row of drills and but a few seconds to quench them, so the work proceeds very rapidly. With the above method of even heating, and the constant temperature of the hardening bath, there can be little chance for poorly hardened drills, if the steel is of good quality—and it is.

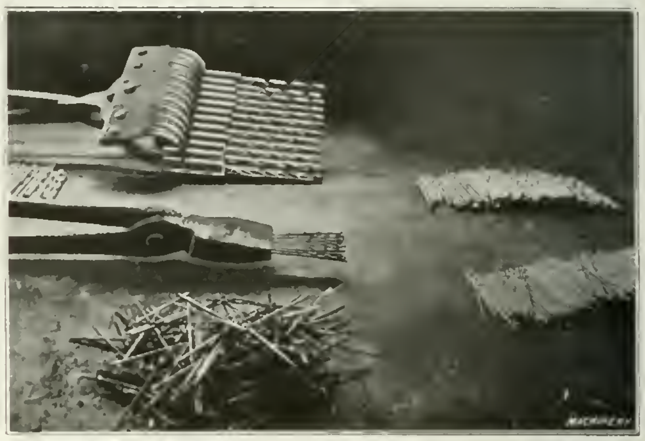


Fig. 17. Special Tongs used in Hardening Small Drills

Oil-tempering the Drills

Hot oil furnishes the best known method of tempering any kind of a tool that requires an even temper throughout its length, and, of course, it is desirable that drills be evenly tempered throughout their lengths. At *A*, Fig. 19, may be seen the tank in which the drills in this factory are oil-tempered. As will be noticed, the tank is on rollers, running on a track above the gas furnace *B*. The drills are placed in an iron basket *C*, lowered into the hot oil, and left there until they have been brought up to the temperature of the oil, which is approximately 450 degrees F. This gives the drills a degree of toughness that it is impossible to attain in any other way. The box *D* contains sawdust for drying the drills after being taken from the hot oil. At *F*, Fig. 1, may be seen the drill after hardening.

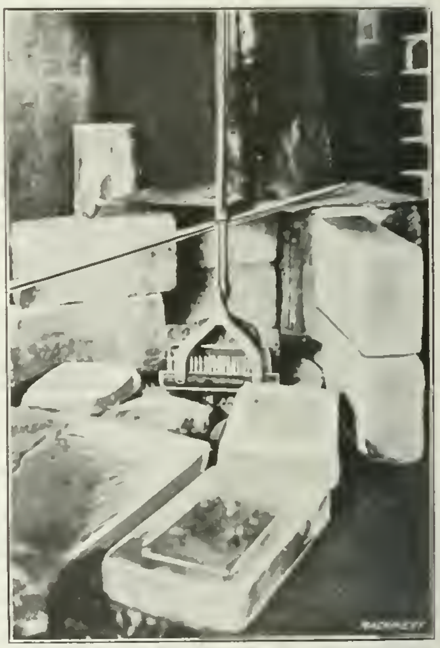


Fig. 18. Method of heating Drills in Lead Pots

Straightening

In spite of all the precautions that are taken to have the drills come from the hardening tank straight, a good many drills will be warped to a more or less degree. To straighten such drills, they must be heated at the top of the curve and pressure applied. This operation is practically the same as the cold straightening being done in Fig. 6, except that the small drills, under ¼-inch, are straightened on a lead block with a soft metal hammer. Heat is applied with a small gas torch.

Cleaning out and Grinding

After leaving the hardening department, the drills go to the cleaning bench, where they are brushed out with fine emery and oil as shown in Fig. 20. The operator takes three or four drills at once, and holding them at the angle of the flutes, brushes out all of the scale and dirt left by the hardening process.

The final operation in the making of a twist drill is to grind the shank and blade true with the centers, for of course there is bound to be a little distortion. even after straightening Other reasons for grinding after hardening are to size the drill and give it sharpness throughout the length of the blade. This operation is illustrated in Fig. 21, the finished drill being shown at *G*, Fig. 1.

Inspecting and Testing

After hardening, every drill is examined for fire cracks and tested for hardness. After grinding, each drill is tested for size of blade and correctness of taper in the shank, if the drill is of the tapered-shank variety. In addition, drills are selected at random from the different lots, and tested in actual use, for the Lincoln-Williams Co. believes that the proof of the drills is in the drilling. For this purpose, semi-annealed steel is used, and careful records are kept of the performances of the tested drills.

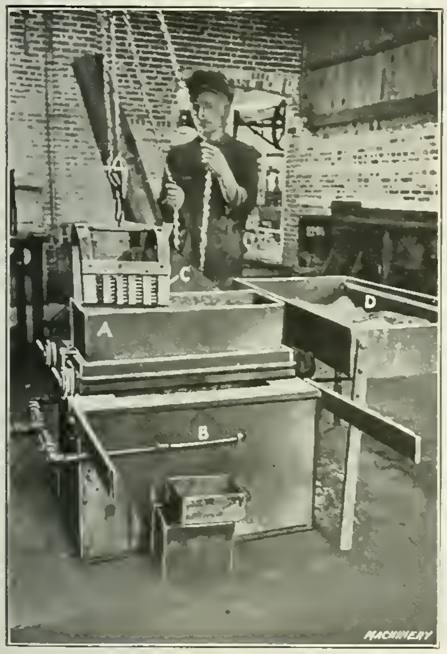


Fig. 19. Tempering Drills

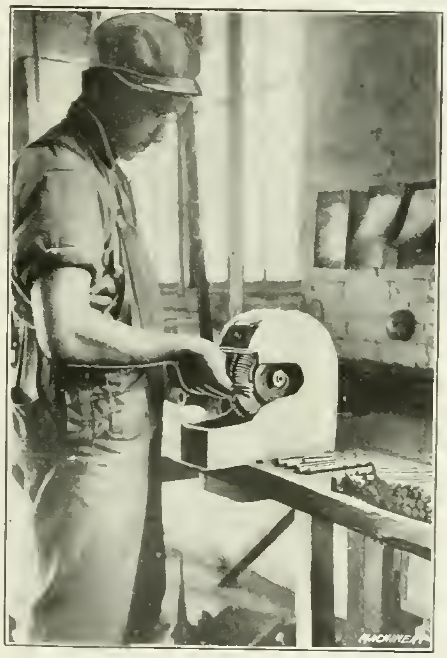


Fig. 20. Cleaning out the Drills

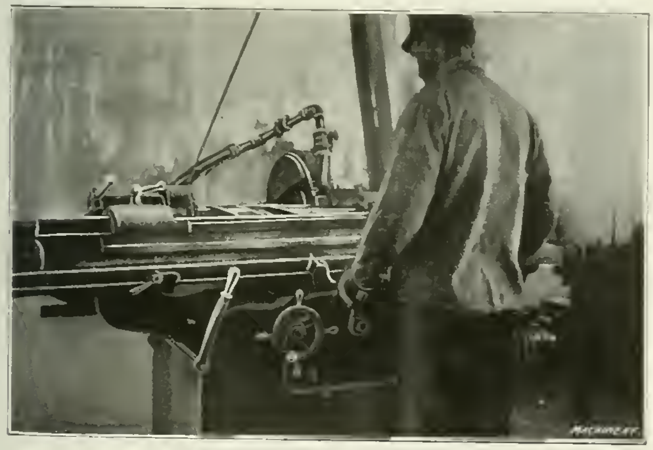


Fig. 21. Grinding the Hardened Drills

Welding Special Shanks

Fig. 22 illustrates the operation of electric welding special shanks to small drills that are used by woodworkers in bit-braces. The special square shanks are first forged; the drills are made and hardened and the last operation is to weld the two parts together. The drill is held in the spring collet that is closed by handwheel *B*. Several of these collets, which are made of copper, may be seen in the block *G*. At *E* is a rack of drills and at *F* may be seen a box of shanks. The shank is held in the head *A* of the machine. The current quickly brings each part to a welding heat; handwheel *C* runs the head of the machine forward, uniting the two parts while at a white heat. The operation of the head, by means of the handwheel, automatically admits and cuts off the current that comes through the coil at *D*. By means of the handwheel that may be seen at the right of the coil, the amount of current may be regulated to suit any of the sizes of drills that are required to be welded to special shanks. With this machine, approximately 4000 drills may be welded per day of ten hours.

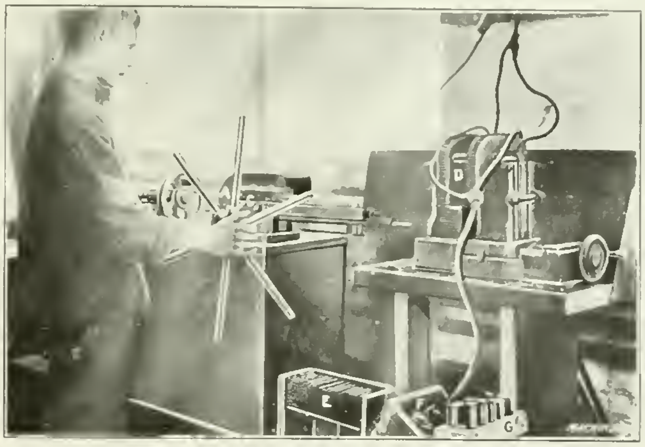


Fig. 22. Welding Special Shanks to the Blades

* * *

GASOLINE OR OATS?

Many persons who have studied the case of the auto *vs.* the horse are of the opinion that within ten years the use of horses will be forbidden upon the streets in the congested parts of cities. One of these experts asserts that by 1920 not a horse will be allowed south of Fourteenth St. on Manhattan Island. Another authority says that today the horse is hampering business in all the crowded delivery sections of cities and that horse-drawn vehicles take up so much room that in New York City alone, if the horse were done away with, three hundred miles of streets could be saved.

It is all a question of dollars and cents, this gasoline or oats proposition. Even with an ordinary pleasure automobile it simmers down to that. Tests have shown that the balance is in favor of the motor-car just as it is in the case of the heavier vehicles that do the truck-horse work. A six days' trial, for purposes of comparison, was made not long ago. The automobile ran four hundred and fifty-seven miles in that time at a cost of one and one-half cent per passenger per mile. Depreciation was charged in this cost, too. With a horse and buggy the distance covered in the six days was one hundred and ninety-seven miles and the cost was nearly two cents per passenger per mile.—*Harper's Weekly*.

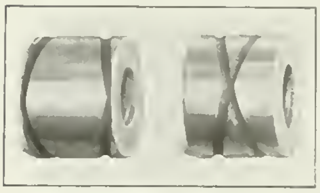
* * *

The National Twist Drill & Tool Co., Detroit, Mich., uses a simple method of etching on cutters and other tools. The steel is brushed with asphaltum varnish which is allowed to stand a few minutes until it thickens and hardens to the right degree. Then the desired inscription is pressed through the asphaltum with a rubber stamp and the etching fluid (aqua regia) is applied with a medicine dropper. Good results are obtained, but some practice and experience are required to judge just when the varnish has dried to the right consistency.

OIL GROOVE CUTTING TOOL[*]

A SPECIAL TURRET TOOL FOR THE BROWN & SHARPE AUTOMATIC SCREW MACHINE

By DOUGLAS T. HAMILTON[†]



Oil-grooved Pin

Cutting a helical oil groove in a cylindrical piece of work in the Brown & Sharpe automatic screw machines is a feat, the successful accomplishment of which demonstrates some of the possibilities of these machines in the hands of a resourceful designer. A turret tool for performing this work was designed by the Brown & Sharpe Mfg. Co., and was used for cutting an oil groove in a needle bar connection pin for the Wilcox & Gibbs sewing machine. This turret tool, which is illustrated in Figs. 1, 2, 3 and 4, is designed on the generating crank principle, so that the cutting tool is moved back and forth in a straight path parallel with the axis of the work while the latter is rotating. The cutting tool while being longitudinally traversed is at the same time fed into the work to the desired depth by means of a rising block held on the cross-slide.

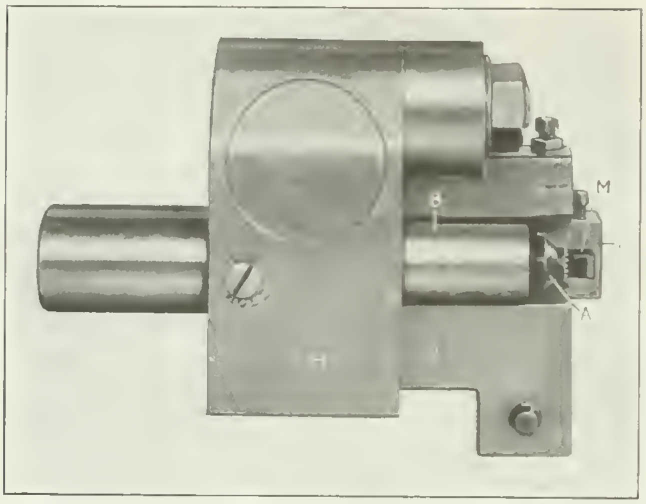


Fig. 1. Oil Groove Cutting Tool showing Driver and Cutter

Operation of the Oil Groove Cutting Tool

The oil groove cutting tool shown in Figs. 1, 2, 3 and 4 is operated in the following manner: After tne end of the work has been knurled, the turret is advanced, bringing the driver A into contact with the knurled end of the work. The rotating motion of the work is transmitted by driver A to spindle B, the latter being connected to the driver by a pin C fitting in an elongated hole in the spindle. The spindle B is provided with helical teeth that mesh with the helical gear D, held on a shaft E to which link F is eccentrically connected. The other end of link F is pivoted to the crank-slide G, which fits in a V-groove cut in the main body H. The tool-slide I, which fits in a V-groove in the swinging member J is connected to the crank-slide G by a tongued block K held by two screws in a slot cut in the crank-slide.

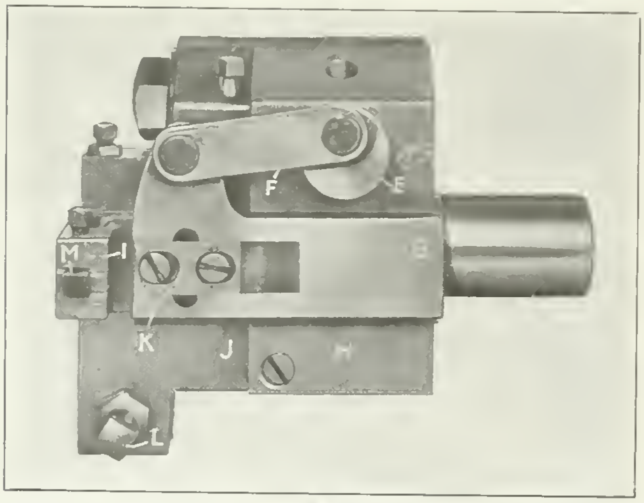


Fig. 2. Rear View of Oil Groove Cutting Tool showing Crank-Tool-slide, etc.

When the driver A is in contact with the work, the front cross-slide is advanced and the rising block coming in contact with the end a of the set-screw L forces in the swinging member J carrying the turning tool M. While this is taking place, the turning tool is being traversed back and forth by means of the crank mechanism, and thus produces the helical groove in the work. Upon the completion of the oil groove, the cross-slide drops back, and the coil spring N returns the swinging member to its former position; and when the turret drops back, the coil spring O returns the driver A to its "out" position.

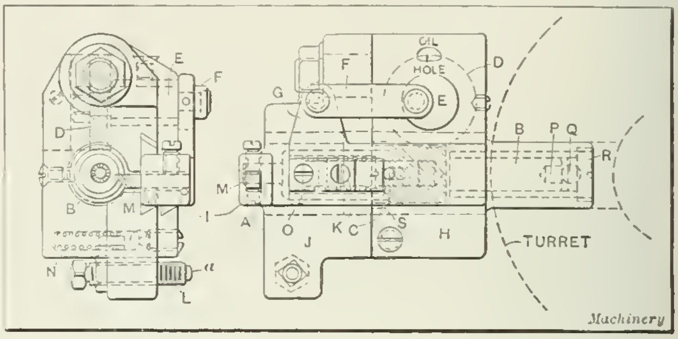


Fig. 3. End and Side Elevations of Oil Groove Cutting Tool

Construction of the Oil Groove Cutting Tool

This tool embodies some features in its design which could be incorporated in other turret tools of the generating type, so that a description of its construction might be of value. Referring to Figs. 3 and 4, it will be seen tnat the driver A is countersunk and knurled on the end, and is provided with a shoulder against which the spring O abuts. The driver is prevented from coming out of the spindle B by a pin C, driven into the former and fitting in an elongated hole in the spindle. This pin also acts as a stop to prevent further movement of the driver A, when it has once come in contact with the work.

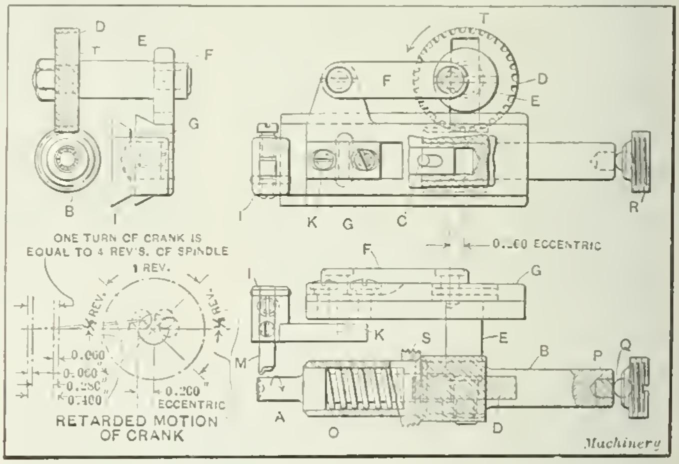


Fig. 4 Diagram showing Operation of the Oil Groove Cutting Tool

The driving spindle B is made from machine steel, counterbored to receive the driver A, and provided with helically cut teeth. To take the thrust of the driver coming up against the work, the rear end of the spindle is provided with a hardened block P; this block bears against a ball Q held in the nut R, which is screwed into the shank of the holder. The spindle is retained in the main body H by a hollow-nut S, and runs in a phosphor-bronze bearing. The helical gear D is held on the end of the crank stud E which runs in a phosphor-bronze bearing, by a nut as shown, and is retained in the correct relation to the eccentric by the slot *T* which fits the flattened sides of the stud.

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[*] For a description of other tools on the generating principle, built by the Brown & Sharpe Mfg. Co., see the following articles: "Cutting Helical Gears on the Brown & Sharpe Automatic Screw Machines, April, 1909; and "Attachment for Cutting Helical Steel Gears," August, 1909.

[†] Associate Editor of MACHINERY.

As the swinging member carrying the tool-slide must have a slight movement across the face of the main holder, it is necessary that the two slides be flexibly connected. This is accomplished by inserting a block *K*, which is provided with a tongue to fit in the slot cut in the crank-slide *G*. The tongue extends down through an elongated slot in the slide, and fits in a corresponding slot in the tool-slide *I*. The slot in slide *G* is greater in width than the tongue on the block *K* so that a slight adjustment for the tool-slide is provided. This adjustment makes it possible to start the cutting tool in the correct relation to the end of the work and the driver.

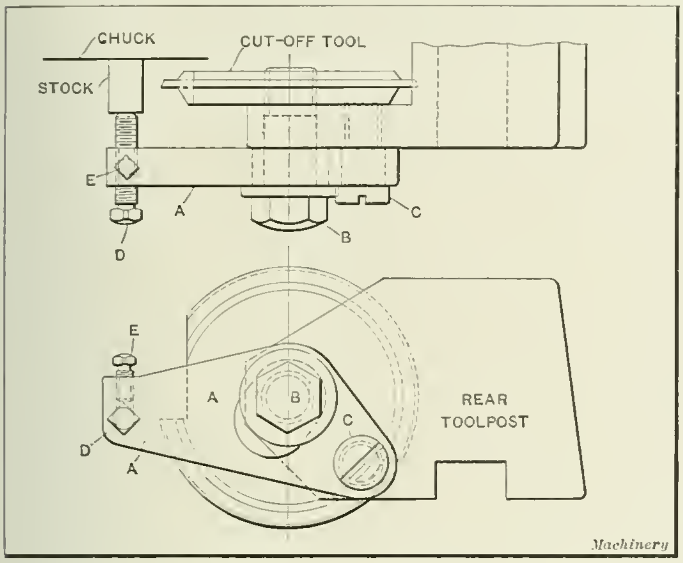


Fig. 5. Stop used on the Rear Cross-slide for Gaging the Stock to Length

Obtaining the Throw of the Crank

Referring to the illustration Fig. 7, where a sample of the work is shown at *A*, it will be seen that the oil groove is to make one complete revolution in 0.282 inch for both forward and return strokes, giving two revolutions in all. The path of the oil groove is more clearly shown in the initial illustration. Now it is evident that the speed at which the tool-slide travels must be less than that at which the work is rotating, or in other words, the work must make four revolutions when the crank is making one complete turn. The helical gears are therefore made in a ratio of 4 to 1.

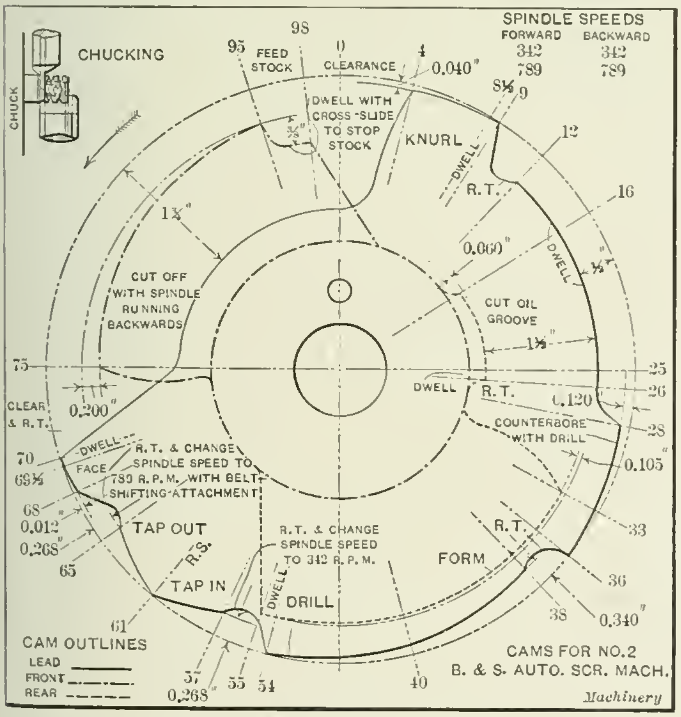
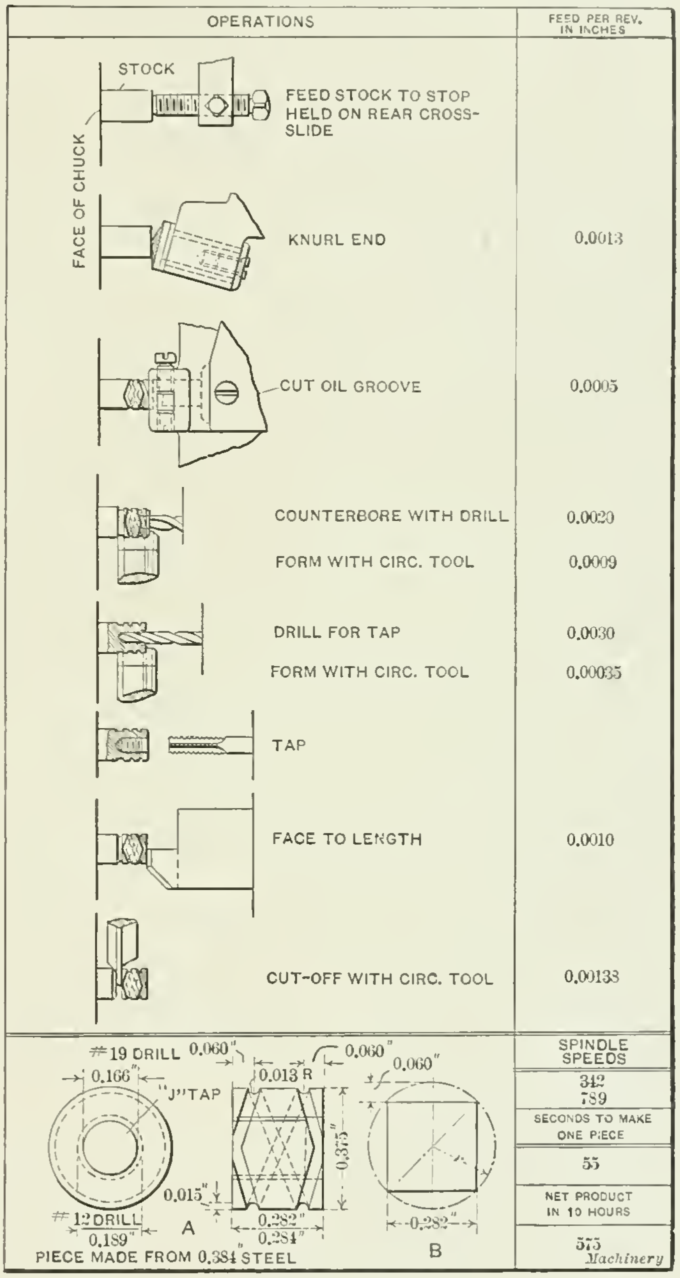


Fig. 6. Cams used in Making and Cutting the Oil Groove in the Needle Bar Connection Pin shown at A in Fig. 7

As this tool is operated by a crank mechanism, it follows that the cutting tool is given a variable movement; that is, it starts up slowly, then increases in speed as it approaches the center, and decreases in speed as it reaches full throw, the same movement being repeated on the return stroke. To obtain the required throw of the eccentric, construct a square having sides equal in length to 0.282 inch, and circumscribe a circle about it. The radius *r* of this circle, see *B*, Fig. 7, will then equal the required amount of throw of the crank. The radius *r* is found by the following formula:

$$r = \frac{\dfrac{0.282}{2}}{\sin 45 \text{ deg.}} = \frac{0.141}{0.707} = 0.200 \text{ inch approximately.}$$

Referring to the diagram in the left-hand lower corner of Fig. 4, it will be seen that the first one-eighth revolution of the crank, which equals one-half revolution of the work, gives a longitudinal movement to the tool of about 0.060 inch. The next revolution of the work (or one-quarter revolution of the crank) gives a movement of 0.280 inch, while the remaining forward movement gives a travel of approximately 0.060 inch. The same movement is given to the tool on the return of the crank, the complete travel of which is 0.400 inch. The groove produced by the tool when its motion is retarded is not required. Hence, when the piece is faced and cut off to 0.282 inch, it leaves an oil groove which makes two complete revolutions around the work. The two half revolutions of the groove on each end are removed by the facing tool held in the turret and the circular cut-off tool on the cross-slide.



OPERATIONS	FEED PER REV. IN INCHES
FEED STOCK TO STOP HELD ON REAR CROSS-SLIDE	
KNURL END	0.0013
CUT OIL GROOVE	0.0005
COUNTERBORE WITH DRILL	0.0020
FORM WITH CIRC. TOOL	0.0009
DRILL FOR TAP	0.0030
FORM WITH CIRC. TOOL	0.00035
TAP	
FACE TO LENGTH	0.0010
CUT-OFF WITH CIRC. TOOL	0.00133

SPINDLE SPEEDS	342 789
SECONDS TO MAKE ONE PIECE	55
NET PRODUCT IN 10 HOURS	575

Fig. 7. Order of Operations and Feeds used in Making the Needle Bar Connection Pin

The chart, Fig. 7, illustrates the tools used and the order in which they are applied. By a close inspection of this chart it will be seen that the turret is full of tools, so that it is necessary to provide some other means for gaging the stock to length. This is accomplished by fastening a block *A* to the rear toolpost as shown in Fig. 5. This block *A* is furnished with an elongated slot so that it can be swung up out of the way to remove the short piece of the bar left in the chuck when it is exhausted. The slot straddles the body diameter of the clamping screw *B*, which is used in holding the circular cut-off tool to the toolpost. The toolpost is drilled and tapped to receive the shoulder screw *C*, which acts as a fulcrum for the block *A*. In the forward end of the block *A* is held a screw *D* which acts as a stop for the stock. This screw is held when adjusted to the correct position by a set-screw *E* bearing upon a brass shoe, which prevents the thread on the screw *D* from being bruised.

Order of Operations

The order of operations followed in completing the needle bar connecting pin is shown in Fig. 7. The first operation is to feed the stock to the stop; then the rear cross-slide drops back and the knurling tool is brought in and knurls the end of the work. The turret is now revolved, bringing the oil groove cutting tool into operation which produces the oil groove. The turret dwells, holding the driver in contact with the work while the swinging memoer is being advanced by the rising block on the front cross-slide, which feeds the tool in to the correct depth. While this is taking place the toolslide, of course, is driven back and forth across the face of the work by the crank mechanism.

After the oil groove is completed, the turret is again revolved and the drill is brought in to counterbore the front end of the work. The turret is then revolved to bring the tapping size drill in, which drills a hole completely through the work. While the drilling is being accomplished, the front cross-slide is advanced, bringing the circular form tool into operation, which turns down the work to the correct outside diameter. The cross-slide then backs out of the way and the turret is revolved, bringing the tap into operation. After the tapping is completed, the turret is again revolved and the work faced to the correct length by a facing tool held in the turret. After this, the rear cross-slide advances, holding the circular cut-off tool, which severs the completed piece from the bar.

The cams used in making this piece are shown in Fig. 6, where the uses of the various lobes are clearly indicated. It will be noticed that four one-hundredths of the cam surface is allowed between the points where the turret dwells with the oil grooving tool and the cross-slide begins to force the cutting tool into the work. This amount of clearance is necessary because of the relative positions of the lead and the cross-slide levers. The procedure to follow in designing a set of cams for performing operations accomplished by swing tools was illustrated and described in the article entitled "Internal Cutting Tools" which appeared in the November, 1910, number of MACHINERY.

* * *

A petrol-electric omnibus has been introduced in London and extensive tests have been made with it. It is fitted with a four-cylinder engine driving a dynamo which, in turn, supplies the driving current for the motors of the vehicle. The advantages of the design over the regular gasoline engine omnibus are said to be that considerable economy in the use of fuel is possible, that the control of the vehicle is made simpler and more effective, and that the arrangement increases the life of the engine, as the shocks from clutching and de-clutching, which are ordinarily so destructive, are eliminated.

* * *

A maker of twist drills investigated a complaint of a customer who had split several drills in drilling a drop forging. He found that the forging was made with a depression in the center where the hole was drilled, but the depression was of a lesser included angle than the standard drill angle of 118 degrees. The result was that the lips of the drill "hogged in" without having a support for the point. Splitting was inevitable. Changing the angle of the drill to conform to the angle in the forging stopped the trouble.

THE PROBLEM OF FOUR TANGENT CIRCLES*

By WILLIAM W. JOHNSON†

The problem of four tangent circles is as follows: Given three circles and the distances between their centers, to find the radius of a circle which is tangent to the three given circles.

This problem sometimes is met with in practical mechanics. For example, it may be required to find the diameter of a gear which will mesh with three given gears, the diameters and the distances between the centers of which are given. The purpose of this article is to show how general formulas may be derived for calculating the diameter of a circle which is tangent to three given circles. There are not less than eight circles which meet the requirements: One, making internal contact with all three circles (see Fig. 1); one, making external contact with all three circles (see Fig. 1); three, making external contact with two circles and internal contact with one circle (see Fig. 2); three, making external contact with one circle and internal contact with two circles (see Fig. 2).

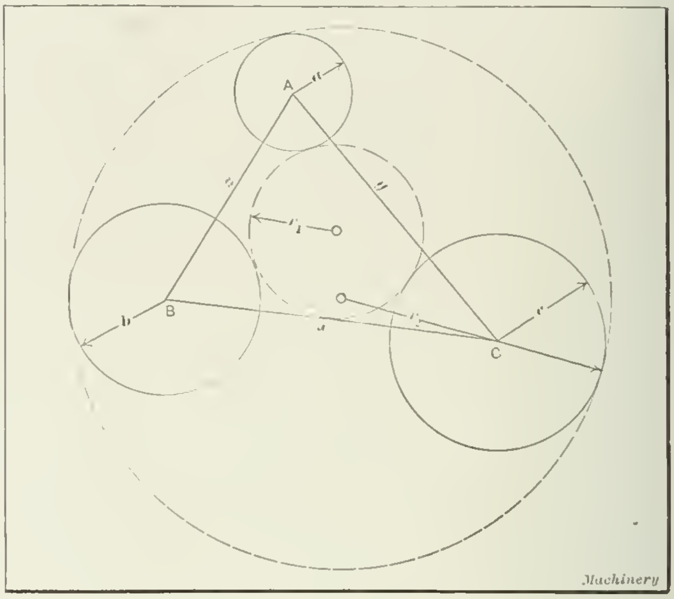


Fig. 1. Circle making Internal Contact with all Three Given Circles, and Circle making External Contact with all Three Circles

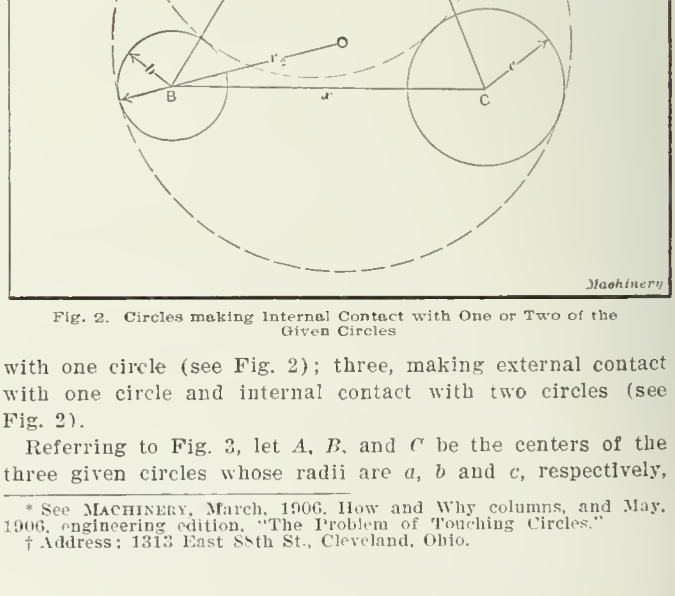


Fig. 2. Circles making Internal Contact with One or Two of the Given Circles

Referring to Fig. 3, let *A*, *B*, and *C* be the centers of the three given circles whose radii are *a*, *b* and *c*, respectively, and let $BC = x$, $AC = y$ and $AB = z$; find r. We can get an equation of the second degree as follows:

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* See MACHINERY, March, 1906, How and Why columns, and May, 1906, engineering edition, "The Problem of Touching Circles."

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Let $AO = p$, $BO = q$, $CO = s$, and angle $AOB = \theta$, angle $BOC = \phi$, and angle $COA = \psi$. Then. $\theta + \phi + \psi = 360°$; $\theta = 360° - (\phi + \psi)$, and $\cos\theta = \cos(\phi + \psi) = \cos\phi\cos\psi - \sin\phi\sin\psi$, or $\cos\theta - \cos\phi\cos\psi = -\sin\phi\sin\psi$.

Squaring both sides we get:

$$\cos^2\theta - 2\cos\theta\cos\phi\cos\psi + \cos^2\phi\cos^2\psi = \sin^2\phi\sin^2\psi$$
$$= (1 - \cos^2\phi)(1 - \cos^2\psi) = 1 - \cos^2\phi - \cos^2\psi + \cos^2\phi\cos^2\psi.$$

Hence, $\cos^2\theta + \cos^2\phi + \cos^2\psi - 2\cos\theta\cos\phi\cos\psi = 1.$ (1)

From the cosine formulas in trigonometry we get:

$$\cos\theta = \frac{p^2 + q^2 - z^2}{2\,p\,q} = 1 + \frac{(p - q)^2 - z^2}{2\,p\,q}$$
$$\cos\phi = \frac{q^2 + s^2 - x^2}{2\,q\,s} = 1 + \frac{(q - s)^2 - x^2}{2\,q\,s}$$
$$\cos\psi = \frac{s^2 + p^2 - y^2}{2\,s\,p} = 1 + \frac{(s - p)^2 - y^2}{2\,s\,p}$$

Put, in the numerators, $p = r + a$, $q = r + b$. and $s = r + c$; then:

$$1 + \frac{(p - q)^2 - z^2}{2\,p\,q} = 1 + \frac{(a - b)^2 - z^2}{2\,p\,q} = 1 + \frac{A}{2\,p\,q}$$
$$1 + \frac{(q - s)^2 - x^2}{2\,q\,s} = 1 + \frac{(b - c)^2 - x^2}{2\,q\,s} = 1 + \frac{B}{2\,q\,s}$$
$$1 + \frac{(s - p)^2 - y^2}{2\,s\,p} = 1 + \frac{(c - a)^2 - y^2}{2\,s\,p} = 1 + \frac{C}{2\,s\,p}$$

Substituting these values in Equation (1). we get

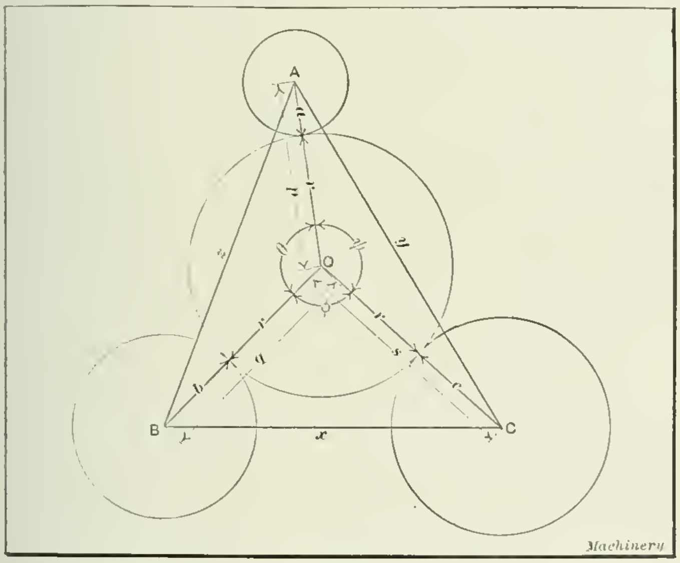

Fig. 3. Diagram for the Analytical Solution of the Problem

$$A^2s^2 - B^2p^2 + C^2q^2 - 2\,ABsp - 2\,BCpq - 2\,CAqs - ABC = 0. \quad (2)$$

Putting $p = r + a$, $q = r + b$, and $s = r + c$, in Equation (2), we get:

$$r^2\,[A^2 + B^2 + C^2 - 2\,A\,B - 2\,B\,C - 2\,C\,A] + 2\,r\,[A^2c + B^2a + C^2b - A\,B\,(a + c) - B\,C\,(a + b) - C\,A\,(b + c)] + [A^2c^2 + B^2a^2 + C^2b^2 - 2\,A\,B\,c\,a - 2\,B\,C\,a\,b - 2\,C\,A\,b\,c - A\,B\,C] = 0. \quad (3)$$

This is the general equation, from which two values for r are always found; one applies to the internal and one to the external circle, Fig. 1.

When $p = r - a$, $q = r + b$, and $s = r + c$ an equation for two other values of r, which apply to Fig. 2, is obtained. When $p = r + a$, $q = r - b$, and $s = r + c$ an equation for two other values is found, and when $p = r + a$. $q = r + b$ and $s = r - c$, an equation for the last two values of r, Fig. 2, is obtained.

By following the same procedure as in the foregoing, and substituting the values for p. q. and s just given, we get as the general equation for the conditions in Fig. 2 ($p = r - a$):

$$r^2\,[A^2 - B^2 + C^2 - 2\,A\,B - 2\,B\,C - 2\,C\,A] + 2\,r\,[A^2c - B^2a + C^2b - A\,B\,(c - a) - B\,C\,(b - a) - C\,A\,(b + c)] + [A^2c^2 + B^2a^2 + C^2b^2 + 2\,A\,B\,c\,a + 2\,B\,C\,a\,b - 2\,C\,A\,b\,c - A\,B\,C] = 0. \quad (4)$$

The other two formulas may be obtained by changing the letters in cyclical order, *i. e.*, changing a to b, b to c, c to a, and x to y, y to z, and z to x. Care must be taken in using the formulas to substitute the values exactly as they appear in the figure. For instance, x is the length of the side opposite the circle of radius a, etc.

Application of the Formulas

In Fig. 1 let $a = 3$; $b = 5$; $c = 6$; $x = 12$; $y = 13$; $z = 10$. Using Formula (3):

$$A = (a - b)^2 - z^2 = -\ 96$$
$$B = (b - c)^2 - x^2 = -\ 143$$
$$C = (c - a)^2 - y^2 = -\ 160$$

Coefficient of $r^2 = A^2 + B^2 + C^2 - 2\,AB - 2\,BC - 2\,CA = -\ 48{,}671$.

Coefficient of $2\,r = A^2\,c + B^2\,a + C^2\,b - A\,B\,(a + c) - B\,C\,(a + b) - C\,A\,(b + c) = -\ 230{,}909$.

Absolute term $= A^2\,c^2 + B^2\,a^2 + C^2\,b^2 - 2\,A\,B\,c\,a - 2\,B\,C\,a\,b - 2\,C\,A\,b\,c - A\,B\,C = 1{,}250{,}089$.

This gives the quadratic equation

$$48{,}671\ r^2 + 2\ (230{,}909)\ r - 1{,}250{,}089 = 0$$

Solving for r we find:

$$r_1 = 2.1978, \text{ and } r_2 = -11.6864.$$

In Fig. 2 let $a = 1$; $b = 2$; $c = 3$; $x = 7$; $y = 6$; $z = 5$. Using Formula (4):

$$A = (a + b)^2 - z^2 = -\ 16$$
$$B = (b - c)^2 - x^2 = -\ 48$$
$$C = (a + c)^2 - y^2 = -\ 20$$

Coefficient of $r^2 = A^2 + B^2 + C^2 - 2\,A\,B - 2\,B\,C - 2\,C\,A = -\ 1136$.

Coefficient of $2\,r = A^2\,c - B^2\,a + C^2\,b - A\,B\,(c - a) - B\,C\,(b - a) - C\,A\,(b + c) = -\ 4832$.

Absolute term $= A^2\,c^2 + B^2\,a^2 + C^2\,b^2 + 2\,A\,B\,c\,a + 2\,B\,C\,a\,b - 2\,C\,A\,b\,c - A\,B\,C = 26{,}176$.

This gives the quadratic equation:

$$1136r^2 + 2(4832)\,r - 26{,}176 = 0.$$

Dividing by 16, reduces to:

$$71r^2 + 2(302)\,r - 1636 = 0.$$

Solving for r, we find:

$$r_1 = 2.1601 \text{ and } r_2 = -10.6671.$$

* * *

DOUBLE-CUTTING PLANERS

A planer for cutting on both the forward and return stroke has been developed by Joshua Buckton & Co., Leeds, England, and was described in a paper read by Mr. J. Hartley Wicksteed at a recent meeting of the Institution of Mechanical Engineers. Many attempts have been made in the past to adapt the planer to double-stroke cutting, but the objection has always been made that with an equal speed of the planer table on both the forward and return strokes, the absence of a quick return motion on the idle stroke in such cases where the work does not permit of the use of both tools, on account of lack of clearance at the end of the stroke, discounts the advantages gained on work where double-cutting could be employed. This objection is overcome in the double-cutting Buckton planer by adopting for the drive a variable speed motor and using a small auxiliary motor for such operations as feeding and traversing the tools. A special advantage of the Buckton arrangement is, therefore, that it is flexible, so that either the forward and return strokes can be made at a uniform speed, or the return stroke can be made at an increased rate of speed when required. Another design has also been introduced with belt drive to the planer, by means of which the same flexibility as regards the rate of speed of the return stroke can be obtained. The method of holding the double-cutting tools is to fasten them back to back and exactly in line.

* * *

In painting or otherwise coloring the walls of any workroom, this question naturally arises: What color reflects the most and what the least light? Here are the data, based on recent experiments in Germany. Dark blue reflects 6½ per cent of the light falling upon it; dark green about 10 per cent; pale red a little more than 16 per cent; dark yellow, 20 per cent; pale blue, 30 per cent; pale yellow, 40 per cent; pale green, 46½ per cent; pale orange, nearly 55 per cent; *pale white, 70 per cent.* Glossiness and varnish increase the amount of light reflected.—*Detroit-Fenestra.*

THE CINCINNATI METHOD OF INDUSTRIAL EDUCATION—A FRIENDLY CRITICISM*

By JAMES A. PRATT†

The writer recently visited Cincinnati with the purpose of becoming acquainted with the work done there along the lines of industrial education. An opportunity was afforded to visit four very well equipped plants, attention at these visits being given solely to the mechanical engineering and machinist's shop courses there provided in connection with studies at the Cincinnati University or the apprentice continuation school. In each case the writer made his purpose clearly known, and requested the privilege of talking with the students.

The Course for the Students of Mechanical Engineering

In order to obtain an idea of the practical shop knowledge assimilated by the students, a number of questions of the character indicated below were put to them.

What is the advantage of the floating collet as used in small tool design?

In assigning work to the boring mills, what general division would you make between that going to the horizontal mill and that going to the vertical?

What factors would you consider in deciding whether a casting should be made from a full pattern or swept up?

Assuming that you were running a certain mixture, which had previously given satisfaction, in the cupola, and you unexpectedly found your casting coming hard, what would be your line of procedure to determine the cause of the difficulty?

These are questions which with proper shop teaching in engineering, students should be able to answer. Out of five men, however, but one was able to give passable answers to questions of this kind. This man was in the fifth year of the course, and yet, on certain phases of shop work, he could answer no questions, as many subjects had never been taken up at all. According to his own statement, this young man has never been asked, throughout the five years of his course, to make a shop report of any kind to a college authority.

The work done by the engineering students in the shop is in no way different from that given to the ordinary mechanic. It is evident that great breadth of view and ability would result if a man studying to become an engineer could at the same time be trained to be a thorough mechanic in at least one of the trades, while he was given a fair degree of familiarity with all the other trades bearing on his profession. Such a plan, however, could not be carried into effect in much less than seven years entirely devoted to understudy work, not including the three or four years of preparatory work required, and few persons are willing to spend this length of time in training, especially as it is not absolutely necessary for the engineer to be a skilled mechanic.

Since, therefore, some details of the shop work must be dropped from the course of training, which should these be? Logically it would appear that those details which develop dexterity to a greater degree than they impart knowledge of tools and processes, could be eliminated with the least danger. What the student requires most, in order to tell in the future when a man, or a gang of men, is working efficiently, is to understand the purpose and efficient operation of various machines. Outside of this the shop work of the engineering student should have in view the development of his ability to solve engineering shop problems, rather than to train him to be a skilled mechanic. However, the writer was told by a person in authority at one of the shops visited that no attempt was made to give the engineering students any other class of work than was given a boy who was learning a trade.

The manufacturer is surely not to blame for this condition. He is not running an educational institution, and his position was presented clearly by the statement of one manufacturer who said that the manufacturers were glad to have the boys get anything that they could out of the scheme, but no special shop arrangement would be permitted for the benefit of the engineering students. From a business point of view this position is not open to criticism, nor can those in charge of the plants be expected to act otherwise. There is, however, a reason for discussion when the claim is made by educators, that the scheme, as worked out, is a full and satisfactory substitute for proper college shop training. Such a claim is made by those responsible for this method of training in Cincinnati. It is admitted by the writer that there is a great deal of college shop work which does not give the student any better view of actual shop work, nor perhaps as good, as that obtained by the Cincinnati students, but such conditions exist only because of incompetence or indifference on the part of the educators, and this neglect cannot be excused. In any event, the training as obtained by the students in Cincinnati—so far as the work was shown to the writer—does not give a sufficiently broad training, because the student must do the work wanted in the plant regardless of whether it benefits him or not, and, further, some of the plants do not maintain all the departments in which training is usually considered essential to the engineer.

The Coordinator

In visiting the plants it was expected that the coordinator would be met with and an opportunity afforded to talk over this matter with him. The writer had expected that he made frequent calls on the boys while at work. In the first shop visited, however, a man having such duties as ascribed to the coordinator was not known, and the most precise statement obtainable was that a man came around once in awhile, and if a student was kept too long on one job he tried to get him changed. The students interviewed said that there was no connection between the work in the shop and the studies in the college. In theory the coordinator may be clearly defined and his purpose fixed, but as far as ascertainable, the practical results of his work are not effective, since he has no authority over the students or their work in the shop. It is, therefore, open to question whether the cooperative plan is an efficient substitute for proper college shop work, especially since even under the best conditions there is much that is necessary for an efficient training which is not presented.

In three of the four plants visited, it was stated that the students, under the cooperative system, were not to work except in the machine shop, no pattern shop, foundry nor forge shop training having been arranged for. The reason for this was that these plants did not have such departments, work of this character being done for them by outside firms. In another case an engineering student stated that upon authoritative advice he was omitting training in the pattern shop and foundry, because these branches were unnecessary as a part of a mechanical engineer's course.

Apprenticing Engineers

Literally, an attempt is made in Cincinnati to apply the apprenticeship method of teaching engineering. This plan would be satisfactory if the shop work were supervised in such a way that the student covered the proper field in a correct manner, and providing only a small number of students were to be handled. As soon as a large number are placed under such a plan, the training is likely to be insufficient, because there is not enough of the proper kind of work in any one plant to meet the student's needs. The point where there is a surplus of students to permit proper training has evidently been reached in Cincinnati, if it be true, as it is stated, that there are two courses available to students, one under which he can agree to a contract at a certain wage rate, according to which contract the company must place him in all of its departments, and one under a later form of contract where there is no agreement on the part of the employer to afford experience to a student in more than one department of a shop; but in this case a higher wage scale is offered. The writer did not see the latter contract, but was told that such a course was taken by many. This method permits of the entry of a larger number of students to the course, but it does not give them an efficient training.

There are certain excellent features of the engineering shop work as practiced in Cincinnati, one of which is the association with the workmen; but the most important feature of all—that the training of the student should be carried on without curtailment until the requirements of the course are met with in full—is being neglected. There is no department of a technical school which may be used so effectively as the shop in developing executive ability, provided the shop course is properly managed; and the factor of the development of executive ability should be kept well in mind by all who are training young engineers. Yet this feature is entirely lacking in the method applied in Cincinnati.

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* For previous articles on the Cincinnati plan of industrial education, see "Industrial Education—The Cincinnati Plan," November, 1909, and "Cooperative Industrial Education," October, 1908.

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Summary

Summing up the points in favor of the Cincinnati plan and the points that are against it, we find the following favorable conditions embodied in the method.

1. The student has an opportunity to see a shop arranged for commercial production. During noon hours and, perhaps, at other times when not engaged, he may go about, ask questions, and observe for himself, thus gathering much valuable information.
2. The student has an opportunity to see modern tools installed and running in an efficient manner, and observe the operation of all classes of shop devices.
3. He gets used to factory routine.
4. He learns his place as a factor in the productive plan, and finishes his college course with a balanced estimate of his knowledge and usefulness.
5. He develops dexterity.

The unfavorable points, as the writer sees them, are as follows:

1. The student does not obtain a full understanding of the possibilities and the wide application of any one tool.
2. The ability to discriminate between methods of production, and their bearing upon economy, is not developed.
3. The underlying reasons for using jigs and fixtures and similar labor-saving devices are not made thoroughly clear.
4. There is a lack of general familiarity with elementary shop processes with which the engineer must necessarily come in contact.
5. The student cannot be placed to advantage in the various shops by the college authorities who are responsible for his training.
6. His executive capacities are not developed.
7. Necessary branches of the work are dropped from the course at will.
8. The trend is toward training a mechanic for the shop rather than an engineer.
9. There is insufficient supervision of the shop work by the college authorities, or else the supervision is ineffective.
10. A large number of students do not get the proper training and the opportunities which may be available are for a few.
11. The feature of alternating between shop and school (the Cincinnati system being based upon the plan of the student working one week in the shop and then the next week in the college, and so on) is detrimental to the student's work in both branches, because of the frequent extended interruptions, first in one department and then in the other.

The Trade Course

The previous discussion has dealt with the engineering work only, no thought having been given to the training of mechanics, as the method of teaching for the two classes should be entirely different. Boys learning a trade have four hours a week off to go to school, and are paid apprentice wages for this time. In the apprentice school the problems given are related to the shop. The writer did not have an opportunity to see a class in session, but talked with some of the boys, and apparently this work consists of a series of shop talks with related problems. The subject matter of these shop talks appears to be good, though limited in its scope. They are delivered by persons who know their business, which by the way, is a very important feature. The apprentice classes meet in a separate school building devoted to this work alone. This school feature, however, is the only feature which is in any way different from the apprentice course available almost anywhere in the country to a boy who enters a machine shop.

One must not regard shop talks and the solution of problems as the whole of trade teaching. They are important and necessary adjuncts, but the real teaching of the trade is done on the shop floor by a man who makes it his business to see that the apprentice understands what he is doing; at the same time he is given such a range of experience that he may enter any shop as an all-around man. This involves the ability to operate all the principal machine tools, as well as familiarity with floor work; as principal machine tools are classed the lathe, planer, shaper, slotter, milling machine, boring mill, and grinding machine.

Now it depends on the position which one takes relative to trade teaching, whether the manufacturer is morally responsible for teaching a trade such as outlined above or not. If no claim is made to public attention or funds, any manufacturer may give any kind of training that a boy is willing to accept, or may be compelled by force of circumstances to accept, and there is no fault to find. The manufacturer has a right to make the apprenticeship he offers meet his own requirements for the benefit of his plant, and take care that the working personnel may not become depleted. This is what the men in charge of the shops in Cincinnati claimed to be doing and nothing more. No person in authority with whom the writer talked claimed to be training all-around men. "Three branches is all we give, at most," someone said, "and all the boys do not get these." One man in charge at one of the shops stated very clearly that there was no claim towards doing anything in this matter of trade training that is not done in almost every community, except that in the continuation school an effort was made to give the boy a proper view of his trade.

While thus the writer was not given any erroneous impression of the nature of the training afforded boys under the Cincinnati arrangement by those in charge of the shops, yet is it claimed by the educational authorities in presenting the cooperative plan of work in Cincinnati that the boy has an excellent chance to learn a trade. and this is the one point where the system is open to criticism—when it is claimed before the public that a course based on the needs of the apprentice is offered, and that his needs are the prime consideration. Persons connected with the school work in Cincinnati, however, have no control over the shop work and no assurance that the boy shall apply any of the matter taught at school in practice. In fact, the school work seems to be merely a scheme to keep the boy interested in what he is doing in the shop, in a vague way, rather than having direct application to his work. No one on the shop floor gives the apprentice any special attention. The instruction he gets is mere chance, and is not a certainty for every boy.

Therefore, in view of the fact that, at best, but a limited course is offered, and that even such a course is frequently curtailed, it hardly appears that the cooperative plan is a good way to teach a trade, nor even a desirable way in view of the fact that there are better ways open at a low cost to any community. This way is the trade school pure and simple. Worcester, Bridgeport, and New Britain, as well as some other communities have tried this method and seem to be satisfied with it. To say that such a school is too expensive is to admit that one does not understand the operation of a plant on a business basis, because all the trades taught at a school can be made to contribute to its support in the making of its own equipment.

This article should not appear without an acknowledgment of the courtesies extended the writer at the various plants, and an appreciation of the frank and open way in which each of those in authority at these plants answered all questions and assisted in the obtaining of the required information.

* * *

When steel balls are used for burnishing small metal articles by tumbling, it is important that a liberal amount of steel balls be used. There is a strong tendency, particularly among the smaller manufacturers, to attempt to economize on the balls and use too few. The result is, according to the *Brass World*, that not only is it difficult to obtain a good burnished surface on the goods in a reasonable time, but sometimes the appearance of the articles is such that the manufacturer will condemn the ball burnishing process. If too small a quantity of balls is used, they do not come in contact with the surface of the work being burnished as often as is necessary, and hence the process is slower than it would otherwise be. Also, if a small quantity of balls is used, the surfaces of the articles being burnished come in contact with one another instead of with the balls, and abrasion takes place instead of burnishing. In establishments doing some excellent work by the use of steel balls it is customary to use about twice the quantity of steel balls as compared with the quantity of the work in the barrel.

* * *

When the New York, New Haven & Hartford railroad shall have completed the electrification of its lines all the way to New Haven, as recently decided upon, it will have a mileage of about 150 miles under electric operation, or a trackage of about 600 miles. It is expected that these lines will be electrified before the end of 1913. This electrification marks the greatest undertaking along these lines as yet definitely proposed.

IMPROVED DESIGN OF HYDRAULIC ACCUMULATOR

By ALEX. W. BEGGS[*]

In the December number of MACHINERY an illustrated description on designing a hydraulic accumulator appeared. The writer has no fault to find with this article, or the calculations as given for the design presented, but he takes exception to the design or type itself. The design shown is considered out of date, being what one might call "upside down." Furthermore, the author of the article states that it is better to make the plunger small in diameter and the stroke long, thus saving in the number and size of cast-iron weights required. The latter statement is, of course, correct, but it makes a more costly machine to build. Castings 23 feet long are difficult to make in the foundry and to handle in the machine shop, and few shops have lathes that will take castings of that length. In addition, there is the guide frame to build and to fasten to the building, and the overhead room required. It is also troublesome for the man who has to crawl in under the accumulator to pack the gland on the plunger.

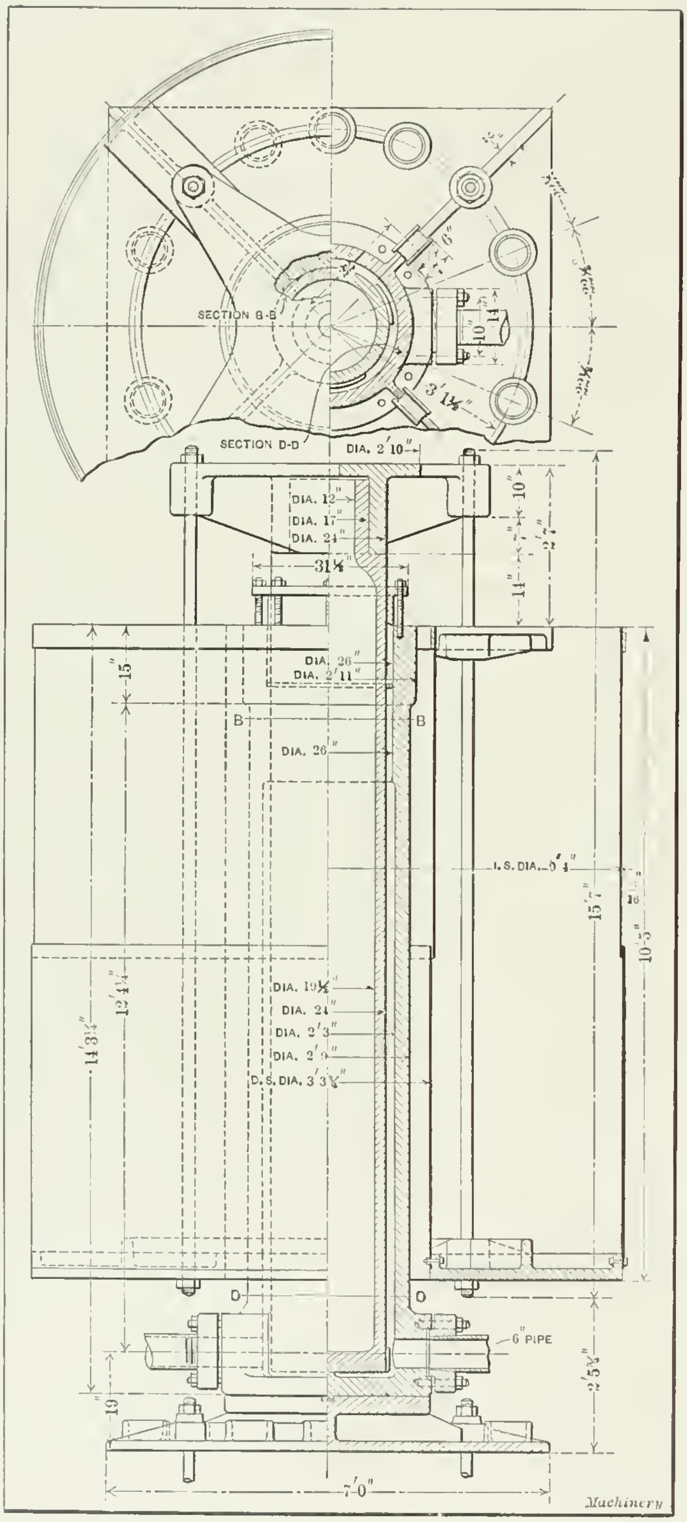

Fig. 1. Improved Design of Hydraulic Accumulator

If it is necessary to save on the cast-iron weights, a tank can be used which can be filled with any kind of cheap scrap. The accompanying illustration shows a 24-inch accumulator for 600 pounds pressure, of which several have been built. It is self-contained, and as the packing of the gland is at the top, it can be easily reached. It is the practice in some plants employing hydraulic power, to use about 600 pounds pressure for general work. If a higher pressure is required an intensifier is used.

All the principal points of the design are indicated in the illustration, and it is not necessary to elaborate on them. One point in the design may, however, be worth while calling attention to. As will be seen in the engraving Fig. 2, the plunger is provided with four lugs, 9 inches wide, on the lower end. Four similar lugs are also provided on the inside of the upper end of the cylinder. If the plunger is placed in the cylinder and then given one-eighth of a turn, this will bring the lugs exactly in line with each other, and when the plunger is extended to its full stroke, the lugs will come in contact with each other and prevent further movement of the plunger. The plunger is prevented from turning back by a 1½-inch bolt at the upper end, which passes through both the yoke and plunger. The yoke is prevented from turning by the flanged guide wheels on the bottom of the tank.

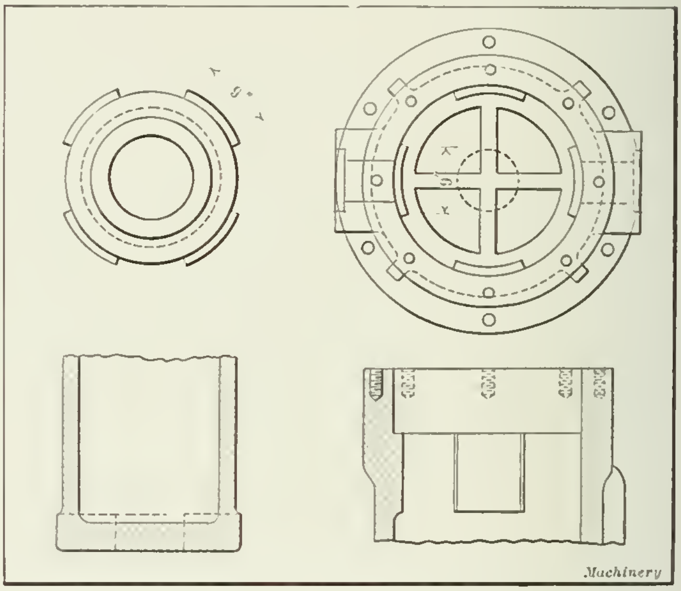

Fig. 2. End Views of Cylinder and Plunger, and Sections of Upper End of Cylinder and Lower End of Plunger, showing Safety Lugs

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BRITISH STANDARD DEFINITIONS OF YIELD POINT AND ELASTIC LIMIT

The Engineering Standards main committee has agreed upon the following definitions for yield point and elastic limit. The elastic limit is the point at which the extensions cease to be proportional to the loads. In a stress-strain diagram plotted to a large scale it is the point where the diagram ceases to be a straight line and becomes curved. The elastic limit can only be determined by the skillful use of very delicate instruments and by the measurement of the extensions for small successive increments of load. It is impossible to determine it in ordinary commercial testing.

The yield point is the point where the extension of the bar increases without increase of load. Practically, the yield point is the load per square inch at which a distinctly visible increase occurs in the distance between gage points on the test piece, observed by using dividers; or at which, when the load is increased at a moderately fast rate there is a distinct drop of the testing machine lever, or, in hydraulic machines, of the gage finger. A steel test piece at the yield point shows rapidly a large increase of extension, amounting to more than one two-hundredth of the gage length. The point is strongly marked in a stress-strain diagram.

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SHOP PROBLEMS INVOLVING GEAR AND PULLEY SPEEDS*

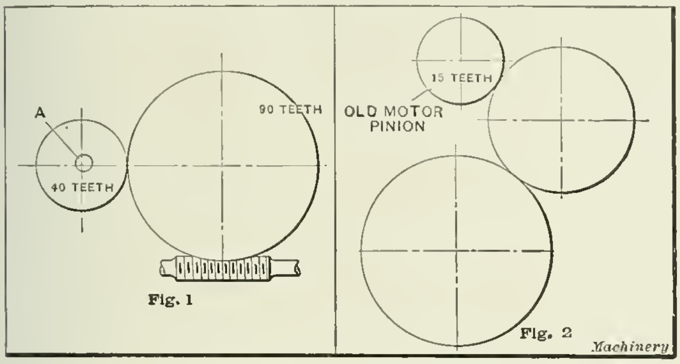
By J. H. CARVER†

In the following article are given a number of problems involving gear and pulley speeds. The problems are of a type likely to occur in ordinary shop practice, and their solutions are submitted with the hope that they will be of interest and value to those who may meet with similar instances, where the methods here given might be employed.

In the first place, assume that we have two gears with fixed center distance and a given ratio, which are to be replaced by two gears of a different ratio. Let R be this new ratio; and let the sum of the number of teeth in both the new and the old gears be $N + n = S$, where

$N =$ the number of teeth in the large new gear,

$n =$ the number of teeth in the small new gear.



Figs. 1 and 2. Problems in Gear Ratios

R and S are known, and N and n are to be found. But, as $R = n \div N$, we have $NR = n$, or $NR - n = 0$. We have also $N + n = S$. Adding these two equations we have:

$$NR + N = S, \text{ or } N = \frac{S}{R+1} \qquad (1)$$

$$\text{From } R = n \div N, \text{ we have } n = NR. \qquad (2)$$

These formulas determine the number of teeth in the two new gears, which are of a different ratio but have the same center distance as the old gears.

As an example, assume that we have two gears on fixed studs, each having 60 teeth, and that these gears are to be replaced by two having a ratio of 4:11. Then, from the equations just given we have:

$$N = \frac{S}{R+1} = \frac{120}{(4 \div 11) + 1} = \frac{120 \times 11}{15} = 88 \text{ teeth.}$$

$$n = NR = 88 \times \frac{4}{11} = 32 \text{ teeth.}$$

In the arrangement of gearing shown in Fig. 1, shaft A is turned by a worm- and spur-gear train. It is required to revolve shaft A thirty per cent faster by replacing the 40- and 90-tooth gears by other gears of proper ratio and suitable for the fixed center distance.

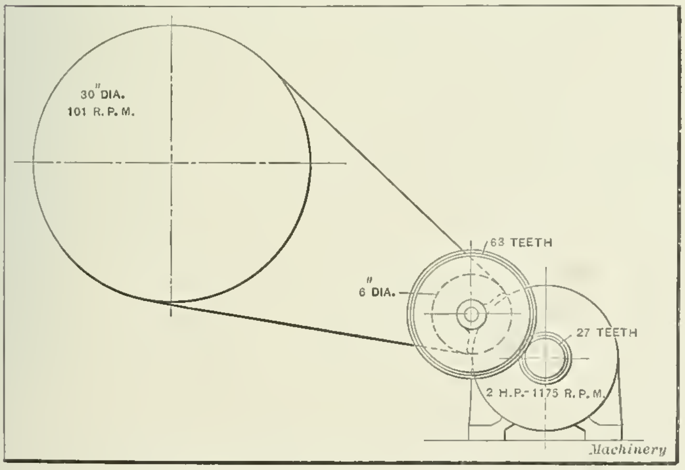


Fig 3. Speed Reduction obtained by Gearing and Belting in Combination

$$\text{Old gear ratio} = \frac{40}{90}. \quad \text{New gear ratio} = \frac{40}{90} + \left(\frac{30}{100} \times \frac{40}{90}\right) = \frac{52}{90}$$

$$\text{Hence, } N = \frac{S}{R+1} = \frac{130}{(52 \div 90) + 1} = 82.3,$$

or say 82 teeth, which is the nearest whole number. Further

$$n = NR = 82 \times \frac{52}{90} = 48, \text{ approximately.}$$

Hence, two gears of 82 and 48 teeth, respectively, making $S = 130$ teeth, as it should be, will give an increase of speed to shaft A of practically 30 per cent.

It is sometimes desired to change the size of the motor because of the increased duty of a motor-driven machine. For example, a 30-inch engine lathe is provided with a 2½ horsepower variable speed motor running at 700–1400 R.P.M., and it is desired to replace it with a 5 horsepower motor running at 500–1500 R.P.M. The speeds of the lathe spindle must cover at least the same range as before. The arrangement of the gears near the motor is shown in Fig. 2. The only change necessary would be in the motor pinion. The number of teeth N in this pinion is found from the proportion:

$$\frac{N}{15} = \frac{650}{500}, \text{ or } N = \frac{15 \times 650}{500} = 20 \text{ teeth, approximately.}$$

The value 650 is used in place of 700 because both slower and faster new speeds can thereby be provided for.

It often happens when belting from the motor to the pulley on a motor-driven machine, that the desired slow speed cannot be obtained by belting directly to the regular motor pulley. In this case the motor may be geared as illustrated in Fig. 3. A bracket carrying a shaft is mounted on the motor frame. This shaft has a gear on one end meshing with a pinion on the motor shaft, and a driving pulley on the opposite end to which the pulley on the machine to be driven is belted.

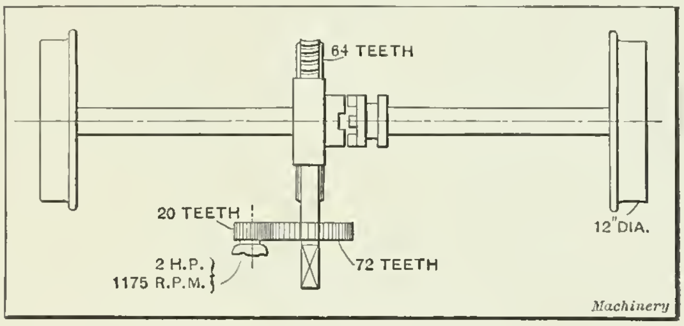


Fig. 4. A Simple Problem in Gear Ratios

A punch-press, for example, has a balance wheel 30 inches in diameter, as indicated in Fig. 3, and is driven by a two-horsepower constant-speed motor running at 1175 R.P.M. The required speed of the balance wheel is 100 revolutions. It will be found that by the arrangement shown a speed of

$$\frac{1175 \times 27 \times 6}{63 \times 30} = 100.7 \text{ R.P.M.}$$

will be obtained, which is near enough for practical requirements.

An inclined hydraulic press, whose back yoke is mounted on wheels and designed to be moved by an individual motor at a speed of 16 feet per minute, is arranged in the manner indicated in Fig. 4. A two-horsepower constant-speed motor is used, running at a speed of 1175 R.P.M. The wheels on which the yoke is mounted are 12 inches in diameter, or 3.14 feet in circumference. Hence, the number of revolutions necessary for a speed of 16 feet per minute equals $\frac{16}{3.14} = 5.1$ revolutions. Further, the speed of the worm $= 64 \times 5.1 =$ 326.4 R.P.M. Assume that we choose a 20-tooth gear on the motor shaft. How many teeth should the gear on the worm-shaft, meshing with this 20-tooth gear, have? Denoting the number of teeth to be found by T, we find this number as follows:

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* For a treatise dealing more completely with the principles involved in the problems presented in the present article, see MACHINERY's Reference Books No. 18, "Shop Arithmetic for the Machinist," and No. 52, "Advanced Shop Arithmetic for the Machinist."

† Address: 761 Eastern Ave., Schenectady, N. Y.

$$T = \frac{20 \times 1175}{326.4} = 72 \text{ teeth.}$$

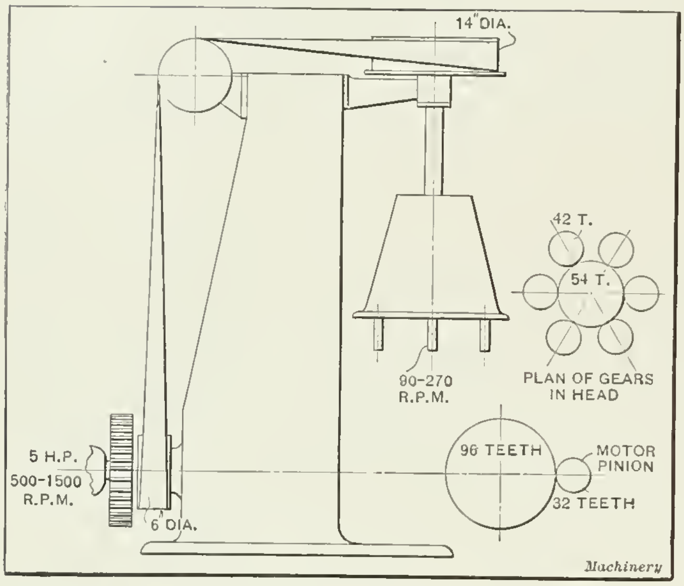
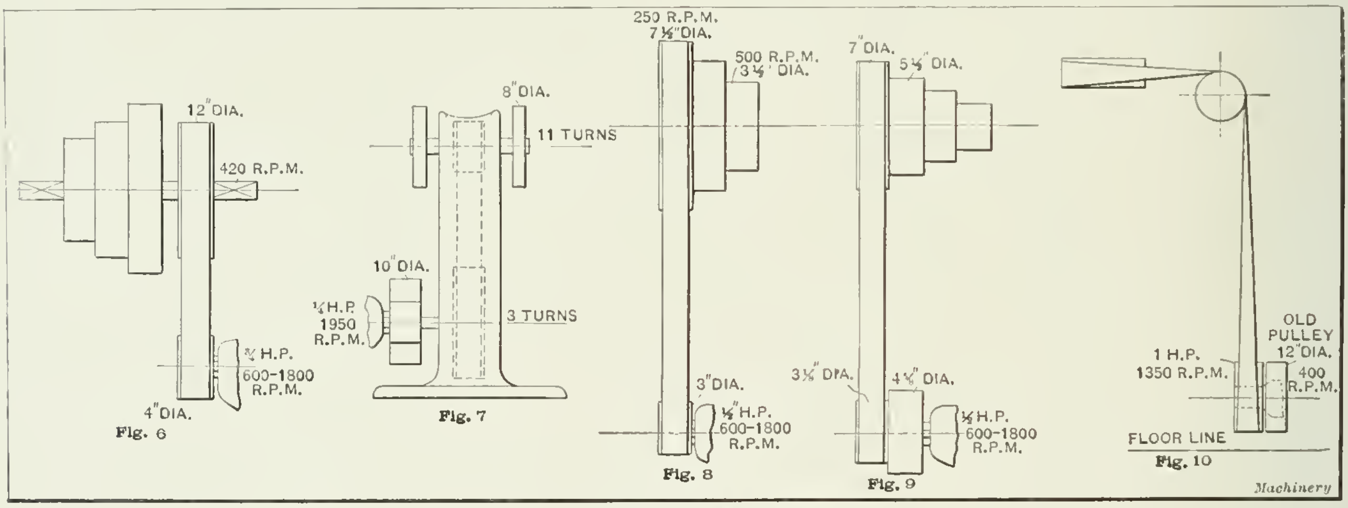


Fig. 5. Drive of a Six-spindle Drill Press

In Fig. 5 is shown a diagram of gears and pulleys used on a six-spindle multiple drill. A 32-tooth pinion on the motor meshes with a 96-tooth gear, as shown. A five-horsepower motor, 500–1500 R.P.M., was used. The drill speeds necessary were 90–270 R.P.M. The number of teeth in the motor pinion was found as follows:

$$\frac{96 \times 14 \times 42 \times 90}{6 \times 54 \times 500} = 32 \text{ teeth, approximately.}$$



Figs. 6 to 10. Miscellaneous Examples of Belt Drives

A three-spindle sensitive drill was to be equipped with a ¾-horsepower variable speed motor, running at 600–1800 R.P.M. It has been found that ¼ horsepower per spindle is ample for driving sensitive drills. In the old belt-drive arrangement, the drive was to a 12-inch pulley, driving the cone-shaft at 420 R.P.M., as indicated in Fig. 6. The motor is belted to the same pulley, as shown. The diameter of the pulley on the motor is found as follows:

$$\frac{12 \times 200}{600} = 4 \text{ inches diameter.}$$

The value 200 is used instead of 420 in order to give a slower speed for the lowest motor speed than that obtainable by the belting arrangement. The average motor speed will then give the required speed to the cone shaft.

A grinder using an 8-inch emery wheel is to be driven as shown in Fig. 7, by a ¼-horsepower motor running at 1950 R.P.M. The emery wheel is run at 2100 R.P.M. The pulleys shown dotted are enclosed, and it is difficult to measure their diameters so as to determine the proper size for the motor pulley. By turning the emery wheel spindle, however, it can be found that eleven turns of the emery wheel correspond to three turns of the 10-inch pulley belted to the motor pulley. Hence, the speed of the 10-inch pulley equals $\frac{3 \times 2100}{11} = 573$ R.P.M., and the size of the required motor pulley will be $\frac{10 \times 573}{1950} = 3$ inches, approximately.

When changing the style of drive on a machine tool from belt to motor drive, it often happens that a cone pulley must be belted to the motor pulley. In the case of many lathes, profiling machines, drill presses, shapers, slotters, milling machines and special tools, the ratio of the speeds obtainable through the cone pulley may run from 3 to 1, according to whether the belt is on the smallest or largest step of the pulley. In such a case a 3 to 1 variable speed motor with the proper diameter of pulley to give the desired slow speed when belted to the large step of the cone will also give the corresponding high speed. As an example, assume that a turret lathe runs at 250 R.P.M. with the belt on the largest step, and at 500 R.P.M. with the belt on the smallest step, as indicated in Fig. 8. This lathe is to be belted directly from the motor pulley to the largest cone step. A 3-inch motor pulley gives a greater speed range than the old speeds, when using a ½-horsepower motor running at 600–1800 R.P.M.

In the case of higher ratios of machine cone pulleys, where the motors obtainable do not cover the desired speeds, a two-step motor pulley will meet the requirements. For example, a speed lathe, the cone of which together with the two-step cone of the motor is shown in Fig. 9, is driven by a ½-horsepower motor running at 600–1800 R.P.M. The lathe originally ran at 200–1500 R.P.M. With the motor pulley shown the speeds are 270–810 R.P.M. with the belt on the large step of the lathe pulley, and 500–1500 R.P.M. with the belt on the next smaller step.

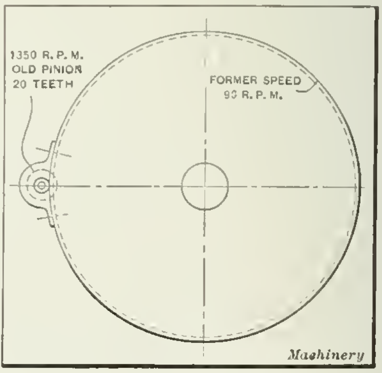


Fig. 11. A Problem in Gear Ratios

A drill press was belted in the manner shown in Fig. 10. The 12-inch tight and loose pulleys shown were to be removed and replaced by a motor with pulley. The pulleys ran at 400 R.P.M. The motor was 1 horsepower, running at 1350 R.P.M. The peripheral speeds of the 12-inch pulley and the required motor pulley must be the same, if the drill press speed is to remain unchanged. Therefore, when the speed is increased, the diameter will be proportionately decreased, and hence, the diameter D of the required motor pulley will be found as follows:

$$\frac{D}{12}=\frac{400}{1350}, \text{ or } D=\frac{12\times 400}{1350}=3.55,$$

or, say, 3½ inches, which is near enough for all practical purposes.

Fig. 11 shows a diagrammatical view of a punch press arrangement, the balance wheel being driven by a ½-horsepower motor running at 1350 R.P.M. The motor pinion has 20 teeth meshing with teeth in the balance wheel. The wheel runs at 96 R.P.M. It is desired to change to a 2-horsepower motor running at 1175 R.P.M., and at the same time increase the speed of the balance wheel to 110 R.P.M. The balance wheel is enclosed, making it difficult to measure or count the number of its teeth. By the calculations in the following, the necessary number of teeth in the new motor pinion is determined without reference to the balance wheel. If N is the number of teeth required, then

$$\frac{N}{20}=\frac{1350}{1175}, \text{ or } N=23 \text{ teeth, approximately}$$

if 96 turns per minute, only, were required; but when 110 R.P.M. are required, we would have:

$$\frac{N}{23}=\frac{110}{96}, \text{ or } N=26 \text{ teeth.}$$

* * *

An electrically operated blueprinting machine, used for making the blueprints for the municipal departments of St. Louis, Mo., produced 15,900 blueprints last year. According to the *Engineering Record*, the cost per square foot, including labor, material, and depreciation of the machine, was 1.5 cent for blueprints, 3.4 cents for brown-prints, 5.4 cents for black-prints, and 6.4 cents for blue-cloth-prints.

AUTOMATIC DIE-CASTING MACHINES[*]

By E. F. LAKE[†]

Nearly all die-casting machines in use at the present time are operated by hand, that is, a number of levers are pulled back and forth to perform the different operations of closing the mold, moving the plunger to force the metal into the mold, cutting off the sprue, opening the mold, and ejecting the castings. Nearly all of these machines require two men to operate them, and in some cases it requires five men to operate two machines. With these hand-operated machines a large quantity of castings can be manufactured in a day, and many have not considered it necessary to design and build more expensive machines. Some manufacturers, however, have built completely automatic machines for their own use, in order to save the labor cost of the hand-operated machines. These automatic machines are very successful, and are producing die-castings at a very low cost.

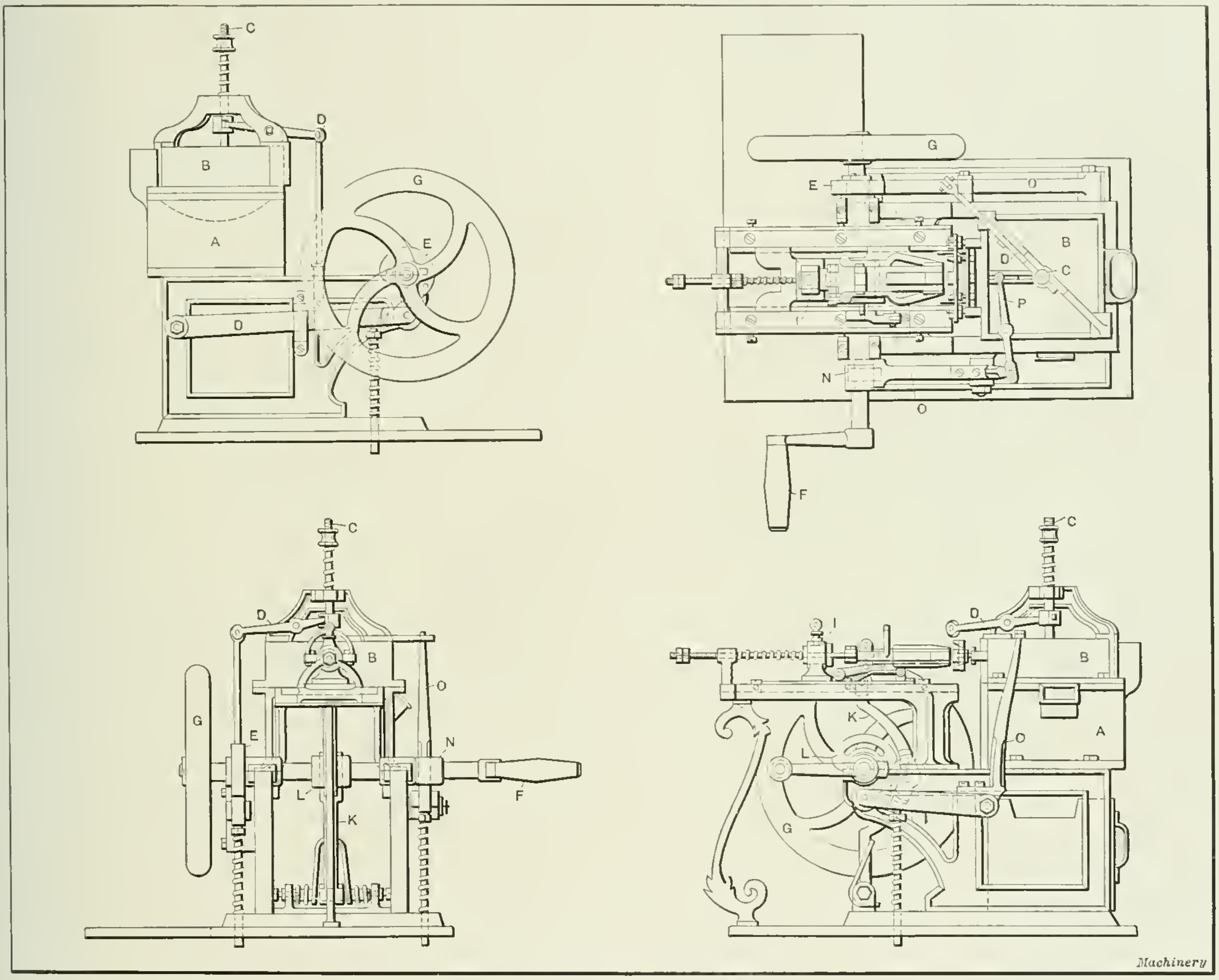


Fig. 1. First Automatic Die-casting Machine

Automatic machines for casting type have been in use for more than sixty years, and these are, in reality, die-casting machines, although only used for the particular purpose of manufacturing type. Like all other die-casting machines, the automatics were devised from ideas and principles adopted in the type-casting machines, and are, in fact, largely improvements of these. The first attempt at applying such machines to the manufacture of castings, other than type, is shown in Fig. 1. This machine was patented by M. Dimock in 1875 for the manufacture of sewing machine bobbins. By turning crank F, all movements were produced that were necessary for the casting of a bobbin and throwing it out of the machine. By putting a pulley in place of the crank, it could be belt-driven and thus made completely automatic. In this machine,

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[*] See MACHINERY, July, 1911, engineering edition, "The Design of Die-casting Machines—Alloys for Pressure Castings," and also the previous articles there referred to.

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A is the furnace and *B* the melting pot located over the furnace, in which the metal is melted and held, ready for casting; *C* is the upper end of the pump or plunger that forces the metal into the mold. This plunger is raised and lowered by levers *D*, which in turn are moved by cam *E* located on the driving shaft, which passes through the machine from crank *F* to the flywheel *G*. The mold and the apparatus for opening and closing it and ejecting the casting are located on a framework just above this shaft. The die-mold receives its metal from a nozzle in the side of the melting pot.

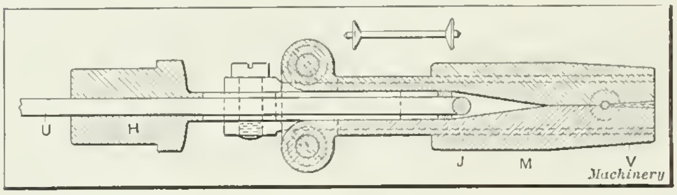

Fig. 2. Die-mold and the Bobbin cast

The cross-section of the die-mold, with shank *H* on which it is pivoted, is shown enlarged in Fig. 2; the bobbin which is cast in it is shown above the mold. Shank *H* fits into cross-head *I*, and is, by means of this cross-head, pulled back from the spout so that it can be opened. The two halves of mold *M* are opened like an alligator's jaw by turning bar *J*, which is long enough for this purpose and is located on the end of shaft *U* that passes through shank *H* and carriage *I*. The cast bobbin is then thrown out and the mold closed, ready for another casting. The cross-head and mold are moved back and forth by lever *K*, one end of which is pivoted to the frame at the bottom of the machine, while the other end works in a slot in the cross-head. Lever *K* is operated by cam *L* which is located on the center of the main shaft. When mold *M* is moved up to the nozzle of the machine, the tapered end at *V* enters a socket, thus holding the mold firmly closed. As soon as the mold assumes this position, a cam located on the main shaft at *N* operates hinged lever *O*, and this, in turn, moves lever *P*, which opens a valve that allows the molten metal to be injected into the die-mold. This valve operates in practically the same manner as valve *T* in Fig. 3 and valve *L* in Fig. 5, to be described later. In the meantime, plunger *C* has been raised to the top and as soon as the metal cut-off valve opens, the plunger is forced down and fills the mold with metal.

While this machine was simple in design, it worked fairly well, and many castings were made with it. The springs which gave the levers their return motion, however, were not positive enough, and on later machines cams were added for this work. A sprue cutter, such as is now used, was not provided, and hence the sprue had to be broken off from each casting. These were about the only faults that could be found, and the principles here adopted were developed to a point that enabled automatic die-casting machines to cast pieces very intricate in shape. Movements were devised for pulling out pins, located in the die-molds, as well as other loose pieces that might form any size or shape of hole in the casting.

In 1902, Mr. C. H. Veeder patented the machine shown in Fig. 3. On this he was granted patents on nineteen combinations claims, but it will be seen that, although the machine is greatly improved in its design, the basic principles on which it operates are practically the same as those of the machine patented in 1875. The furnace is located at *A*, the melting pot at *B*, and the upper end of the plunger at *C*, as in the former machine. Lever *D* is operated by cam *E* and moves rod *Q* and lever *R*, which latter causes plunger *S* to travel up and down and squirt the molten metal into the die-mold. Another cam moves pivoted lever *O*, which is connected with the valve rod, and opens and closes valve *T* in identically the same manner as did the earlier machine; in fact, the shape of lever *O* is almost the same. This, however, is a design that has been successfully used for years on type-casting machines and is difficult to improve upon.

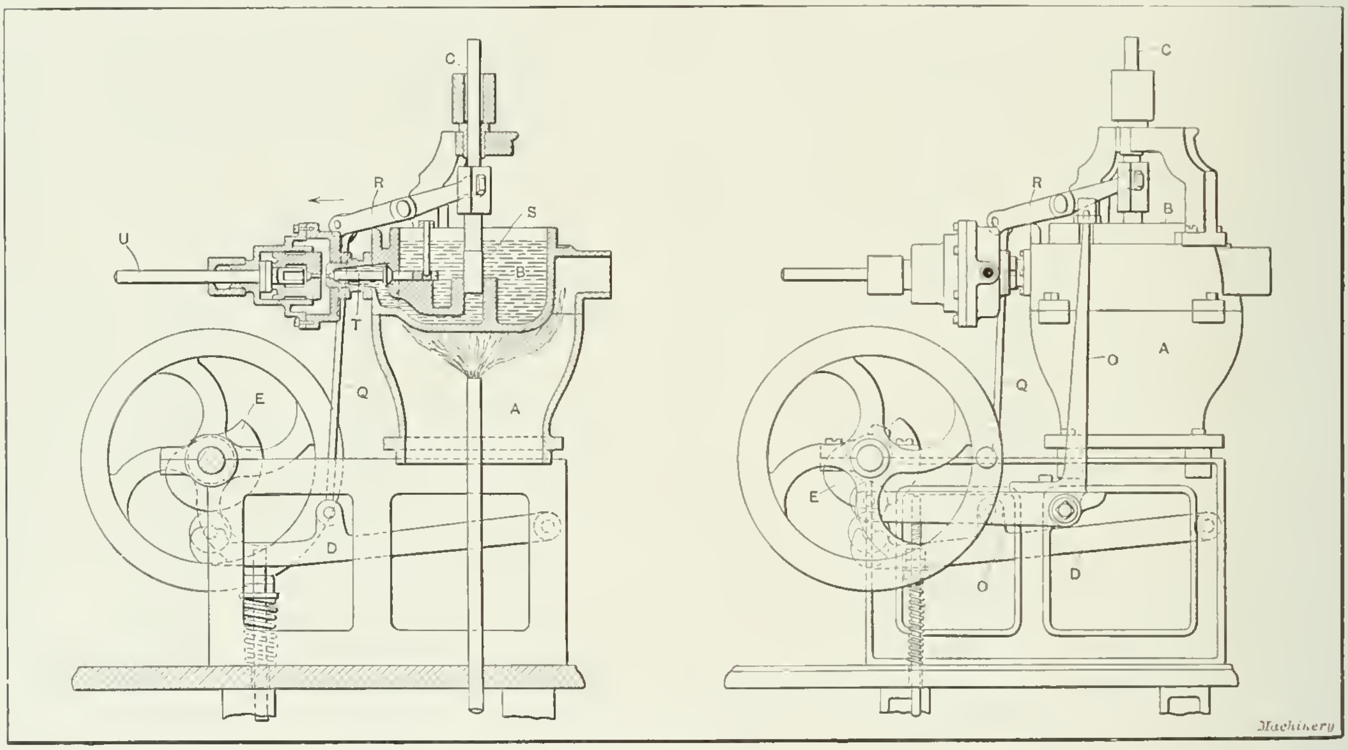

Fig. 3. Modern Die-casting Machine

The manner of parting the mold to remove the casting is altogether different. Instead of opening it like an alligator's jaw, as in the earlier type of machine, a part of the mold is moved back, away from the machine, and the casting is thus allowed to fall out. The mechanism that opens and closes the mold is not shown in Fig. 3, but it is done with a very similar supporting frame and cross-head to that which draws the mold away from the nozzle in the Dimock machine in Fig. 1; but, instead of using rod *U* to turn bar *J* and thus open the mold, as in the Dimock machine, rod *U* is used to form a core in the casting and after the casting has been made, rod *U* is pulled back to free the casting from the mold. This machine has been used for several years, but has also been improved upon. It has been made entirely automatic by putting a pulley in place of the crank wheel.

While in most automatic machines cams have been used to control nearly all of the movements, in others springs and gears have been used in combination with cams. Such a machine is shown in Fig. 4. In this a cam *E* is used to control the motion of the pump plunger and a large spring is used to hold the lever against this cam. The mold is moved up to the spout and away from it by a crank on the end of the shaft that holds the cam. This shaft is driven by a gear *N* that meshes with a pinion *L* driven by a worm-wheel *K* and worm *J*; the worm, in turn, is driven by a pulley *F* and belt. A stationary cam is used to control the motion of a knife which cuts off the sprues and a brush that brushes off the knife. With the exception of the spring for holding the lever that operates the plunger against the cam, this machine works successfully. A spring in this location is liable to fail, owing to the plunger's sticking in the cylinder, due to dross in the molten metal; no metal would then be forced into the mold.

This machine was especially designed for casting electric storage battery grids, but can well be used for making many shapes of castings for machine parts. These grids are thin strips of metal, crossing each other at right angles, the strips being joined together at each intersection; they thus contain a number of square openings, and resemble wire netting, except that the strips are not round. As in the other die-casting machines, *A* is the furnace, *B* the melting pot over the furnace, *C* the plunger rod, and *D* the lever that operates the plunger. A roller attached to lever *D* rides on cam *E*, to guide the up and down motion of plunger *G*; spring *I* holds lever *D* against cam *E*. It would doubtless be better to use another cam to perform the work of this spring and thus make the upward motion of the plunger as positive as is the downward motion. Cam *E* is so shaped and timed in its motion as to cause the plunger *G* to move down only when the mold is closed tightly against the nozzle and ready to receive the metal. To reduce the air pressure in the mold against the plunger's action and insure that all parts are filled with the incoming metal, an air pipe *Y*, with pump, is often connected to the mold. This automatically pumps out the air and creates a vacuum in the cavity of the mold that shapes the casting, just before the molten metal is injected into it by the plunger.

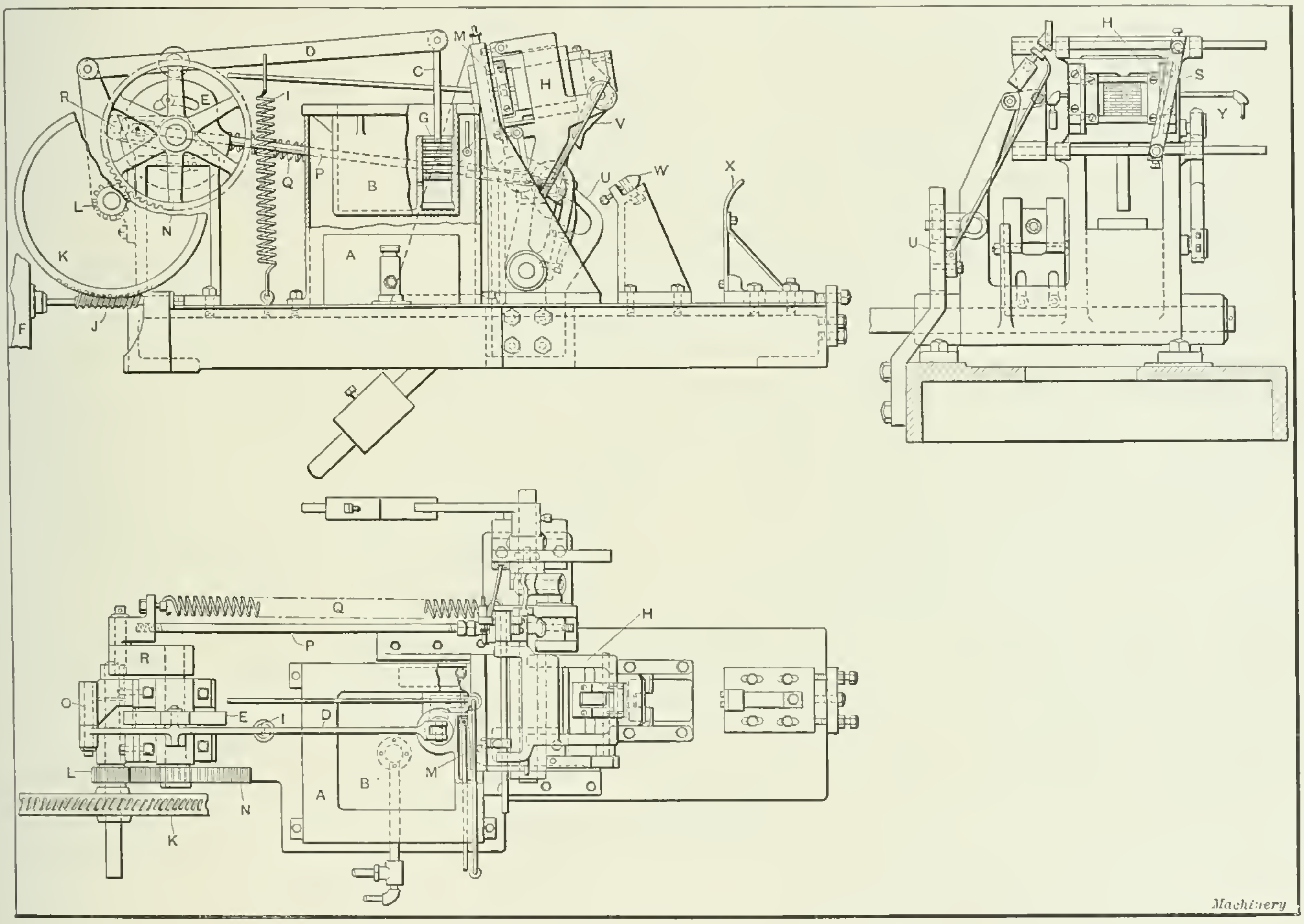

Fig. 4. Another Modern Type of Automatic Die-casting Machine

The mold is operated by a mechanism that is as simple, positive and handy as that of any die-casting machine made. Mold *M* is located on rocker arm *H*, which is connected by rod *P* and spring *Q* to crank *R*. Thus, while cam *E* is controlling the operation of plunger *G*, crank *R* is controlling the movements of the mold. Mold *M* is thus brought up to the nozzle and held there while plunger *G* descends and squirts the metal into it. Plunger *G* is then raised for another stroke, while mold *M* is rocking back away from the nozzle. For the grid casting made in this machine many gates are used, and while the rocker is carrying the mold back to the end of its stroke, knife *S* travels across the face of the mold and cuts off the sprues. A brush then travels across the face of knife *S* and brushes off any chips that may have accumulated. These motions are controlled by cam *U*, which is bolted to the side of the frame.

On many kinds of castings for machines or instruments, the shape is such that this knife and brush could not be used for the sprue cutter, but it is easy to take off this mechanism and attach others that would perform the necessary operations, and which might be even simpler in design. The distance through which rocker arm *H* travels can be adjusted by shortening or lengthening rod *P* by the nuts provided. The mold can thus always be kept tightly against the nozzle, and also go back far enough to eject any casting. When rocker arm *H* reaches the end of its backward stroke, arm *V* strikes block *W* and this operates the mechanism that ejects the casting from the mold. To insure no jar, flat spring *X* is provided for rocker arm *H* to strike against.

One of the most complete automatic die-casting machines built is shown in Fig. 5. This machine was patented by Mr. C. H. Veeder and is a vast improvement over the machine shown in Fig. 3. It is supplied with two melting pots and is completely automatic. All that the attendant has to do is to keep the secondary melting pot filled with metal and carry away the finished castings. With each casting that is made, the metal lowers in the melting pot and the secondary melting pot is used for the purpose of keeping the primary melting pot filled. In this machine the air is exhausted from the mold with an air pump before forcing the metal into it, thus insuring the filling of every crevice. The machine differs from nearly all other types in that it has provision for a powerful, positive pressure for forcing the metal into the mold, in addition to the vacuum. Thus, the formation of gas bubbles or air pockets in the cavity that forms the castings is overcome and deformed castings are not produced. The percentage of bad castings has, therefore, been reduced to a minimum.

In this machine also, *A* is the furnace; *B* the melting pots; *C* the plunger; *D* the lever that moves the plunger up and down; *E* the cam that causes the movements of this lever; *F* the pulley that drives the machine; *H* the carriage that holds and operates the mold; and *M* the mold.

A single shaft *J*, driven by pulley *F*, controls all the movements. Cams are located on the central portion of this shaft and cranks on the two ends to give the machine all of its movements. No gears are used. A double-action valve is used to control the injection of the metal into the mold, and to cut off the sprue. This valve is shown at *L*. Before plunger *C* starts moving downward, arm *N* is moved away from valve *L* and the flow of metal due to the downward motion of plunger *C* causes valve *L* to move to the left and close the opening between the passage in which this valve is located and the melting pot. Thus, all of the pressure exerted by the plunger is used to force the molten metal from this valve chamber into the mold. When the die-mold has been filled, arm *N* pushes against valve *L* and causes it to close up the nozzle opening through which the metal flows into the die-mold, and, at the same time, valve *L* cuts off the sprue of the casting. Arm *N* is moved by lever *O*, which, in turn, derives its motion from cam *P*.

Carriage *H*, which holds the mold and controls its movements, is operated by a series of levers that are moved by two cams. Lever *Q*, with its connecting levers is moved by cam *R*, and this pulls carriage *H* to the right to open the die-mold as shown in the lower left-hand view of Fig. 5. By the action of cam *R*, lever *Q* afterwards moves carriage *H* to the left, thus closing the mold and holding it tightly against the nozzle while it is being filled with the casting metal. Spring *I* holds the roller of lever *Q* against cam *R*. This is a weak point of the machine, as the pressure that forces the molten metal into the mold is exerted against this spring, unless a locking device is attached to the mold, and this requires additional mechanism. Another cam could more easily be used to close the mold and hold it against the pressure of plunger *C*. While the mold is opening, bar *S* is moving to the left through carriage *H* to eject the casting from the mold. The movement of bar *S* is controlled by a series of levers moved by cam *T*. While the mold is closed, vacuum tanks *U* are automatically connected with it and draw out all of the air. A vacuum is constantly maintained in these tanks by an air pump.

With all of these movements properly timed, die castings are made as fast as the metal will solidify, and can be ejected from the mold without deforming the castings. Most die-casting machines do not apply as much pressure to the plunger, but depend on the suction created by the vacuum to draw the metal into the mold. This does not produce castings with as fine and dense a grain as when a high pressure is applied, and they are more liable to have porous and spongy places. The high pressure, combined with the vacuum in the mold, also makes the casting correspond exactly to the contour of the cavity cut in the mold. One die-mold can be taken out and another, for a different casting, inserted in its place with very little labor. Thus the machine can be made to operate on several kinds of castings in a day's run.

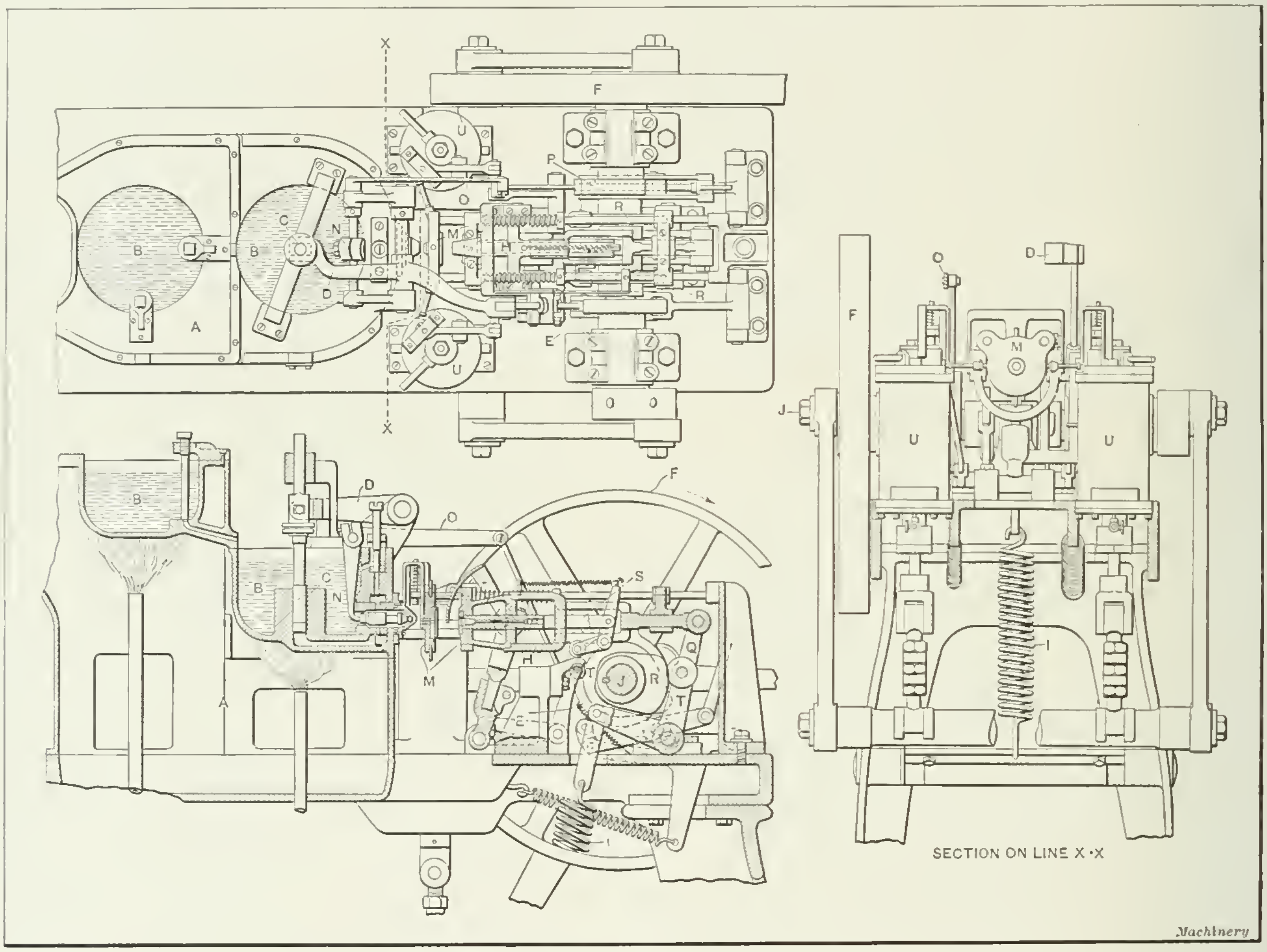

Fig. 5. The Latest Type of Automatic Die-casting Machine

These and other reasons make it one of the most economical machines built, as the cost of the castings has been reduced to little more than the cost of the metals for making the alloys, the gas that keeps the metal molten, interest on original investment, and the expense necessary to keep the machine in repair. Automatic type-casting machines cast one type at a time, at the rate of 240 per minute. This speed is largely due to the fact that cold water is forced through a water-jacket that surrounds the type cavity in the mold; as many as 240 per hour would be a high figure for die-castings for machine or instrument parts, as these are nearly always more intricate in design and have a larger volume of metal to be cooled. Many times, however, more than one casting can be made in a mold. When the mold is water-jacketed, and the machine completely automatic, the output of perfect castings will be many times that of hand-operated machines, and at a very low labor cost.

The formation of coarse crystals is an inherent trait of all metals when they are slowly cooled from the liquid state. This coarse crystallization is more pronounced in some metals than in others, and the alloys from which die-castings are made are composed of the metals that form the coarsest crystals, when so cooled. The most notable example of this crystalline formation is antimony, while zinc is another metal that has a very flaky crystalline structure. This formation of coarse crystals can be overcome to a large extent if the metals are chilled and suddenly solidified from the molten state, when casting them into shape. This is done in the machine shown in Fig. 5 by circulating a stream of cold water through a water jacket formed around the cavity in the mold that forms the casting. While the vacuum created in the cavity of the mold and the pressure used to force the metal in have a tendency to reduce the coarse grain and crystallization, the rapid cooling and solidification that is caused by the current of cold water still further aids in refining the grain.

The action is similar to that which takes place when hardening steel. In this case, the grain is refined by heating cold metal to the desired temperature, and the fine grain is retained by instantly quenching in a liquid, and thus suddenly cooling the metal. If it were allowed to cool slowly, the grain crystals would return to the coarse size of the unheated steel; or if heated to too high a temperature, a coarse grain would be formed that could only be refined by the pressure or hammering applied during forging operations. In the die-casting alloys, this fine grain is produced by melting, and the quicker it can be cooled down from the molten state, the finer will be the grain of the metal in the castings. It is not a difficult matter to surround the casting cavity in all die-molds with a water-jacket. This, of course, will not only give the metal a more dense, homogeneous grain, but will also solidify the castings much more quickly and enable many more castings to be made per hour than can be made in a machine where the mold is not water-jacketed.

* * *

The manufacture of tungsten lamps has been a difficult and expensive matter because of the characteristics of tungsten. Up to a few months ago it was impossible to draw tungsten into wire as the common ductile metals are drawn, but it had to be squirted while in the so-called "colloidal" state to form the required filaments. The other elements mixed with the powdered tungsten had to be driven off by heat, thus leaving a very brittle wire, exceedingly difficult to mount in the lamp and easily broken by shock. Now, thanks to improved methods of treatment, it is possible to draw the pure metal into wire of great tenuity, diameters of 0.003 inch or less being readily produced. The metal is drawn through diamond dies into lengths of 600 or 700 feet and can be wound on spools without danger of breakage. The success of the research has made the tungsten lamp as practicable as the old carbon filament lamp which it is rapidly displacing because of its much greater efficiency.

* * *

A reader suggests that the boss who refuses to help a man acquire knowledge of those things in which he is weak for fear that he might get the boss's job some day, is not up-to-date. The modern foreman strives to surround himself with intelligent men, realizing that the higher the grade of average intelligence of men, the better will *he* stand with his employers. The intelligent foreman should cooperate in the training of an understudy who will be able at a moment's notice to take charge of his department. The late R. T. Crane of Crane & Co., absolutely required that every man occupying a responsible position have an alternate who knew all his duties and how to execute them. Did this mean that the foremen were likely to lose their jobs at any moment's notice? No, on the other hand the tenure of position was much more secure there than in the common run of factories.

THE EVOLUTION AND PRESENT DEVELOPMENT OF THE TURBINE-PUMP[*†]

At the present time the use of the turbine-pump has become so extended that it is difficult to find services to which it cannot be advantageously applied. It will no doubt, therefore, be a matter of interest to trace the evolution and development of machines of this design, and this, perhaps, cannot be better done than by considering in particular one type only. As a description of the commercial application of the steam-turbine is a history of the Parsons machine, so that of the turbine-pump can be adequately portrayed by an account of the evolution of the Osborne Reynolds pump.

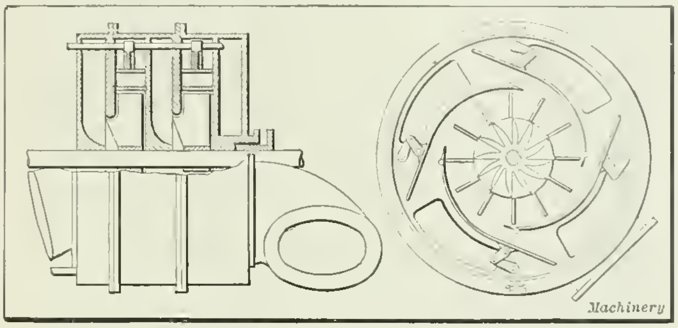

Fig. 1. Reynolds Turbine-pump, 1875

Centrifugal pumps were in the past accepted by engineers as suitable appliances for easily and cheaply (as to first cost) raising water to low heads. It was not realized that they were capable of dealing with any but low heads; in fact, this view became a canon of ordinary engineering practice, creating a tradition which took many years to remove. It is singular that, though the water-turbine with its guide-vanes was a matter of common knowledge at the time, no attempt appears to have been made to reverse its action with the prospect of obtaining a similar high efficiency and increase of head, for the purpose of raising water. There was, however, one exception in the invention of Prof. Osborne Reynolds'. It is the object of the present article to trace and discuss the development of this invention.

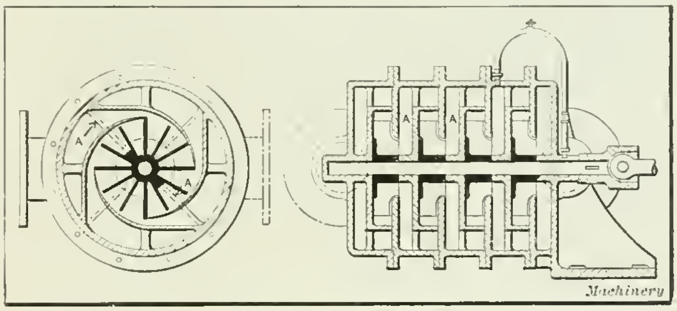

Fig. 2. Reynolds Pump, 1887

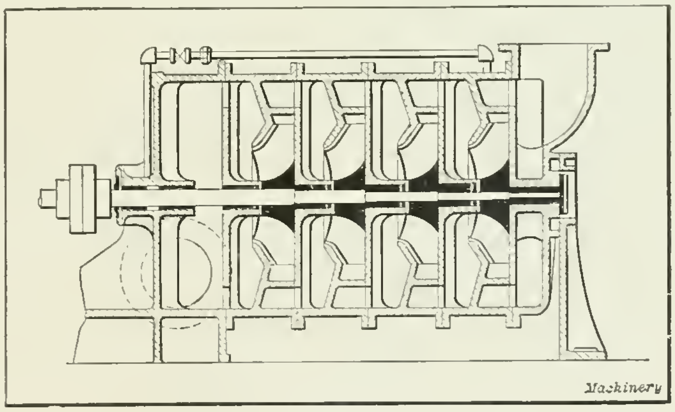

Fig. 3. Mather-Reynolds Pump, 1895

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[*] Abstract of paper by Dr. Edward Hopkinson and Mr. Alan E. L. Chorlton, of Manchester, England, read before the Institution of Mechanical Engineers, January 19, 1912.

[†] For additional information on this and kindred subjects, see the following articles previously published in MACHINERY: "Self-contained Turbine Pumping Engine," April, 1910; "Turbine Pump Motor Drive," and "Electric Drive of Turbine Pumps," December, 1909, engineering edition; "Centrifugal Pumps," June, 1909, engineering edition; "Centrifugal Pumps," February, 1909, engineering edition. See also the note published in connection with the last mentioned of these articles.

In 1875 Prof. Osborne Reynolds invented a turbine-pump of the series type, fitted with guide-vanes, as shown in Fig. 1. Comparison of this figure with illustrations following show how the essential features of his original proposition have been adopted in subsequent practice. In this pump the impeller delivered its water to tangent guide-vanes, as shown, and the similarity to an inward-flow turbine of the Thomson type is noticeable, for, as in that machine, the mouths of the guide-channels could be regulated to raise the efficiency of the pump for smaller outputs, a device however seldom adopted in later practice.

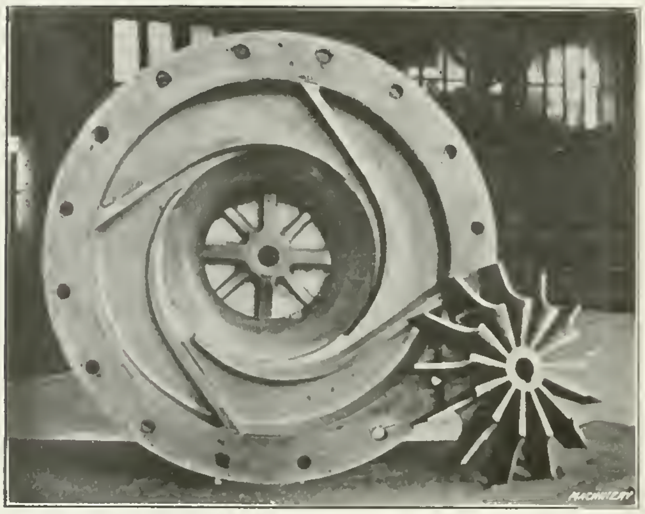


Fig. 4. Impeller and Guide-passages of Mather-Reynolds Pump

Nothing of any commercial value appears to have been done with the invention for many years; in fact, the first pump of which records and tests are available was constructed in 1887 by the firm of Mather & Platt for the engineering laboratory of the Owens College, Manchester. This pump, shown in cross and longitudinal section in Fig. 2, had four impellers in series and gave at 1500 revolutions per minute a total head of 148 feet or 37 feet per chamber. The average efficiency recorded in the tests made by Prof. Reynolds was 58.5 per cent, a high result, in proportion to its small size, for a pump made twenty-five years ago. The readings were taken from a dynamometer fixed between the pump and the belt-pulley, and, as no method of damping the indicating finger seems to have been employed, they may be liable to some error. Thus the maximum efficiency obtained, *viz.*, 70 per cent, appears open to some doubt. The guide-vanes, after leaving the wheel in a curve, reached the inner periphery of the outer shell of the chamber at an angle. The water having had its velocity of whirl converted into pressure-head in these passages, had then to pass sideways at right angles into radial-return passages formed in the back portion of the chamber and marked *A* in Fig. 2. In these passages the water was guided and prevented from rotating by radial vanes. The water on reaching the center passed into the eye of the second impeller, and so on until it was finally delivered at the pump outlet at the head pressure required. It will be observed that the impeller was of the open type with radial vanes.

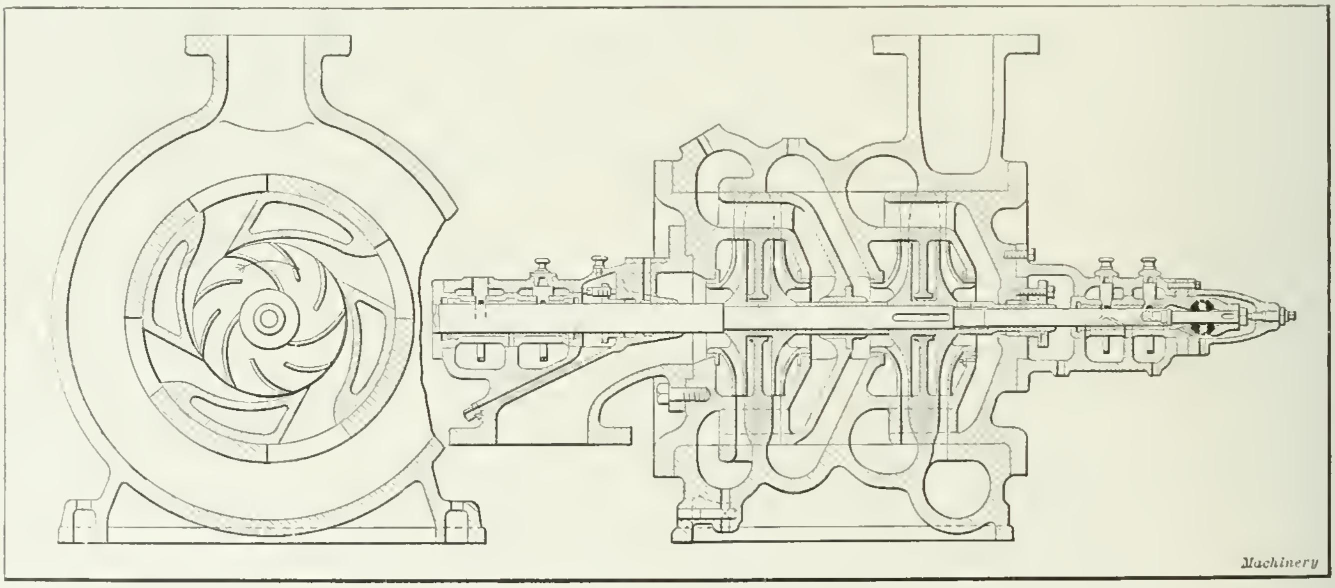


Fig. 6. Four-chamber High-lift Centrifugal Pump of Sulzer's Design

The tests of Prof. Reynolds proved the capability of the pump to perform many duties, previously thought impossible by centrifugal pumps, and in 1893 the firm of Mather & Platt took up its commercial manufacture. The mechanical construction of a standard Mather-Reynolds pump as built in 1895 is illustrated in longitudinal section in Fig. 3. The impeller and guide-passages are also shown in Fig. 4. The pump consists of four chambers working in series. At one end, these are secured by bolts against the circular flange of a frame carrying the driving pulley or shaft coupling, this having the suction branch and entrance to the first chamber cast with it. At the other end the delivery chamber forms the final cover, and has the delivery pipe cast on the upper part connecting to the annular space into which the last set of guide-passages deliver, and at this end a suitable stay is attached to support the pump from the floor. The chambers are secured to each other by bolts through external flanges, each chamber being recessed and spigoted so as to preserve the correct alignment of the whole. This forms an inexpensive design, and permits of accurate manufacture. It allows of

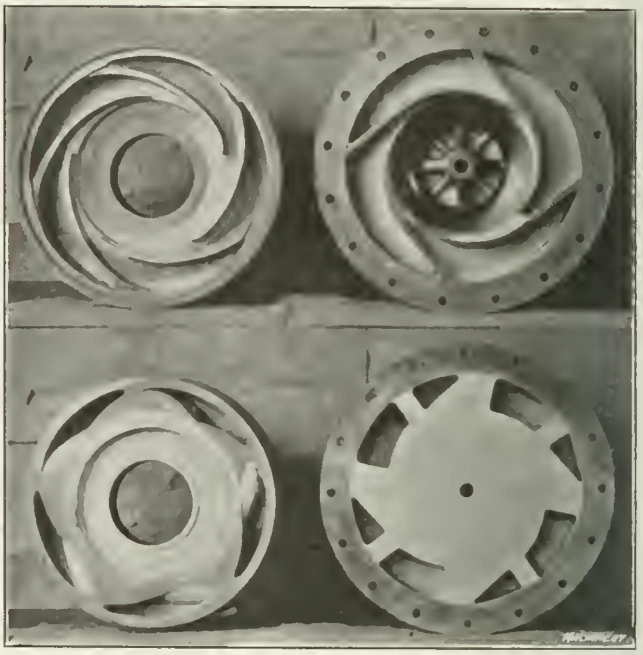


Fig. 5. Comparison between Guide-vanes in Pump of 1895 and Modern Pump

chambers being added or subtracted for higher or lower heads. Each chamber is distinct in itself, and has on one side the guide-vanes, receiving the discharge from the impeller, and on the other the return passage to the eye of the next impeller. This return passage is walled by a diaphragm integral with the casting. The water leaving the impeller, guided by the delivery vanes, passes to the next chamber and is there guided to the eye of the following impeller.

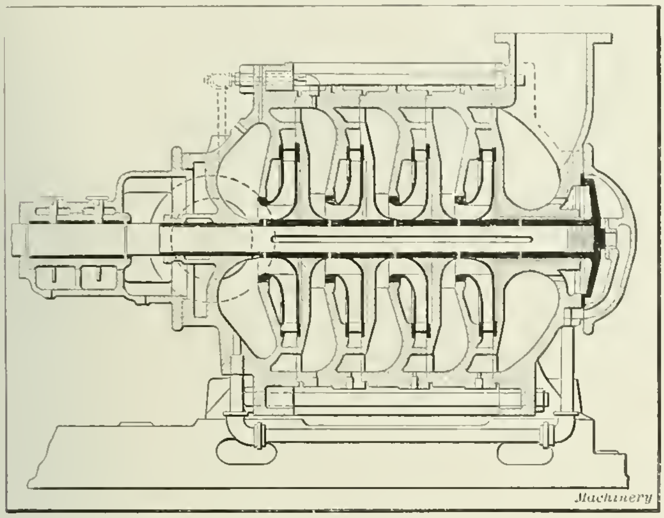


Fig. 7. Modern Four-chamber Pump

In comparing such a pump with a modern one (see Fig. 5) it will be found that it is in the form of its impeller and its delivery-casing that the original Mather-Reynolds pump differed most from the present design. The impeller, as shown in Fig. 4, is of the open type (not shrouded), with radial vanes, the roots of which are carried across the openings of the eye into the boss, necessitating the use of a modified form of Francis entrance. This form was probably adopted in order to secure sufficient strength to drive the vanes, necessitating their being carried through full width to the boss on the pump-shaft, and not starting level with the outer diameter of the eye as now. The impeller was turned all over, and revolved a close fit in its casing, which was turned to a corresponding form. This prevented leakage and loss of efficiency by the return of the water from the tip to the suction along the impeller sides.

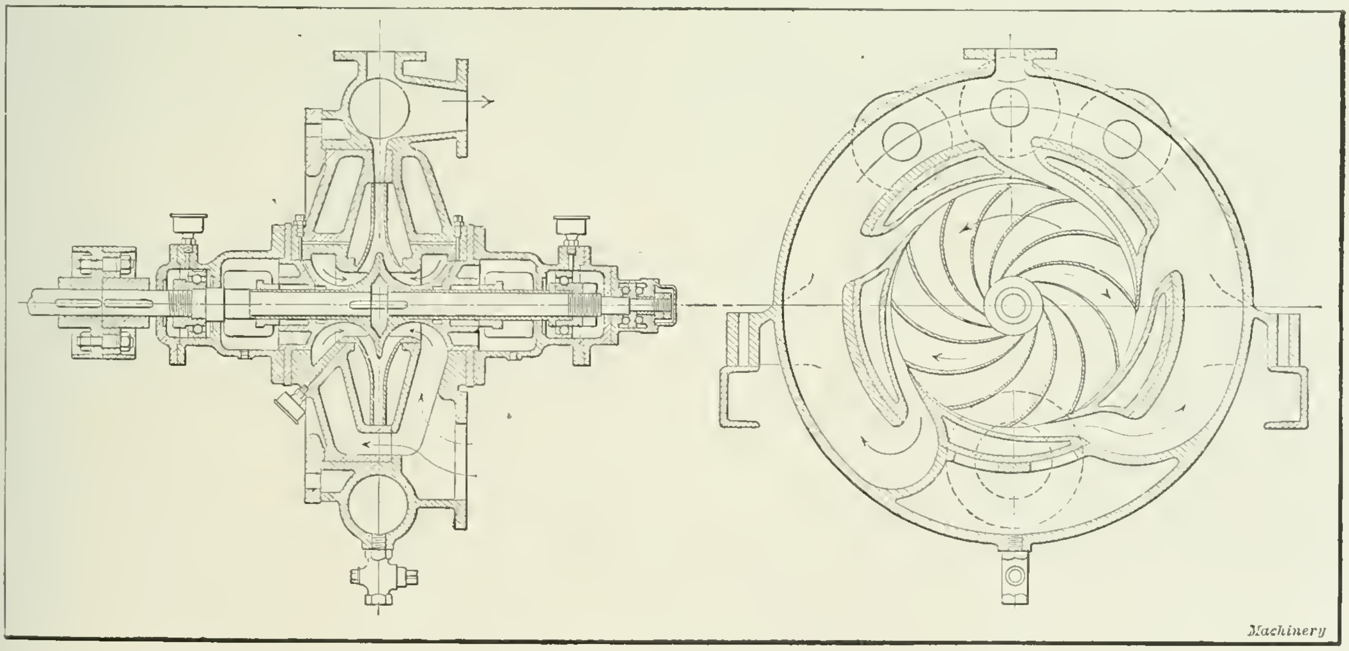


Fig. 9. Single-chamber High-lift Turbine-pump

In the 1895 pumps the speeds of the water through the impeller and passages were comparatively low, and large areas were therefore necessary. Each wheel being of the open type was nearly balanced as to end-thrust in itself, and so with the moderate heads pumped against, troubles with lateral end-thrust were not experienced. There is no doubt, however, that end-thrust did occur, and this caused the impellers to rub on the sides of their casings with consequent friction, the wear causing leakage and loss of efficiency, the varying conditions of which make the true comparison of various tests difficult. This, however, did not cause any serious trouble in practice on account of the large areas on which the end-thrust was taken, and the low head per chamber.

Considering the guide-vanes, it will be seen that in the 1895 pump these are shorter, or rather open out more quickly than in a modern pump. (See Fig. 5.) They are obviously less efficient if judged from the analogy of a Venturi tube, which must have a certain length if serious loss is not to be occasioned by converting velocity into pressure.

A considerable number of pumps of the 1895 form were constructed for installations in this country and abroad. Meanwhile Messrs. Sulzer Bros., of Winterthur, had commenced the manufacture of multiple turbine-pumps about 1896, and had evolved various modifications in the Osborne Reynolds design, whereby both the efficiency and the lifting capacity were considerably improved. They had established in 1898 an interesting and novel installation of these improved pumps at the Spanish mines of Horcajo, which attracted considerable attention. Two years later an agreement was concluded between Messrs. Sulzer Bros. and Messrs. Mather & Platt, providing for an interchange of future improvements.

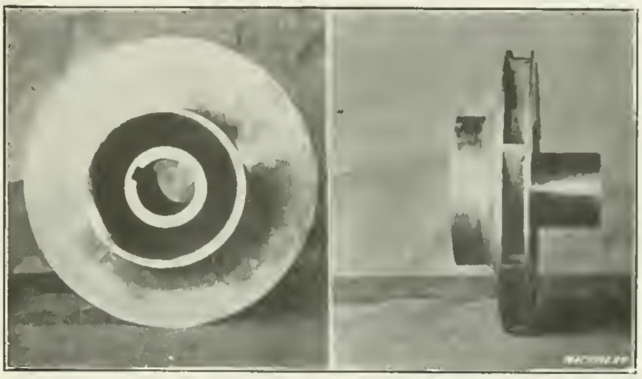


Fig. 8. Impeller of Pump in Fig. 7

A four-chamber pump of the Sulzer design is shown in longitudinal and cross sections in Fig. 6. Comparing this with the 1895 design, three important differences are noticeable. Firstly, the body casting of the pump is constructed in one piece, with the intermediate pieces, guide-vanes, and impellers put in from one end. Secondly, the impellers are shrouded and have backward-curved vanes. Thirdly, the impellers are arranged back to back to compensate for the increased lateral end-pressure set up by the higher heads worked against. This arrangement of the impellers involved the use of somewhat tortuous passages in the pump to bring the discharge of the first impeller to the eye of the second, and so on. Moreover, these passages passing several joints increased the probability of internal leakage from one stage to another. The agreement between Sulzer Bros. and Mather & Platt came to an end by mutual consent in 1904, and after that date each firm further developed their pumps on their own lines.

Proceeding now to the discussion of later designs, a four-chamber pump is shown in longitudinal section in Fig. 7, its guide-vanes being shown in Fig. 5, to the left in the lower view, and its impeller in Fig. 8. It will be seen that constructionally this pump differs principally in that the extended suction-end is shortened, and is similar to the delivery-end. This enables various classes of drives—motor, belt, or steam-turbine—to be better negotiated with a standard pattern. Successive chambers, instead of being secured to their neighbors by bolts and flanges, are held together by long bolts extending the entire length of the pump body and held only at the two ends (suction and delivery).

The impeller is of the shrouded type, having vanes bent well backwards and the guide-passages are longer and more correctly divergent, while the return-way to the eye of the next impeller is of a curved form and more in line and continuous with the receptive ports, thus preventing the abrupt right-angle turn through the casing obtaining in the Reynolds pump. The losses in the Reynolds impeller through side friction in its casing are obviated, and any leakage from the periphery back to the suction is prevented or greatly minimized by the outer circumference of the impeller eye running in neck bushes with a very small radial clearance, amounting to less than 0.005 inch. The importance of preventing this leakage is very great if high efficiency is to be secured. The impeller is turned all over on the outside, to reduce loss by skin friction, and with the same object it is usual to use as many wheels as the circumstances will otherwise allow.

An interesting application of the turbine-pump for fire-prevention purposes, as fitted to petrol automobile fire engines, is shown in Fig. 9. The capacity varies usually from 350 to 1000 gallons per minute, against a head of 250 to 300 feet. The pump has a single chamber and is designed to fit on the back part of the chassis of an automobile, and to be driven by an extended shaft from the engine. The regularity of the flow of water delivered renders the holding of the hose-jets much easier and the action of the turbine-pump allows the shutting off of any particular jet, or of all the jets, without any tendency to burst the hose-pipes, as may be the case with a reciprocating pump. Further, the pump is much lighter than a corresponding pump of reciprocating type, and takes up considerably less space. The difficulties incident to starting with a heavy suction can be met by the provision of a small auxiliary pump which exhausts the suction pipe, thus causing the water to fill the turbine-pump. As soon as the turbine-pump has developed its head pressure, the auxiliary pump can be put out of action, and the turbine-pump will continue to work with suction lifts up to at least 80 per cent of the height of the barometric water column.

* * *

"PRESSURE OF COAL ON STORAGE BIN WALLS"—CORRECTION

The formulas for the pressure of anthracite and bituminous coal given in the February number on page 432, engineering edition, second column, should read as follows:

$$P = \frac{w \times 1.454\,h^2}{2} \tan^2 31° \; 30' \text{ for anthracite coal, and}$$

$$P = \frac{w \times 1.574\,h^2}{2} \tan^2 27° \; 30' \text{ for bituminous coal in which}$$

form they agree with the formula

$$P = \frac{wh^2}{2} \tan^2 \alpha$$

* * *

The third and concluding installment of "The Forms of Lathe Beds," by Mr. Joseph G. Horner, will appear in the April number.

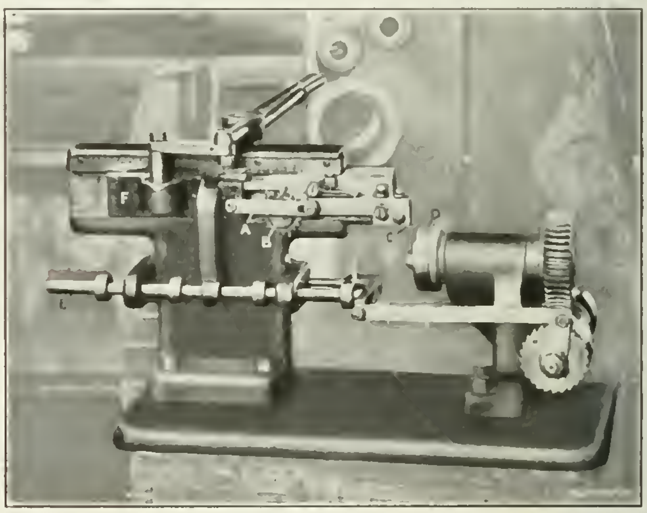
CLEVELAND GRADUATING MACHINE

The halftone shows a simple and effective graduating machine made by the Cleveland Machine Tool Works, Cleveland, Ohio, and used in the manufacture of the Cleveland horizontal boring machines, to graduate the collars of feed and adjusting screws.

The machine comprises a work spindle (at the right in the illustration) driven by a worm and worm-wheel, the collar to be graduated showing at *D;* and a slide at the left which is in two parts, consisting of the part *F* and the tool-slide proper on which the marking tool is mounted. Both slides work in the same guides. The slide *F* is worked by the hand lever at the top, and *F* has an arm projecting downward loosely fitting the horizontal rod *E* on which are four collars. The outer collars limit the travel of the slide, and the position of the middle pair of collars determines the swing of the ratchet indexing lever on the end of the worm.

The form of graduation most used is markings in groups of five, every fifth graduation being denoted by a longer line than those indicating the intermediate graduations. The means by which the variation in length of lines is effected constitute the chief novelty of the machine.

The tool that cuts the lines is fixed just at the left of *C* in the tool-holder. In advance of the cutting tool at *C* is an adjustable hardened stop which limits the depth of the line. This stop is pressed against the collar to be graduated, by the flat spring seen above, so that any irregularities in the work do not affect the depth of the line. As stated before, the tool-holder is mounted on a slide moving between the same guides as the slide *F*. It is connected to *F* by the link *A* which is slotted at the right end. Behind the link is a ratchet wheel *B* having every fifth tooth longer than the intermediate teeth. This wheel is mounted on the slide carrying the tool-holder, and is turned one tooth at each stroke of the operating handle by the pawl shown above it. The tool-slide is pushed to the right by a pin in *F*, concealed by *A*, which strikes the end of the ratchet teeth in *B;* and it is pulled to the left by the link *A*. The lost motion or dwell of the slide, due to the slotted link connection, operates the ratchet. The action is as follows:



Cleveland Graduating Machine

Suppose that the first four graduations are the short lines. Then the tool is pushed to the right for the minimum length of line. On the fifth stroke, however, the ratchet has turned so that the driving pin strikes on top of the long tooth, and thus the tool slide is pushed to the right an amount greater than the previous four strokes by the difference in height of the long and short ratchet teeth.

Of course the machine is not limited to a fixed order of graduations. Other graduations can be made by using ratchets to suit the required combination of long and short lines.

* * *

The output of steel from electric furnaces during 1910 amounted to almost 112,000 tons in Germany, the United States and Austria-Hungary. There are at the present time in use, or being built, not less than 118 electric furnaces of all types.

THE NEW PLANT OF THE CINCINNATI MILLING MACHINE CO.*

Some years ago, when the Cincinnati Milling Machine Co.'s business had grown beyond the capacity of the old plant, Mr. Fred A. Geier, president of the company, conceived the idea of organizing a factory colony grouped about a central power plant. Three other companies that were in need of better facilities joined at once in this project, and the outcome of the idea is the factory colony at Oakley, situated forty minutes by trolley from the business center of Cincinnati. Seven plants are now located there. In the present article the new plant of the Cincinnati Milling Machine Co., as built in this location during the last three years, will be described. In many respects this plant is one of the most remarkable factory buildings in the country. It is apparent to the observer that a great deal of thought has been expended to secure, as nearly as possible, ideal shop conditions with regard to mechanical arrangement, light, heat, ventilation and sanitation. It is no exaggeration to call these works a model plant, constructed and equipped for the highest efficiency.

General Arrangement and Character of Plant

A bird's-eye view of the entire plant is shown in Fig. 1, while Fig. 2 shows an outline plan of the buildings, indicating their relation to each other and to the railway tracks, etc. The total floor space of the whole plant is 275,000 square feet; the machine shop proper is 585 feet long, and the three-story building facing south has a length of 380 feet. A general idea of the size and arrangement of the machine shop may be obtained from the interior view Fig. 3.

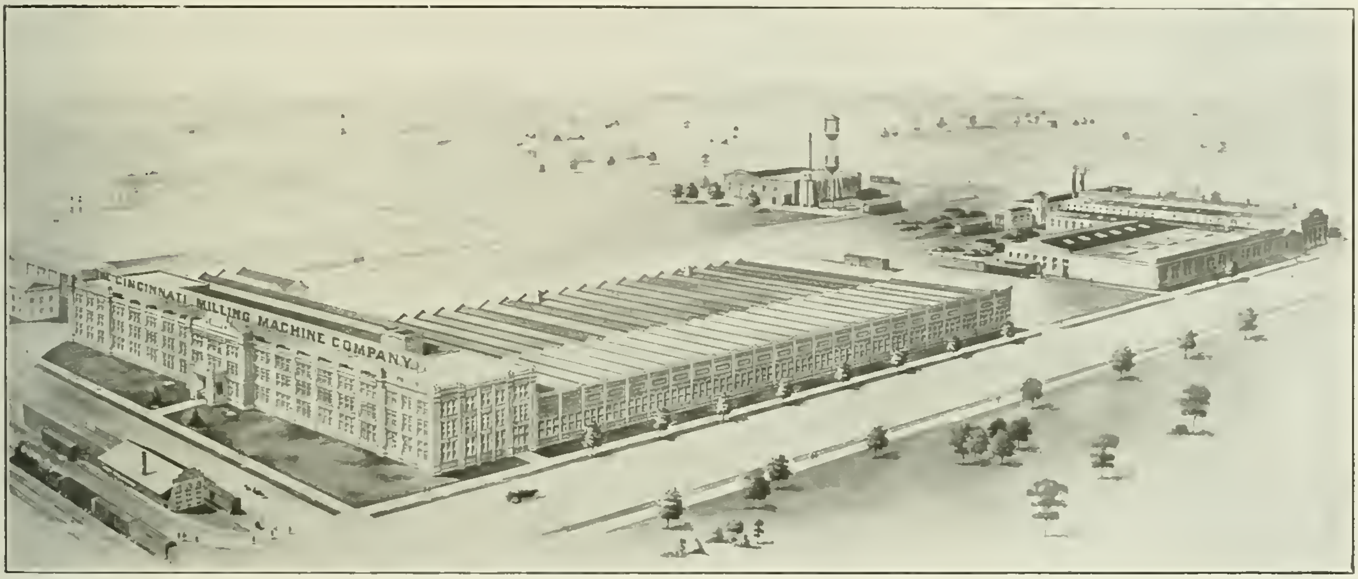


Fig. 1. The New Plant of the Cincinnati Milling Machine Co., at Oakley, Cincinnati

The first section of the machine shop was erected in 1909 and 1910, and was operated in connection with the old plant until the three-story section was completed in the fall of 1911. The machine shop proper is a single-story brick and steel building, 16 feet high under the trusses, and 26 feet under the peak. A 60-foot section along the eastern side of the building is 21 feet under the trusses, and is traversed by 5-ton traveling cranes. The roof is of concrete and steel, covered with Carey roofing. It is supported by hollow cast-iron columns of small diameter, thus avoiding that sense of obstruction which is sometimes present in shops using built-up steel columns. The hollow columns also serve as downspouts. The roof trusses are provided with gusset plates to facilitate the placing of countershafts and crane-ways in either direction.

The floor is of reinforced concrete, 8 inches thick, so that individual foundations for the machines, except in the case of the largest planers, are unnecessary. The heavy concrete floor also provides for that stability in the assembling and testing departments which is essential for satisfactory working conditions. That part of the shop which is occupied by the planers has a floor 16 inches thick, to carry the weight of the smaller planers and the masses of heavy material in process of manufacture which are grouped about them. In preparing the ground for the concrete floors the sod was thoroughly removed and the surface was rolled with a 10-ton roller, after which it was leveled and rolled a second time. A covering of tar felt was then placed over the entire surface, and the concrete was placed directly on this covering. The reinforcement consists of ¼-inch twisted bars laid at right angles with each other and spaced 12 inches apart, the bars being wired together at all intersections. This kind of floor proved so satisfactory during more than a year's use in the first part of the building that it was adopted without hesitation for the addition recently completed.

The three-story south front of the building is of reinforced concrete construction faced with brick. The first floor is a continuation of the one-story shop. The upper floors, each covering an area of 380 by 60 feet, provide quarters for the various offices and space for those departments which should preferably be separated from the main machine shop. Thus the third floor contains the general offices, and the engineering and clerical departments. This floor was selected for the offices because of the desirability of having them on the floor highest above the ground level on account of being more quiet, cleaner and better ventilated. Access to the office is by means of an elevator. The western end of the third floor contains an auditorium, having a seating capacity of 600 people, and is also provided with a kitchen and dining rooms. The floors of all the offices, as well as the floor in the main entrance to the building, are laid with ceramic tiling with a 6-inch sanitary base of green tile.

Immediately adjoining the engineering department on the east is the toolmaking department, this arrangement bringing the latter into close touch with the tool-designing department. In general, as indicated in Fig. 2, the principle of placing all related departments adjacent to each other has been adhered to, and this principle has been carried out in the offices to the same extent as in the manufacturing departments.

The second floor is devoted to stock-rooms for the finished parts, and also to the assembling of cutter grinders, and milling machine attachments. This is the only manufacturing done outside of the main machine shop floor. One portion of the second floor was also especially set aside to provide a place where the dividing heads could be assembled, as experience had shown that this precision work could be done more satisfactorily in an isolated department.

The Shop Departments

When the factory colony at Oakley was decided upon, the Cincinnati Milling Machine Co. retained seventeen acres for foundry and machine shop purposes. The first building erected was the foundry, which is run as a separate organization known as the Modern Foundry Co., but owned by the stockholders of the Cincinnati Milling Machine Co. This foundry has a daily melting capacity of 30 tons of iron for machine-steel castings, all of which, including the largest milling machine column castings, are made on molding machines. As shown, the foundry is located to the north of the machine shop, with which it is connected by an industrial track. A depressed railway siding connects with this industrial track over which all the raw materials enter the north end of the machine shop.

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* For descriptions of other of the new plants located in the Oakley factory colony, see MACHINERY, July, 1911, engineering edition, "Cincinnati-Bickford Tool Co.'s Plant at Oakley, Cincinnati"; March, 1911, engineering edition, "Interesting Tools and Methods of Cincinnati Shops—The Cincinnati Planer Co."; June, 1910, "The New Cincinnati Planer Plant," and "Opening of New Plant of Triumph Electric Co. and Triumph Ice Machine Co."

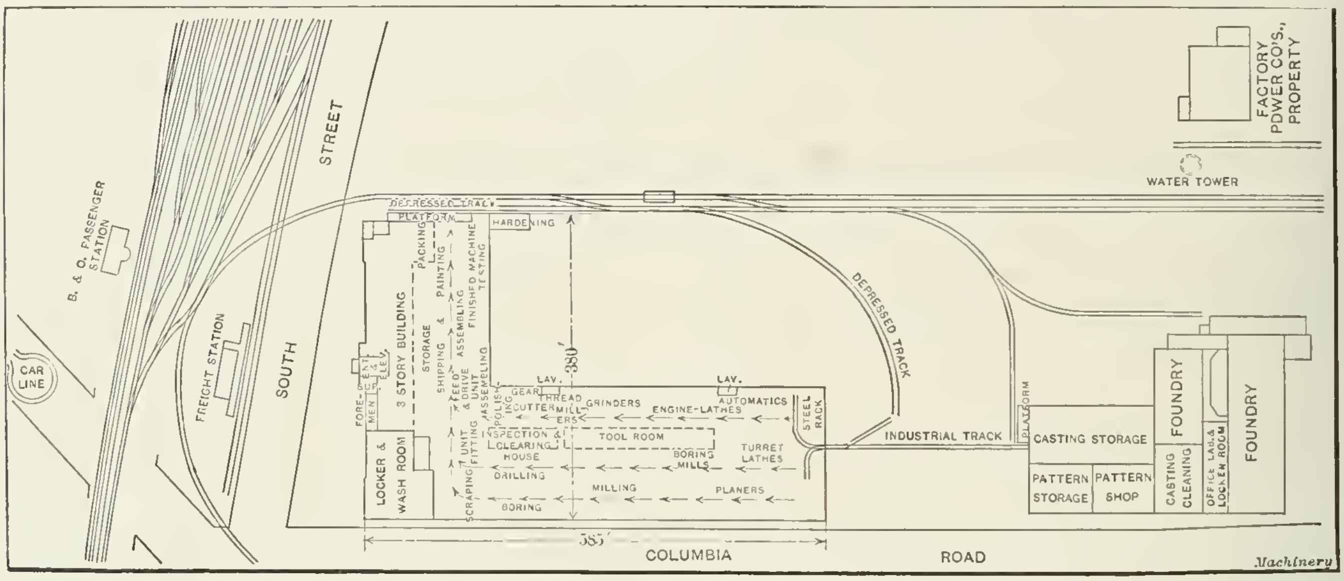

Fig. 2. General Plan of New Plant

As indicated in Fig. 2, the various departments are located with relation to each other in accordance with the sequence of operations. Hence the automatic screw machines and turret lathes are placed at the extreme north end, these machines performing the first operations on bar stock and on small castings, drop forgings, etc. On one side of these departments are racks upon which are stored all the bar steel adjacent to the machines. The machine equipment, in general, is highly specialized, and many machines are especially fitted up for certain work which is never done on any machine except the one so equipped. There are also many special machines which have been designed and installed mainly to improve the quality of the work. Some extremely large bar work is done on automatic machines, the largest automatics taking bars up to 6¾ inches in diameter. Individual motor drives are largely used, the motors being mounted directly on the machines. In some cases, however, this arrangement has not been found desirable, and the motors are then mounted in the ceiling directly over the machines.

Adjoining the automatic machines are the engine lathes, arranged in four rows, the two center rows being placed close together, back to back, with an ample aisle space between each of these and the outer rows. Next to the lathe department is the grinding department, and adjacent to this are the thread milling and screw chasing machines. Here all short screw threads are milled, while long lead-screws are made on automatic thread chasing machines. Next to the thread millers are the gear cutters, the equipment including a Gleason bevel gear generator, and two special tooth-rounding machines. The latter have been designed and built by the

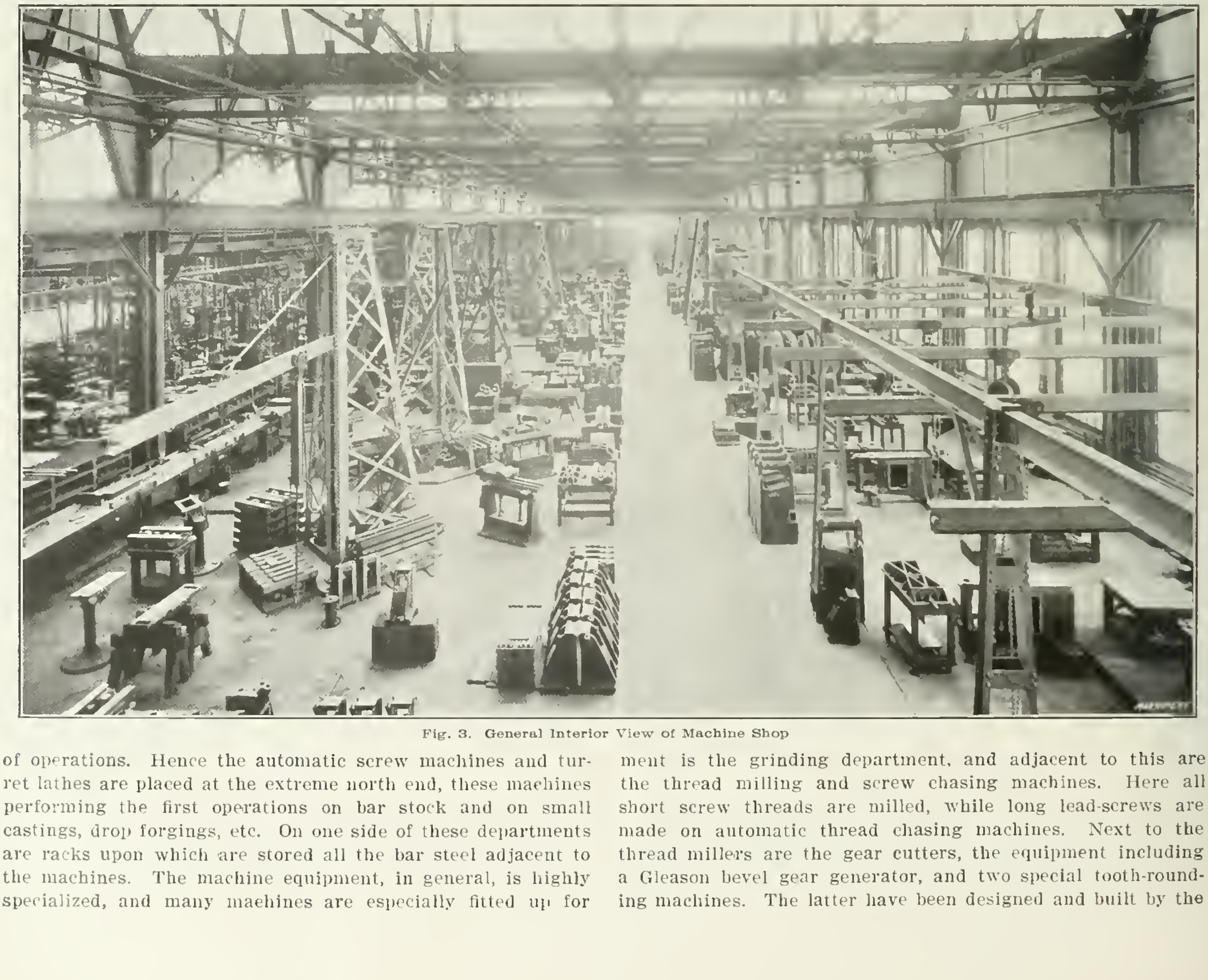

Fig. 3. General Interior View of Machine Shop

company to meet its own special requirements. Special testing devices are provided, on which all gears are tested on fixed centers placed at the correct theoretical distance apart. The gears must show a proper bearing and must revolve freely without pinching or backlash when testing. The 20-degree pressure-angle form of tooth has been adopted because of its greater strength, and the cutters for each gear are especially developed for the correct number of teeth for that gear. The cutters are made in pairs for the two gears that work together. Proper running clearances between the gears are provided in the completed machine by arranging their final center distances a few thousandths inch farther apart than the theoretical distance.

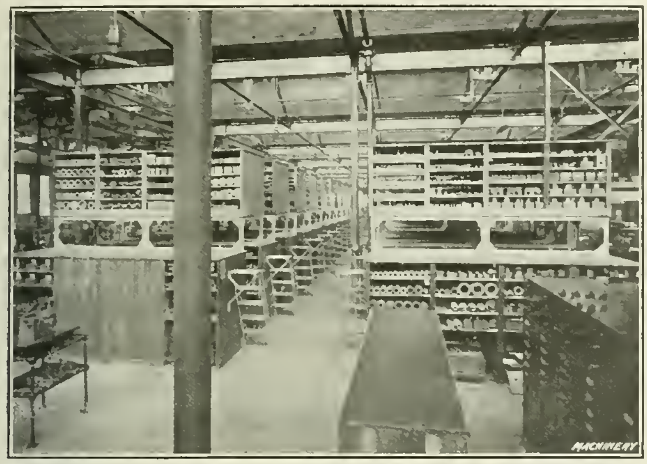

Fig. 4. A View in the Tool-room

Tool-room—Inspection and Routing Department

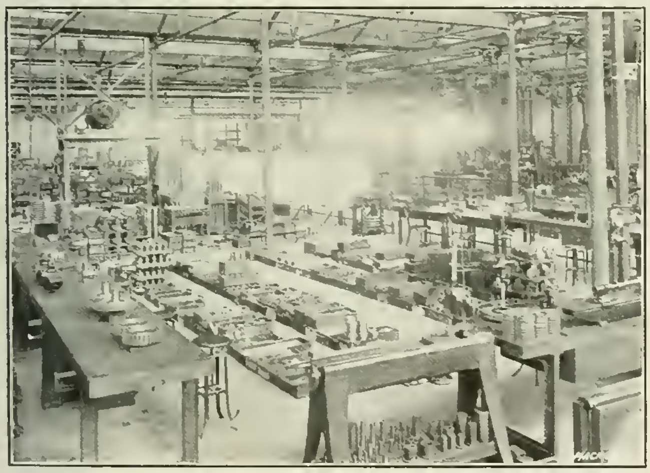
Fig. 5. Inspection and Routing Department

The tool-room, as indicated in Fig. 2, is located as nearly as possible in the central section of the main manufacturing department, and comprises a floor space of 28 by 200 feet. A general view of this department is shown in Fig. 4. All jigs, tools, and fixtures, except some very large ones, are kept in this department, and may be withdrawn only on the presentation of workmen's checks and a shop order, the latter showing the part number and the operation for which the jig is wanted. A carefully planned system is used for taking care of the tools, and an arrangement is introduced which economizes space and gives easy access to all the shelves on which the tools are stored. This tool-room is distinctly a storage and distributing room, no toolmaking or repairing being done here, except that all cutting tools are sharpened here immediately upon their return from the manufacturing departments, and before being again placed on the shelves. Every tool, jig and fixture is inspected after having been used, and, if in need of repairs, is sent immediately to the toolmaking department. Because of the large size of this tool-room, there are three windows, one of which serves the drilling, fitting, and gear-cutting departments, one, the screw-cutting, grinding and engine lathe departments, and the third, the turret lathe, milling and planing departments.

Immediately adjacent to the tool-room is the inspection department shown in Fig. 5. Here all the parts are inspected after each machining operation, the necessary gages, indicators, etc., being conveniently provided. All hardened gears, clutches and similar parts are tested with the scleroscope, definite standards of hardness having been determined upon for each part. The routing department is also located here. The large charts shown in the center of Fig. 5 contain a record of every piece passing through the shop, indicating which department it is in and, therefore, which operation is being performed on it, and also the date when each succeeding operation must be finished. In this way absolute control is kept over the movements of every individual piece and operation.

After having passed the final inspection, the finished parts are delivered to the stock-room shown in Fig. 6, where they are placed on shelves and await withdrawal for assembling.

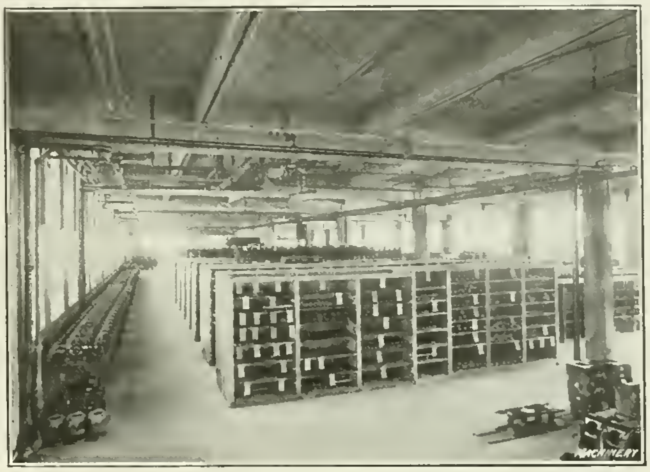

Fig. 6. Stock-room for Finished Parts

An accurate record of receipts, withdrawals, and balance on hand of each individual part is carefully kept on the bin-slips attached to each shelf, a number of which are shown in the illustration. As already mentioned, this stock-room occupies part of the second floor of the three-story building. It is located close to the elevator, which is immediately adjacent to the assembling department on the machine shop floor. The remainder of the second floor, as also mentioned, is devoted to the assembling of cutter-grinders and milling machine attachments. This department is illustrated in Fig. 7. In this view are also shown some of the details of construction of the concrete building. The cast-iron-lined bolt-slots in the bottoms of the girders for suspending the countershafts, and those at the tops of the columns for attaching crane runways, are of special interest.

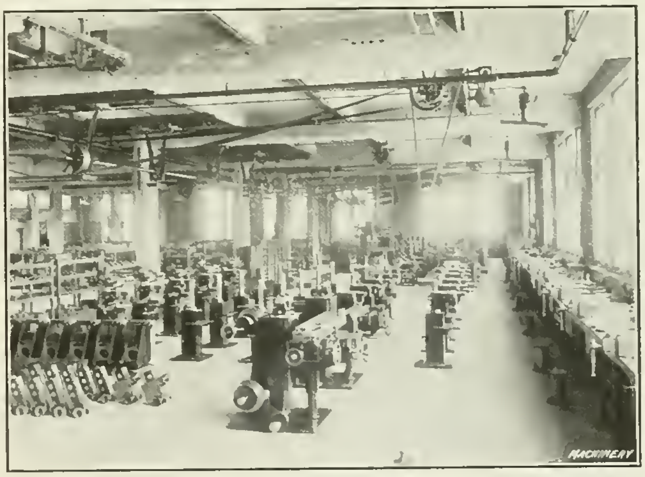

Fig. 7. Department for Assembling Cutter Grinders and Milling Machine Attachments

Planing, Milling and Boring Departments

All the large castings when entering the north end of the building are carried by the industrial track to the planing department, Fig. 8. The planers are all driven by individual motors. A number of them have 40-foot beds, the largest of them being the 72-inch by 72-inch by 40-foot planer, shown in the background at the extreme right. The planers are all provided with a variable cutting stroke and a constant return stroke of 100 feet per minute. After leaving the planer department, the castings pass on to the drilling, milling and boring departments, as required.

A section of the milling department is shown in Fig. 9. The machines are grouped according to size and with regard to the nature of the work done on them. All of the larger machines are provided with individual motor drives and are located under the traveling cranes. A row of vertical milling machines along the wall is served by jib cranes, and similarly a row of large horizontal machines placed on the other side of the main aisle are also served by jib cranes. The space between these machines is entirely clear and available for handling the work. The machines face the jib cranes to facilitate swinging the large castings onto and off the machines. The smaller machines are belt-driven and are arranged in two parallel rows, but in this case they are placed back to back instead of facing each other. The radial drills, which are chiefly employed on large castings handled by jib cranes, are shown in the center of Fig. 3, under the traveling cranes.

The column boring department is shown in Fig. 10. The faces of the columns are first rough scraped, and then the columns are placed in a specially designed machine which bores the spindle hole and the supporting or over-arm hole simultaneously. This machine is shown in the center of the illustration. The boring bars are in a vertical position. They may be operated simultaneously or independently, and either for boring or facing. The correct distance between the holes and their parallelism is taken care of entirely by the guides of the boring bars. The guides for the outer bar are removable and are provided in proper sizes for each size of column. The holding device on the bed of the machine locates the column central with the boring bars, which are connected with the driving spindles by a bayonet lock, facilitating quick and easy release, and providing sufficient play to allow the bars to revolve freely, regardless of the lack of alignment with the driving spindles.

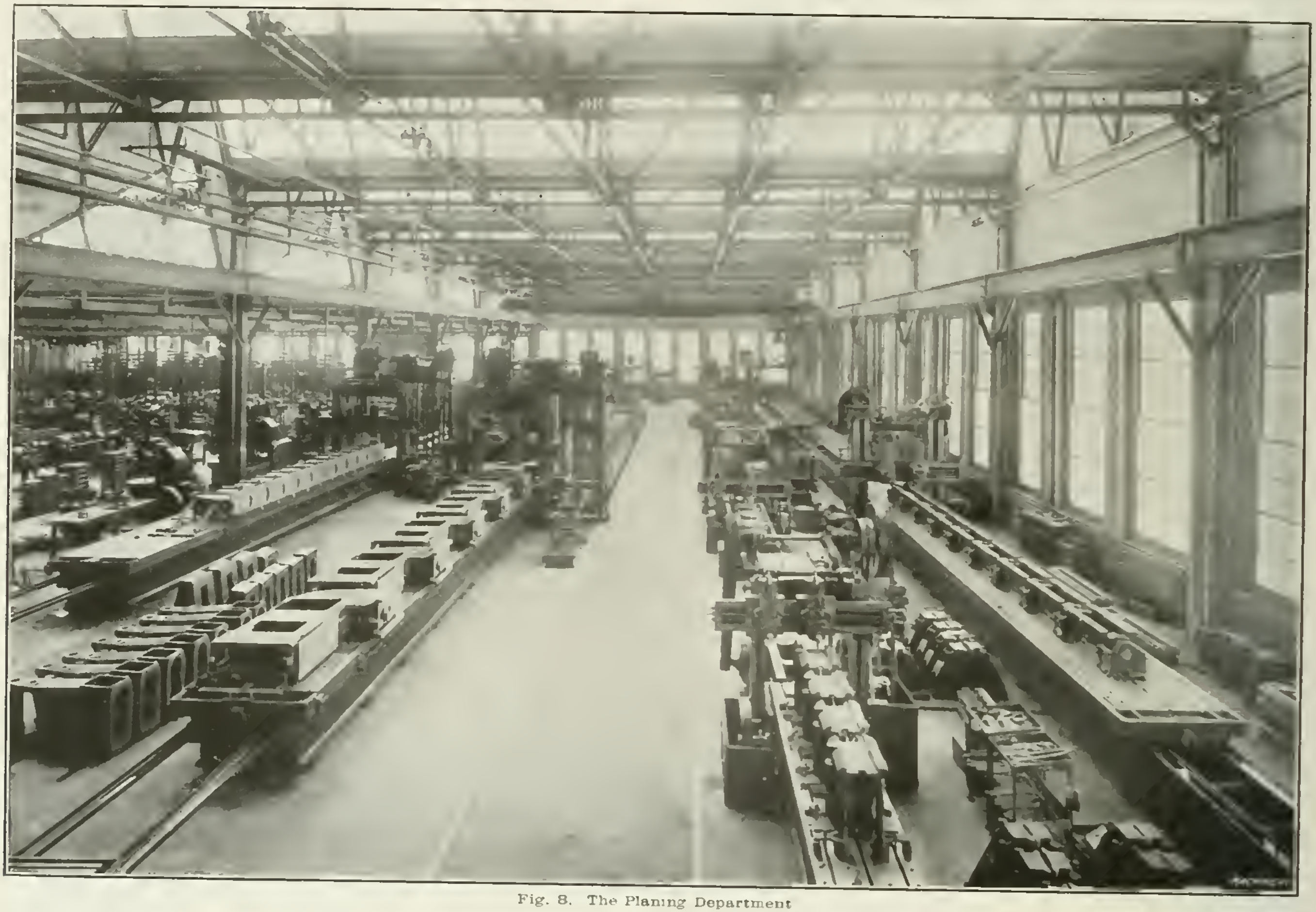
Fig. 8. The Planing Department

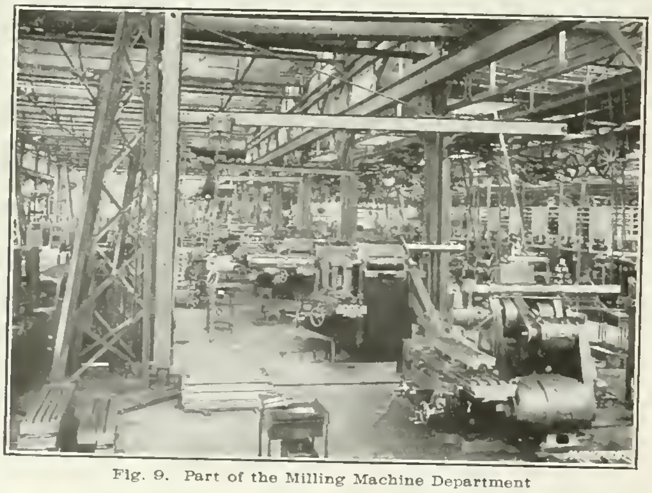
Fig. 9. Part of the Milling Machine Department

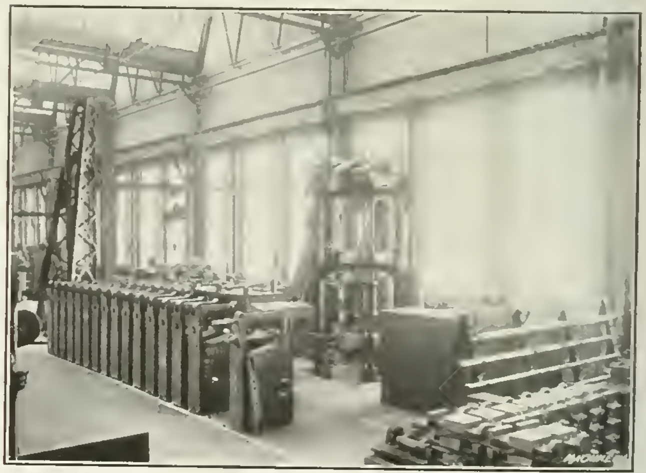
Fig. 10. Column Boring Department with Special Boring Machine

An entire lot of columns of one size is bored without taking the bar out of the machine. When one column is finished, the bars are lowered out of the way, and raised again, when the next column is in place, by means of compressed air. The bed of the machine is moved clear of the housing when chucking the work, it also being operated by compressed air. There are two sets of operating levers, and the operator is provided with an elevator, the framework of which is shown in the front of the machine, for changing his position readily.

The chief consideration which led to the building of this machine was to obtain the highest possible accuracy rather than quantity of output. After the columns have been bored they are tested for accuracy by an inspector located in this department. The column in the foreground shows a testing instrument in place for examining the accuracy of the spindle holes with regard to their being at right angles with the column face in both the vertical and horizontal direction. Further tests are made for parallelism, diameter, distance between over-arm and spindle holes, etc. A record of these tests accompanies each column to the fitting department. This inspection does not take the place of the final accuracy test to which the finished machine is afterwards subjected.

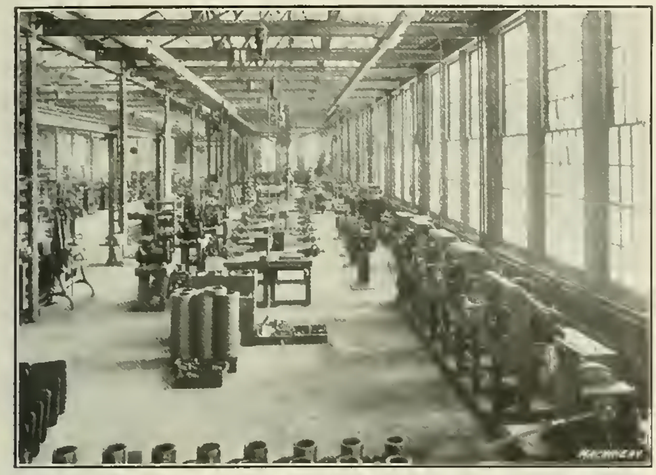

Fig. 11. Department for Assembling and Testing Feed and Drive Boxes

Scraping and Assembling

The large machine parts, such as columns, saddles, etc., next arrive at the scraping department shown in the foreground of Fig. 3. All the scraping is done to surface plates and master gages. In this department there are a number of interesting devices, as, for example, a swiveling arrangement for holding the tables for the scraping operation, enabling the workman to always bring the surface worked upon into a horizontal position. Another interesting device is the so-called "scraping machine" at the left of Fig. 3, between the first two jib cranes. This is a hydraulic cylinder fitted with reversing valves which give the piston a continuous reciprocating movement. This device is used for sliding large parts on each other, to determine the accuracy of their bearings. The device is arranged to swivel, and it may be elevated by hydraulic means to suit the height of the different parts. The column scraping is done under the framework at the right of the picture, the framework forming a number of parallel runways for hoists.

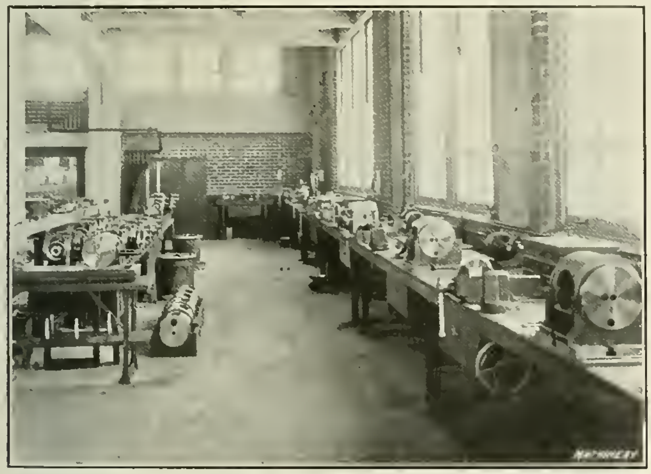

Fig. 12. A Corner of the Department for Assembling Dividing Heads

Fig. 3 also shows the extent to which crane service and hoists are provided. The main traversing cranes are of five-ton capacity with 60-foot span. These cranes serve all the planers at the far end of the building and transport material from one department to the other. The individual machines, other than the planers, are served by self-contained jib cranes. The steel work of the jib crane is fastened to and supported by a large cast-iron base. The mast rests on a ball thrust bearing, consisting of a single ball of large diameter. These cranes are not a permanent part of the building, but are bolted to the floor and can be placed in some other part of the shop at any time that it may be desirable to do so.

The assembling department for feed and drive boxes is shown in Fig. 11. In the foreground is shown the testing stands on which each feed box and each drive box is given a running and endurance test under conditions which duplicate those under which it will operate when placed on the machine. In the immediate foreground is shown the driving clutch pulley testing stand on which the units entering into the single-pulley high-power machines are given a running and load test. This stand is provided with a prony brake and an ammeter which indicates the load applied under each test.

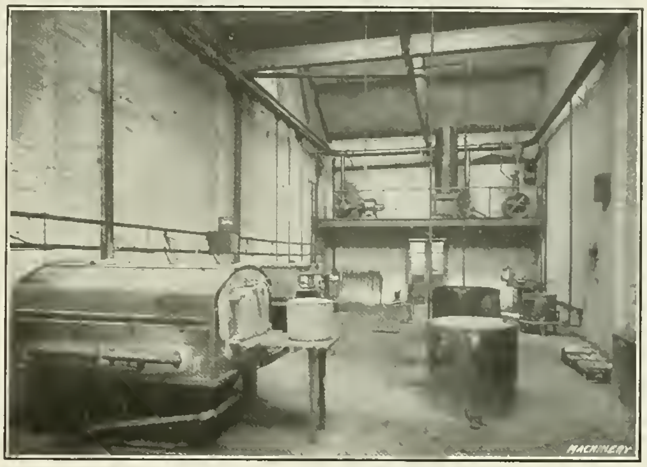

Fig. 13. The Hardening Room

Fig. 12 shows a corner of the dividing-head department. As already mentioned this department is purposely isolated, because of the precision work required. On completion, each dividing head is subjected to the most rigid accuracy tests, and a copy of each test is filed. The dividing-head worm-wheels are hobbed on a machine especially designed for this one operation. The worm-wheels hobbed in this machine will index work 8 inches in diameter with an average accuracy of 0.00025 inch of accumulative error in any one quarter of the circumference.

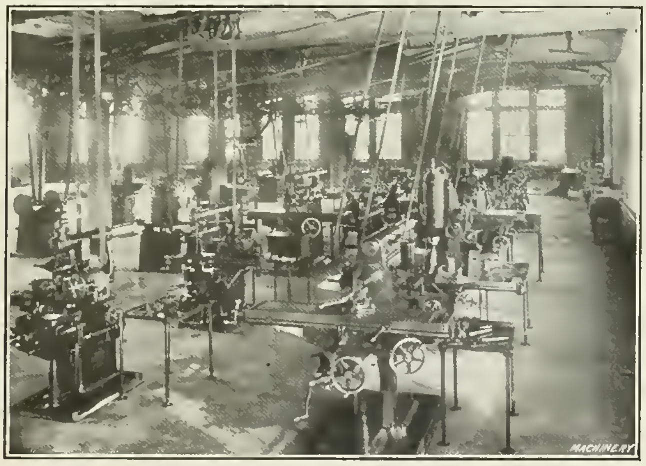

Fig. 14. The Toolmaking Department

The carbonizing and hardening department is shown in Fig. 13. In addition to the clutches and other small parts, a large number of the gears entering into the milling machines manufactured are hardened. The hardening department is equipped with gas furnaces and lead baths. Temperatures are determined by a pyrometer mounted on a track over the furnaces. The pressure blower is motor-driven, and a gas engine is also installed for emergency service, so as to provide for the necessary continuous carbonizing. Two oil tanks immersed in running water are placed in the floor. They are provided with steel covers for closing them when not in use.

Since the toolmaking department does not make any part used in the products of the shop, there would be no advantage in having it located with the manufacturing departments. On the other hand, there is an advantage in having it located by itself, and, therefore, it has been placed on the third floor so as to be close to the tool-designing and engineering departments. This department, a view of which is shown in Fig. 14, is equipped with all the machine tools necessary for toolmaking, including a cylindrical grinder, an internal grinder, and a surface grinder, so that there will be no need to call on any of the manufacturing departments for assistance, except in the case of an unusually large planer job for a heavy fixture. No shapers are employed, all the work of a character for which shapers could be used being done on milling machines.

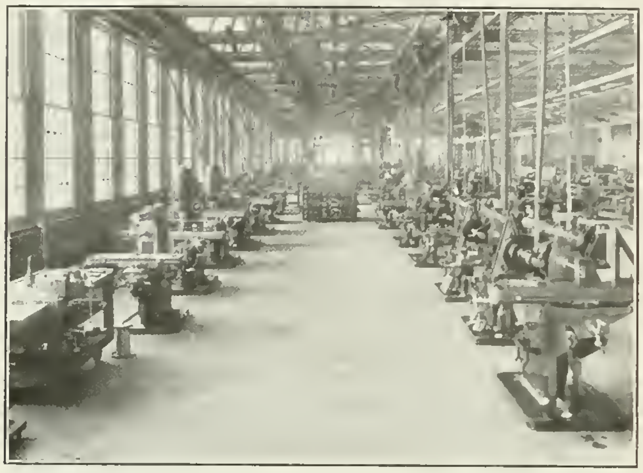

Fig. 15. Department for Testing the Completed Machines

As the new model milling machines built by the company are constructed entirely according to the unit system, the final assembling consists merely in assembling such units as feed boxes, drive boxes, driving clutch pulleys, etc., into one complete machine. After the machines have been assembled by successive groups of men, each attaching one class of units, they arrive at the final testing department shown in Fig. 15. Here each machine is given a thorough test for accuracy of alignment, and a running test under belt for a specified length of time. Each machine must also do a specified amount of milling. A permanent record is kept of all these tests.

Adjacent to the testing department are the shipping and packing departments, the latter of which is shown in Fig. 16. There are two shipping doors leading to the shipping platform. The one in the center of the illustration is provided with a vestibule for the protection of this part of the shop during severe weather. They are closed by steel drop doors and are entirely surrounded by circulation pipes of the hot water heating system. The railway cars come up to the shipping platform on a depressed track so that the floors of the cars are level with the platform. Three cars may be loaded at one time.

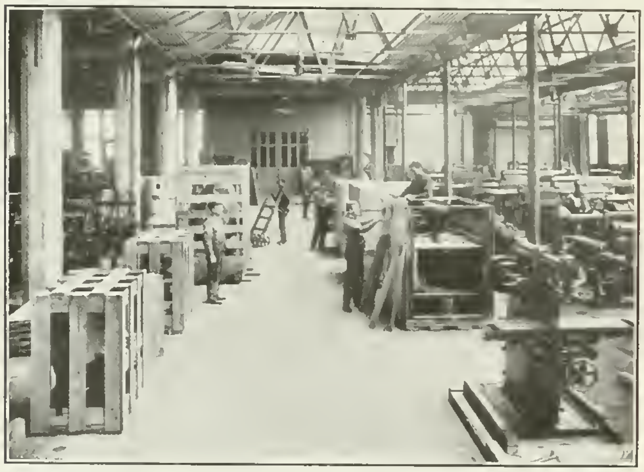

Fig. 16. The Packing Department

Washrooms, Sanitation, etc.

The employes' entrance on the Columbia road side (see Fig. 2) leads directly into the service room where ventilated steel individual lockers are provided for all the men. The wash basins are of the individual type with hot and cold water, and there is one basin for every three men. Hot water for this room and for the shower baths is obtained from instantaneous heaters, one of which is shown in Fig. 17.

The sanitary arrangements are of the very best. The toilet rooms are marble lined, and all metal work is nickel-plated, these materials having been selected in order to keep everything in a sanitary condition. The shower baths for the use of the employes are also built of marble, each compartment being divided into two sections, with a bath in the rear and a dressing room in the front. Sanitary drinking fountains are provided at intervals throughout the shop.

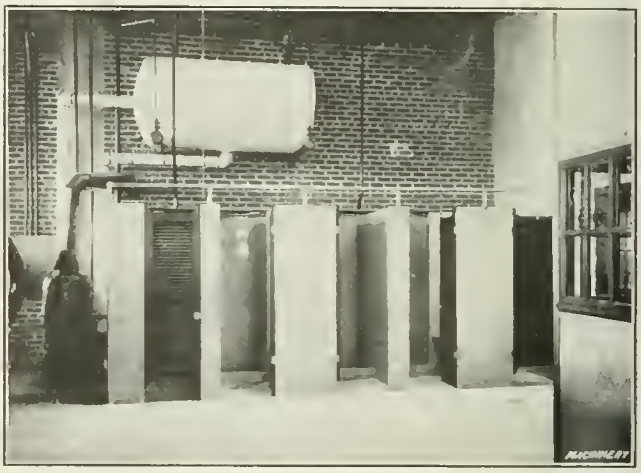

Fig. 17. The Shower Baths

The manufacturing departments are lighted by Cooper-Hewitt lamps which furnish sufficient illumination for all purposes without the use of individual lights, with the exception of a few special cases. The offices and engineering departments are lighted by the indirect system using tungsten lamps in clusters. This soft, diffused and evenly distributed light has proved as satisfactory as good daylight. The buildings are heated by the Evans-Almirall system of forced circulation hot water. In the single-story part of the building, the circulation pipes are placed on the lower chord of the trusses, immediately below the window space, as indicated in Fig. 16. This arrangement prevents drafts caused by descending currents of cold air from the roof windows, and has proved satisfactory during the extreme cold of the present winter. The provisions for ventilation have also proved sufficient during the extremely hot weather of the past summer. The arrangement of the roof windows permits the opening of the entire upper one-third of the sash, providing for 60 square feet of opening for each 500 square feet of floor space, the liberality of which is evident when compared with the usual arrangement of one 48-inch ventilator for every 100-foot length of roof, providing only 12 square feet of opening for each 2500 feet of floor space. The sash opening devices are operated from the floor, and in some cases as much as 100-foot lengths of sash are controlled from a single point.

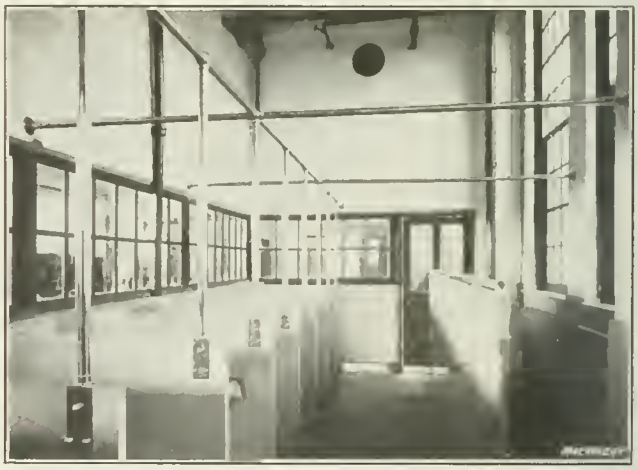

Fig. 18. One of the Marble-lined Toilet Rooms

APPLICATIONS FOR PNEUMATIC TOOLS

By A. M. M.

There are many classes of work now done by hand to which pneumatic tools can be applied with advantage. Many plants have developed special uses for these tools, a few of which are here presented.

A contractor engaged in erecting large electric generators had several thousand tubular rivets, 1½ inch in diameter, which were to be headed cold. This was a very slow and laborious job. The rivets were used to hold together the laminations of the stator, and were drilled at the ends to make them tubular and to facilitate heading. By means of a beading tool and a hand-hammer, they could be riveted up in the same manner that boiler tubes are beaded, but it was found that not more than two per hour could be headed by hand. After considerable experimenting a 9-inch pneumatic riveter was fitted with a special die for the work, and the time was reduced to five minutes per head, with less fatigue to the operator.

Fig. 1, showing the die and rivet end, illustrates the idea. A common riveting die was turned to fit the finished head, leaving a centering pin in the middle of the die. Two opposite sides of the die were then slabbed off on a milling machine, leaving the working edge about ⅜ inch thick. This edge was filed round, and the die hardened. A hole drilled through the die provided means for attaching a piece of ⅜-inch round steel wire as shown. This served as a handle to rotate the die. The operator could form a perfect head on the bolt by slowly rotating the die, and working down the edges as desired.

Hardening Riveting Dies

Many concerns have trouble with the breaking of riveting dies. One large company using about thirty riveters broke on an average ten dies per day. As these dies cost about $1.75 each, it will be seen that the total expense was considerable. The blacksmith hardened the dies only at the cup and shank, leaving the shoulder soft. He decided that as all the dies were breaking at the shoulder, he would leave that part as soft as possible. Many blacksmiths make the same mistake. The trouble, however, is that the tension set up by the uneven hardening causes the breakage. The following method of hardening was adopted, and the breakage fell to one die per week or less, instead of ten per day.

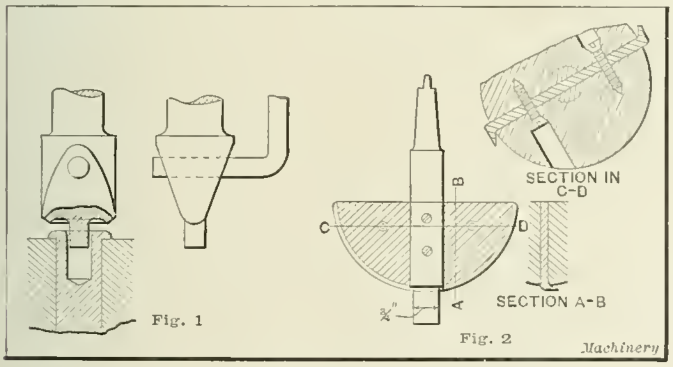

Fig. 1

Fig. 2

Fig. 1. A Pneumatic Beading Tool. Fig. 2. A Pneumatic Wood-cutting Tool

A die was first heated slowly and evenly to a temperature considerably higher than that required for the hardening. It was then allowed to cool for several minutes to insure that the interior of the die was as hot as the outside. It was then (at a dull red heat) quenched in oil. The blacksmith had previously prepared a ring or tube rolled up from a piece of ¾-inch plate. This tube was about 6 inches in inside diameter and 10 inches long. It was heated to a bright red heat, and the die held in the center of it to draw its temper evenly. When the right color was reached, the die was quenched in water. Dies hardened in this manner gave excellent results. A steel costing 12 cents per pound was used.

Driving Drift-bolts in Crib Work

A contractor was building crib work of hard fine timbers, 10 inches square. He had several thousand drift-bolts to drive. The bolts were 8 feet long, and 1 inch in diameter. He had several gangs of three men each working from a staging, driving with heavy sledges. The three men would drive one bolt, striking alternately. The work was progressing so slowly that he determined to try a pneumatic riveting hammer. He found that a heavy riveter, operated by one man, would do the work of two gangs (six men), and dispense with the heavy staging.

Use of Pneumatic Hammer in Broaching Operation

A machine shop had a large number of hexagon bushings whose inside surface had to be finished smooth and of accurate dimensions to make a close fit on a ¾-inch hexagon rod. A hexagon broach of the same dimensions as the rod was machined and the end squared off to a cutting edge. It was found very difficult to drive this tool through the bushing with a hand hammer, but it was easily and quickly accomplished by the rapid blows of a pneumatic hammer.

A Pneumatic Wood-cutting Tool

It often happens that wooden hatches or decks are fitted with I-bolts or handles which must lie flat with the surface. To make room for the fingers or a rope under the ring, the wood must be cut out in the form of a cup or depression. Often, on a large job, there will be several hundreds of these cups to hollow out of the flat surface. A carpenter with his gouge and mallet will take a couple of hours to finish one, but the cutter here described, fitted to a pneumatic machine, will do this work in a few minutes. The cutter blade is formed of ¼-inch tool steel plate, set into a slotted bar and brazed. After this operation is completed, a block of wood, turned in a wood lathe to the shape of the cup, is fitted to it as shown in Fig. 2. This block allows the cutter to project beyond its surface, and prevents it from taking too large a chip. The tool works best in one of the smaller machines of high speed. A ¾-inch guide hole is first bored to the required depth.

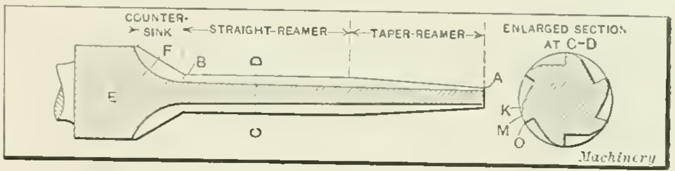

Fig. 3. Combined Reamer and Countersink

Special Reamers for Pneumatic Tools

In a plant handling structural or steel ship work, the reaming and countersinking of the thousands of rivet holes is a large item, and may represent a considerable percentage of the cost of construction. It is important that the reamer with which this work is done shall have certain properties. It must cut rapidly, without heating. It must clear itself when forced, without breaking. It must stand the abuse of unskilled labor. Two men with an ample supply of sharp correctly made reamers will ream several thousand holes per day, where they will only ream several hundred if obliged to work with reamers which do not cut properly. The following description and illustration, Fig. 3, shows how one of the large shipyards increased the efficiency of this operation several hundred per cent by giving careful attention to these points.

This yard had a million, more or less, ¾-inch rivet holes to be reamed and countersunk. The work was started with the ordinary pneumatic reamers and countersinks, making two separate operations. The tool-room, having only a small supply of these tools and having other troubles, was very "economical" in handing out reamers, and kept the men working with the tools long after they were too dull to cut properly. The consequence was that the men would keep a reamer turning in one hole for several minutes, and not only did it not work, but the reamers were burned. The men made no attempt to rush the work as this only resulted in burned reamers and a "call-down" from the tool-room.

The following system was adopted with an increase of about 500 per cent in the amount of work turned out. A special combination reamer and countersink was designed as shown in Fig. 3. Enough of these tools were provided to allow about four reamers per gang. The gangs were put on piecework and one skilled operator in the tool-room was made responsible for keeping the reamers sharp. Each gang was given a can of tallow in which to lubricate the reamer as often as required. The gangs working on the flat decks were cut down to one man, and this man was provided with one of the "wheelbarrow" devices shown in Fig. 4, in place of his "helper." All extension shanks were inspected and those having damaged sockets were thrown out and replaced with new ones of tool steel with close-fitting sockets. Many of these shanks were found to be made of soft steel, and the socket which received the Morse taper shank was so cut out as to allow the reamer to jump out and turn in the socket. Many reamers were ruined by having the small ends of the shanks twisted off. All of these shanks should be carefully made of tool steel. The countersink-reamers insure that the countersink will be concentric with the reamed hole, and the whole job is done at one operation.

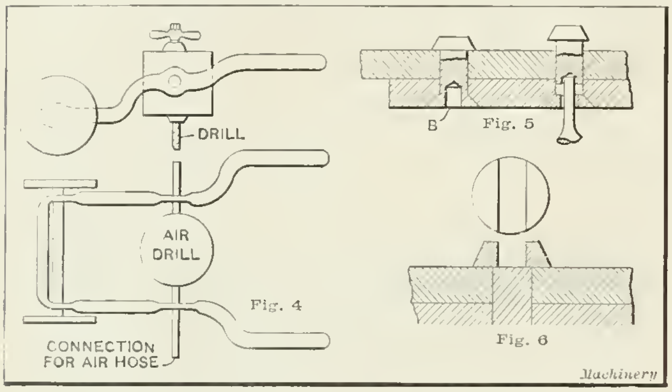

Fig. 4. A Substitute for the "Helper." Fig. 5. Method of Removing Rivets. Fig. 6. Method of Cutting-off Rivet Heads

These reamers are turned out of solid stock ("22-cent" tool steel, box annealed) of the diameter of the countersink-portion *E*. In milling, a single straight cut is made from *A* to *B*, and the milling cutter is of a diameter to form the curve at *F*. This is not an ideal method, but it saves several resetting operations and is satisfactory in practice. Care is taken to grind off the back of the tooth to the proper angle at *K*. A cutting edge must be made with the clearance from *M* to *O* less than at *K*, and is the only portion ground in resharpening.

Easy Way of Cutting out Rivets

An easy way of cutting out rivets is as follows: First drill a hole as shown in Fig. 5 at *B*. Then use a backing-out punch made to fit a pneumatic riveting hammer. If a good backing is available, a pneumatic "jam hammer" can be used to advantage. For cutting off rivet heads proceed as in Fig. 6, using a pneumatic chipping hammer and "cape" chisel. First cut a slot through the head, making it like a slotted screw-head. The two sides can now be cut off without trouble.

* * *

Just so much of forms, rules and regulations as will insure that the right thing will be done in the right manner at the right time, is system. Whatever is more than that is red tape.

MAGAZINE ATTACHMENTS—2

APPLICATION TO THE BROWN & SHARPE AUTOMATIC SCREW MACHINES

By DOUGLAS T. HAMILTON*

Small pieces which have been partly completed in the punch press can be handled satisfactorily in a Brown & Sharpe automatic screw machine by the application of a magazine attachment. The type of attachment to use depends entirely on the shape and character of the work. In the February number, a few of the more simple attachments were illustrated and described. In this article is given a description of three attachments and their auxiliary mechanisms for handling parts blanked out in the punch press. Reference is made to Figs. 5 and 9, which appeared in the February number.

A Snake-shaped Attachment

Fig. 11 illustrates a snake-shaped slide which is used for handling the watch crowns shown at *N* and *O* in Fig. 9. The sectional views of this slide show the shape of the different crowns for which this attachment is used. Of course special slides were made for each different size. The slide shown in Fig. 11 is held in a bracket similar in construction to that shown at *A* in Fig. 12. The watch crowns are made from sheet metal, which is drawn up and formed around a solid center in the punch press. The knurling on the crown is also produced when it is being formed. The reason for making a crown in this manner is that it can be made from "rolled plate," the name given to a class of material used in the manufacture of jewelry, which consists of a block of some composition, such as brass, to one side of which is soldered a thin sheet of gold; this block is then rolled out into sheets

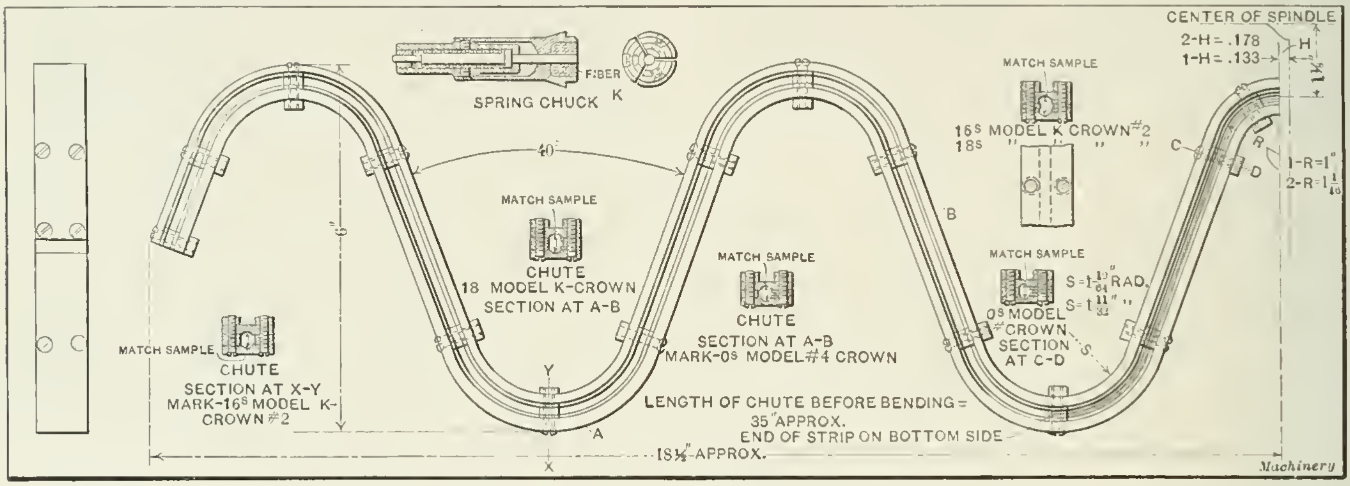

Fig. 11. Magazine Attachment for Handling Watch Crowns

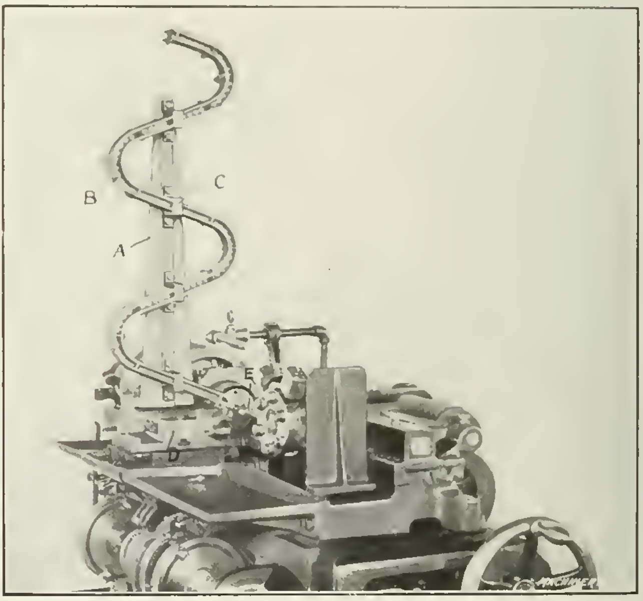

Fig. 12. Snake-shaped Attachment for Handling a Shouldered Stud on a No. 0 Brown & Sharpe Automatic Screw Machine

of the desired thickness and cut up and formed in a punch press. This facilitates the production of an article which is much harder than gold, will not corrode, and wears well.

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* Associate Editor of MACHINERY.

Referring to Fig. 11, this slide consists of two strips *A* and *B* held together by screws and separated by blocks. The strips are milled out to suit the work which is to be placed between them. There are two reasons for having the slide of this attachment made in this manner: First, being bent into the shape shown, it will hold a greater number of pieces in the same height, thus making it more accessible to the operator; second, it gives a practically vertical slide at the curved point, which assists in feeding the work to the machine. The work is carried from the slide to the machine by a carrier, a description of which will be given later. The chuck for holding these crowns is shown at *K* in Fig. 11; it consists of an ordinary spring collet, bored out in the front end to receive a fiber "bushing" which is cupped out to suit the crown. This fiber bushing allows the knurling on the crown to sink into it, thus holding it securely while being counterbored, drilled and tapped. Except for the addition of the fiber bushing this spring collet is similar to those previously described, being provided with a spring ejector.

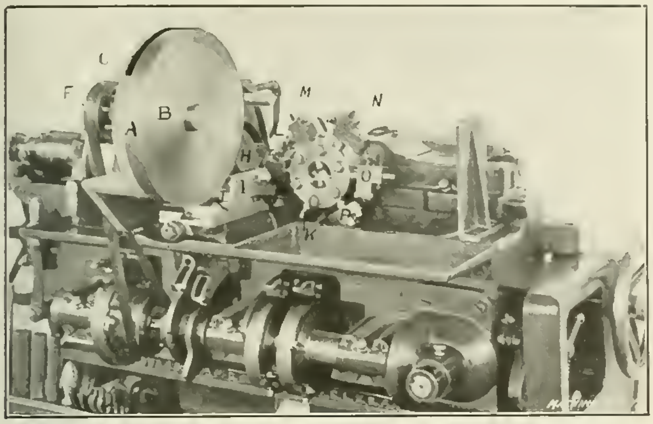

Fig. 13. Semi-automatic Magazine Attachment for Handling Blanks for Watch-spring Barrels on a No. 0 Brown & Sharpe Automatic Screw Machine

In Fig. 12 is shown another snake-shaped attachment, which is used for handling a collar stud. The slide *B* is fastened to the bracket *A* by U-shaped braces *C*. The work is carried from the slide to the chuck by means of a carrier *D*, similar in construction to that shown in Fig. 5. The spring collet used for holding this piece is similar in construction to those previously shown, and the work is inserted by a spring plunger *E* held in the turret. Attachments of this type are bent to an included angle of 40 degrees, which has been found to give the best results for feeding the parts to the chuck.

Semi-automatic Magazine Attachment

The magazine attachment shown in Fig. 13 is used for feeding the blanks from which the barrels for watch springs are made, to the chuck. A watch spring barrel which has been completely machined is shown at *P* in Fig. 9, and also at *A* in Fig. 18. The teeth are cut on this barrel in an automatic gear cutter. This magazine attachment, which is fastened to the bracket on the No. 0 Brown & Sharpe automatic screw machine, consists of a rotating wheel held on a spindle and enclosed in the casing *A*.

The construction of this attachment is more clearly shown in Fig. 14, to which reference should now be made. The wheel *B* is recessed to form a pocket or magazine for the blanks, and is provided with slots in which the blanks fit. The blanks are inserted in the attachment through the slot *C*, which passes down into the pocket *D* of the rotating wheel. The wheel is driven from a pulley *E*, located on the front cam-shaft (see Fig. 13) by a belt running on the pulley *F* keyed to the wheel spindle. An idler pulley *G* is furnished to change the tension of the belt. As the pulleys *E* and *F* are of the same diameter, the wheel *B* rotates at the same speed as the front cam-shaft. The blanks, when carried around by the wheel *B*, drop into the slide *H* and from there into a pocket in the bushing held in the carrier *I*.

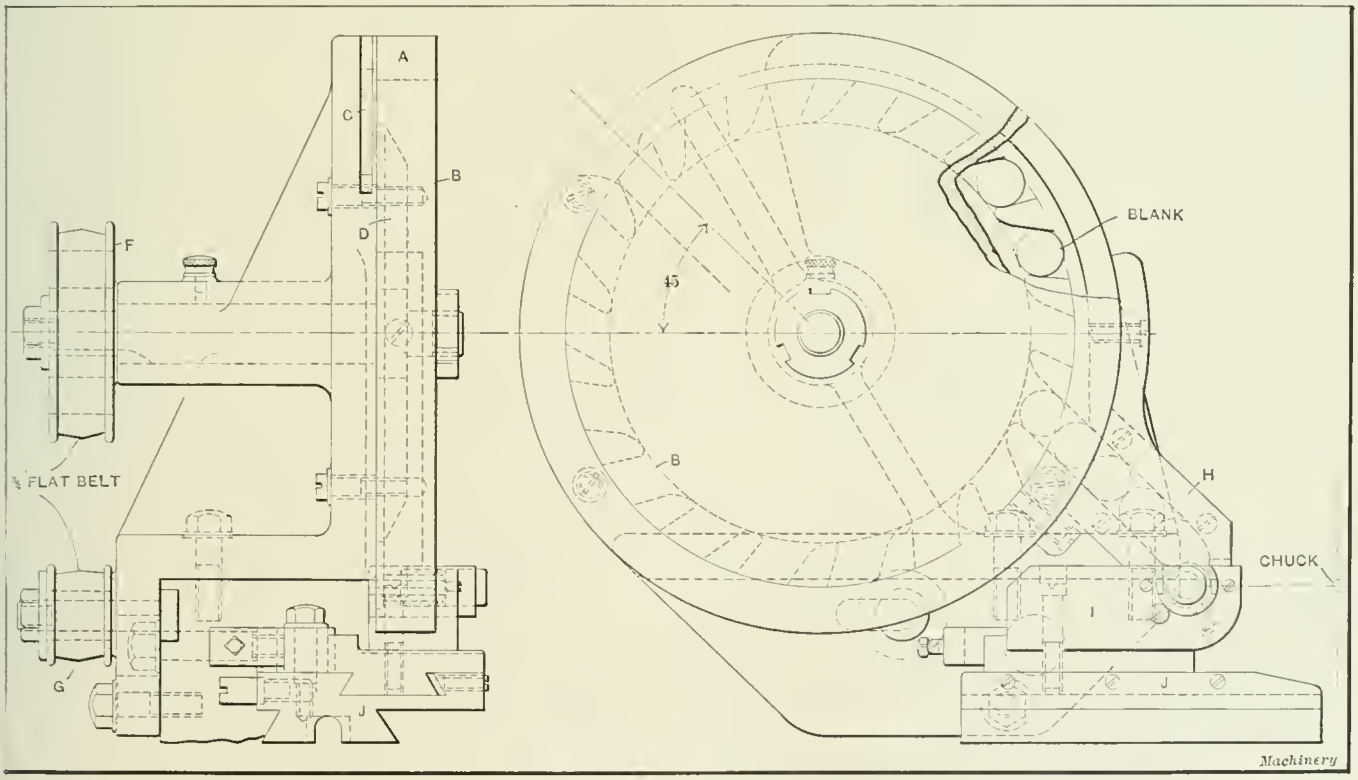

Fig. 14. Assembly Views of Magazine Attachment shown in Fig. 13

On account of the type of tools shown in Fig. 13, which are used in machining the spring barrel, and the shape of the carrier, it is necessary to increase the actual throw of the ordinary cross-slide, so that the carrier, when it drops back, will allow the tools in the turret to get at the work. The ordinary cross-slide is removed, and a slide *J*, which is shown more clearly in Fig. 15, is substituted. Referring to Fig. 15, it will be seen that slide *A* is provided with a dovetailed slot in its top face, in which the auxiliary slide *B* works. Attached to the machine by a shoulder screw *C*, fitting in an elongated hole in the bracket *F*, is a rack *D*, that meshes with a pinion *E* held to the lower slide *A* by a screw as shown. Pinion *E* meshes with teeth cut in the auxiliary or top slide *B*.

In operation, as the cam on the front cam-shaft advances the lower slide *A*, the pinion *E* is rotated, this action carrying forward the auxiliary slide *B*, and increasing the throw of the cross-slide. The rack *D* is formed into an L-shape in the rear end, and a set-screw, fitted into it and butting against the bracket, is used for changing the position of the rack relative to the cross-slide.

The work carrier *I*, Fig. 13, which is shown more clearly in Fig. 16, consists of a block *A* counterbored to receive a bushing *B;* the bushing is also counterbored to receive a spring plunger *C* and cut out to fit the spring fingers *E*. The fingers are made from spring-tempered sheet steel, and fastened by flat-head screws to plugs *F*, which are held in drilled holes in the carrier block *A*, and retained by means of headless screws, as shown. The spring plunger *C* is retained in the bushing *B* by means of a pin driven into the bushing and fitting a terminated slot in the plunger. The bushing *B* is free to slide in the carrier block, and is held back by means of a coil spring *G* bearing against a pin driven into the bushing. The bushing is located in its "back" position by a headless screw acting as a stop for the pin which is driven into the bushing. It is also prevented from rotating by means of a screw *H* turned down on the end to fit a slot in the bushing.

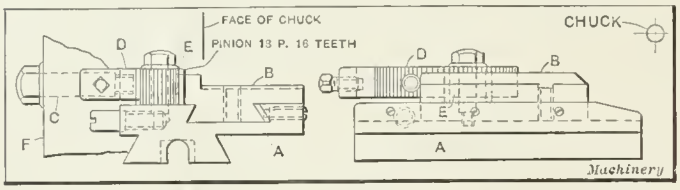

Fig. 15. Double-throw Front Cross-slide for the Magazine Attachment shown in Figs. 13 and 14

In operation, as the blank comes down the slide, it is deposited in the bushing *B*. The cross-slide then advances and brings the blank in line with the hole in the chuck. When in this position the turret is advanced, and the stop *K* (see Fig. 13) pushes the spring plunger *C* forward, forcing the blank out from the fingers and depositing it in the chuck. It will be noticed that the spring *I*, operating the spring plunger *C*, is made much heavier than the spring used for holding back the bushing *B*. The object of this is to insure that the bushing will be brought up close to the face of the chuck before the plunger forces the blank out of the spring fingers.

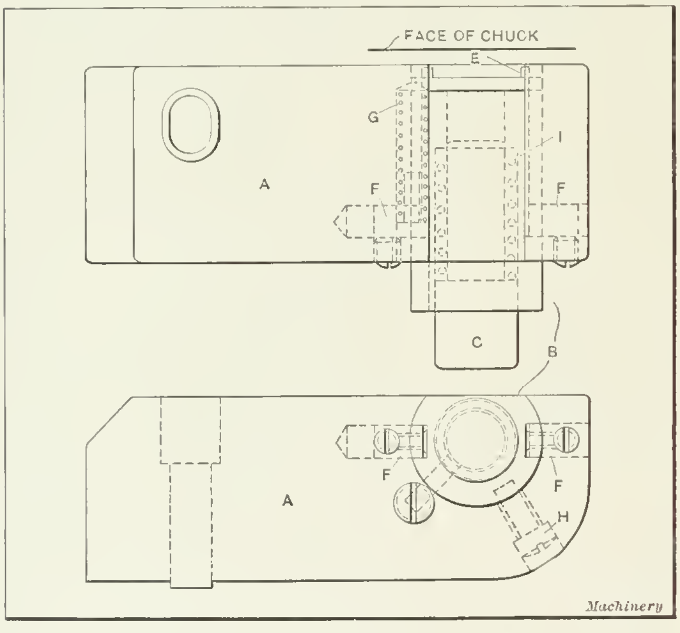

Fig. 16. Work-inserter used in Connection with the Magazine Attachment shown in Figs. 13 and 14

These spring barrels are difficult to hold, as can be seen by referring to Fig. 18. The part not cut down with the circular form tool is only 0.034 inch wide, which means that only about 0.025 inch can be used for gripping purposes, as it will require from 0.005 to 0.010 inch for clearance. It would be difficult to hold this blank rigidly and true in an ordinary counterbored spring chuck, owing to the fact that a recess would have to be made at the shoulder in the chuck which would reduce the gripping portion.

The manner in which these blanks are held is interesting and is clearly shown in Fig. 17. A special threaded cap *A* is made to fit over the nose of the spindle, and is provided with grooves in which a spider *B* is held to it by screws. This spider is made from tool steel, hardened and ground on both faces. The cap is also hardened and ground on the face bearing against the nose of the spindle and in the slots. The spring collet *C* projects past the face of the spider about 0.028 inch, and is cut out to fit the arms of the spider. The hole in the chuck is serrated to hold the blank more securely.

The tools used for performing the operations on this spring barrel are shown in Fig. 13, where *K* is the pusher which forces the piece out of the carrier into the chuck; *L*, a combination drill and countersink; *M*, a roughing recessing tool; *N*, a second roughing recessing tool; *O*, a finishing recessing tool; and *P*, a reamer holder. The cams used in making this blank are shown in Fig. 18 where the uses of the various lobes are clearly indicated. It might here be mentioned that the making of this spring barrel presents an unusual difficulty in producing a wall which will be of an even thickness and not cupped. This is accomplished by using a recessing tool for facing, instead of counterboring with a counterbore held in the turret. The application of recessing tools to work of this class was described in an article which appeared in the November, 1910, number of MACHINERY, entitled "Internal Cutting Tools." Here the proportion of the thickness of the wall to the diameter, for facing operations, and the feeds to be used, were given.

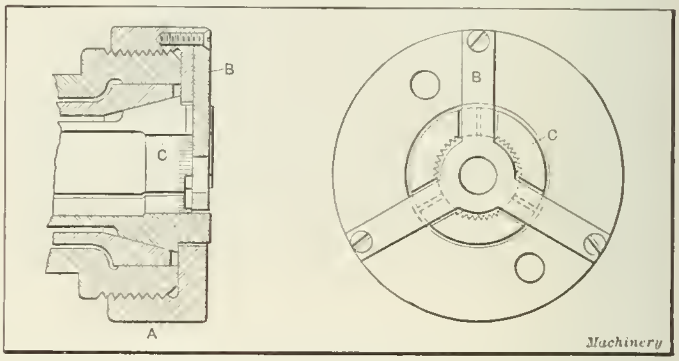

Fig. 17. Special Spring Collet used in Holding the Blank for the Watch-spring Barrel

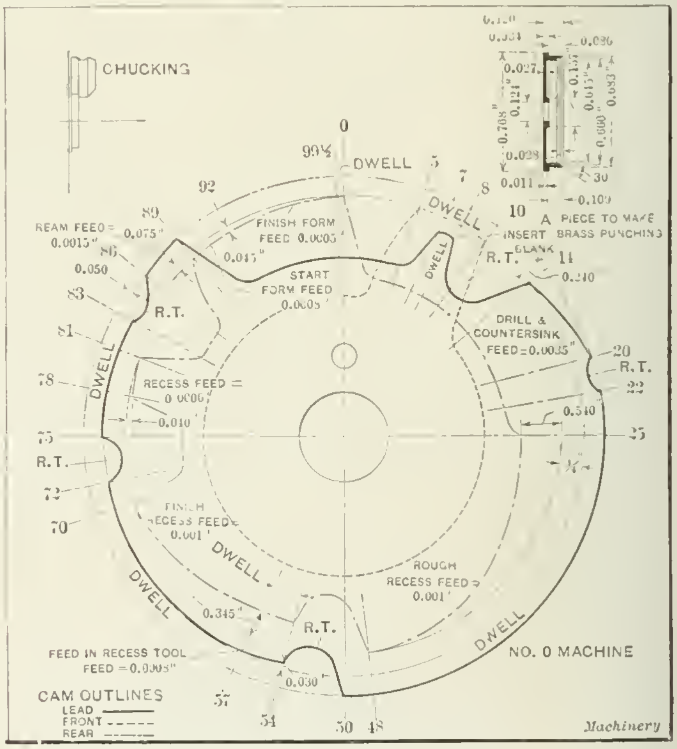

Fig. 18. Cross-slide and Turret Cams used in Producing the Watch-spring Barrel

The order of operations for piece *A*, Fig. 18, is as follows:

Order of Operations	Revolutions	Hundredths
Open chuck	24	2
Eject piece with feeding finger.........	30	2½
Clearance	6	½
Bring up carrier on front cross-slide...	(48)	(4)
Hold carrier in line with chuck........	60	5
Insert piece with inserting tool........	(30)	(2½)
Dwell with inserting tool	(12)	(1)

Close chuck	(24)	(2)
Clearance	6	½
Revolve turret	42	3½
Drill and countersink, 0.240 inch rise at 0.0035 inch feed	72	6
Revolve turret	24	2
Clearance to place recessing tool in position	12	1
Advance rear cross-slide	24	2
Rough recess, 0.540 inch rise at 0.001 inch feed with L. H. swing tool	276	23
Clearance to drop back pusher on cross-slide	24	2
Revolve turret and clear	48	4
Advance recessing tool and feed in for cut 0.030 inch rise at 0.0008 inch feed	36	3
Dwell with rising block on cross-slide	(36)	(3)
Advance pusher on cross-slide, 0.345 inch rise at 0.001 inch feed	156	13
Clearance to drop back pusher on cross-slide	24	2
Revolve turret	36	3
Bring recessing tool into position	36	3
Advance pusher on cross-slide, 0.040 inch rise at 0.0006 inch feed	36	3
Clearance to drop back pusher on cross-slide	24	2
Revolve turret	36	3
Ream, 0.050 inch rise at 0.0015 inch feed	36	3
Start forming with circular tool, 0.030 inch rise at 0.0008 inch feed	36	3
Finish form, 0.045 inch rise at 0.0005 inch feed dwell 0.050	96	8
Total	1200	100

This article completes the extensive series, which have appeared in MACHINERY from June, 1909, up to the present time on the Brown & Sharpe automatic screw machines. Back numbers of MACHINERY containing all of these articles* cannot be supplied, but the complete series will be incorporated in MACHINERY'S Reference Books, in the near future.

In bringing this series of articles to a close, the writer wishes to express his gratitude to the Brown & Sharpe Mfg. Co., who has very carefully gone over all manuscripts which were submitted. This company has also been very liberal in supplying us with drawings and photographs, for illustrating the machines, tools, and other equipments.

* * *

HOLDING WORK FOR GRINDING

The accompanying illustrations show three methods of holding work that are employed in the Stevens-Duryea factory in Chicopee Falls, Mass. Fig. 1 illustrates a chucking fixture for use in the bench grinding machine for holding small disks that must be ground with their peripheries concentric with the central hole. This fixture consists of a shank that fits the spindle of the bench grinding machine. The outer end of the fixture has been turned at *A* to fit the bore of the hole of the piece to be ground. In the center of this turned portion a hole *B* is drilled and tapped. The outer end, *C*, is slightly tapered. Set-screw *D* is made with a tapered section to fit the tapered hole, and, after splitting the end of the fixture with two slots at right angles to each other, the fixture is ready for use. When the pieces that are to be ground are put in place and the set-screw *D* is tightened, the contact of the tapered section of the screw with the tapered hole within the piece to be ground, opens the fixture so that it grips the work tightly and it is certain that the grinding will be concentric with the central hole.

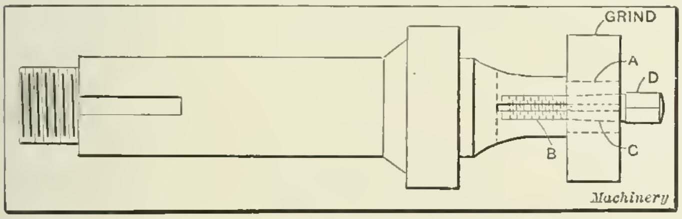

Fig. 1. Fixture for Holding Work by a Central Hole

In Fig. 2 is illustrated another fixture for use in the bench grinding machine. The working end of this fixture consists of a part *A* recessed to accommodate the work *B*. The work is held in the fixture by means of two screws *C* and a washer *D*, after which the conical recess is ground in the edge. One of the interesting parts of this fixture and work is the method used in checking the grinding. This is done by means of gage *E*. The central plug *F* of gage *E* is made to fit a hole in the fixture, which is ground accurately to the same size as the stud. At the two extremities of gage *E* two steel disks *G* that have been beveled to a knife edge are mounted. By means of this fixture the shape of the ground portion may be checked as well as the overall diameter and the concentricity of the grinding with the bore.

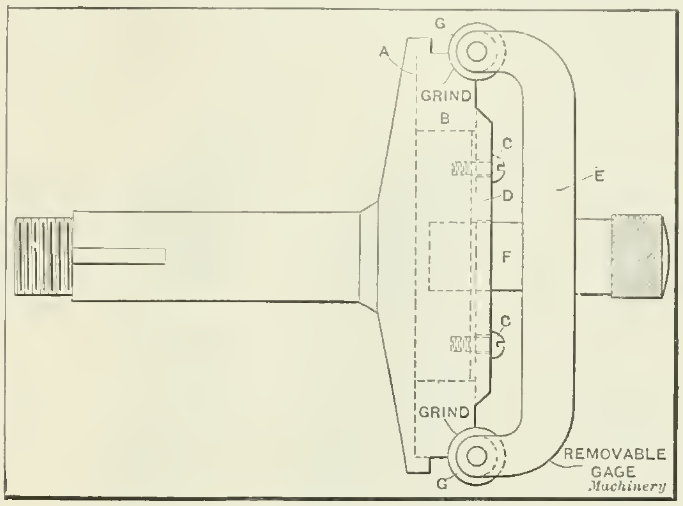

Fig. 2. Fixture for Holding Ball Races for Grinding, and Gage for Testing Work

A somewhat different proposition is illustrated in Figs. 3, 4, and 5. Fig. 3 illustrates the piece that must be ground. This piece, it will be noticed, has a hole crosswise of the cylindrical part. The problem is to grind this cylindrical part exactly true with the hole; that is to say, the distances from the center of this hole to the outside of the piece must be exactly equal and accurate as to size. This point can be best illustrated by referring to Fig. 4, in which the dimensions that must be accurate are noted. The method used in holding this work for grinding is illustrated in Fig. 5 and consists essentially of a stud *A* whose end is milled with a V-slot that is exactly in the center of the stud. The other end of the work is held in the usual manner by the tail center of the grinding machine. Fig. 4 illustrates the method used in checking the accuracy of this grinding. This gaging fixture consists of a bar *C*, having two arms *D* that are drilled and reamed to receive the pin *E*, which, in turn, may be slipped through the holes of the piece and the holes of these arms *D*. The measuring part of the gage consists of a micrometer head *G* that is mounted in the center of bar *C*. By means of this micrometer head the distances from the center of the hole to the outside of the work in either direction may be readily and accurately measured.

C. L. L.

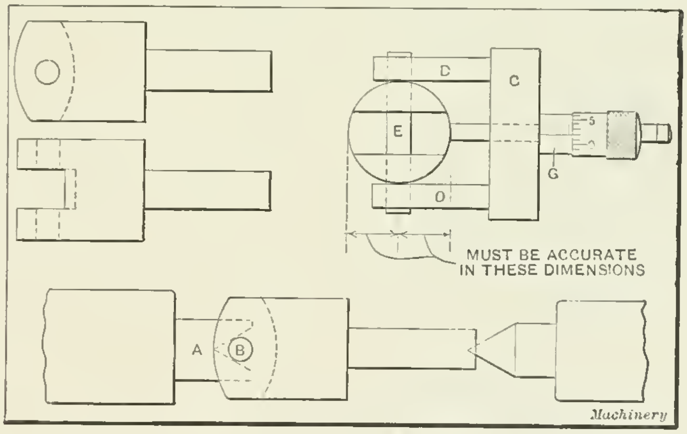

Fig. 3. Piece to be ground. Fig. 4. Method of Testing Accuracy of Grinding. Fig. 5. Method of Holding Work

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* The titles and dates of publication of the complete series of articles on the Brown & Sharpe automatic screw machines are: "Magazine Attachments—1," February, 1912; "Milling Cross-Drilling and Burring Attachments—1-2-3-4," September to December, 1911; "Thread Rolling," August, 1911, engineering edition; "Knurls and Knurling Operations," July, 1911; "External Cutting Tools—1-2-3-4-5," January (except May) to June, 1911; "Internal Cutting Tools—1-2-3," September to November, 1910; "Designing Screw Machine Tools and Cams," August, 1910; "Threading Operations—1-2," June to July, 1910; "Circular Form and Cut-off Tools—1-2," March to April, 1910; "Knurls and Knurling Operations—1-2," June to July, 1909, engineering edition.

LETTERS ON PRACTICAL SUBJECTS

We pay only for articles published exclusively in MACHINERY.

A THREE-SPINDLE DRILLING ATTACHMENT

As the demand for the product of a manufacturing concern increases, new tools must be designed to increase the output. The company with which I am employed makes a large number of cast-brass rings of different diameters and thicknesses.

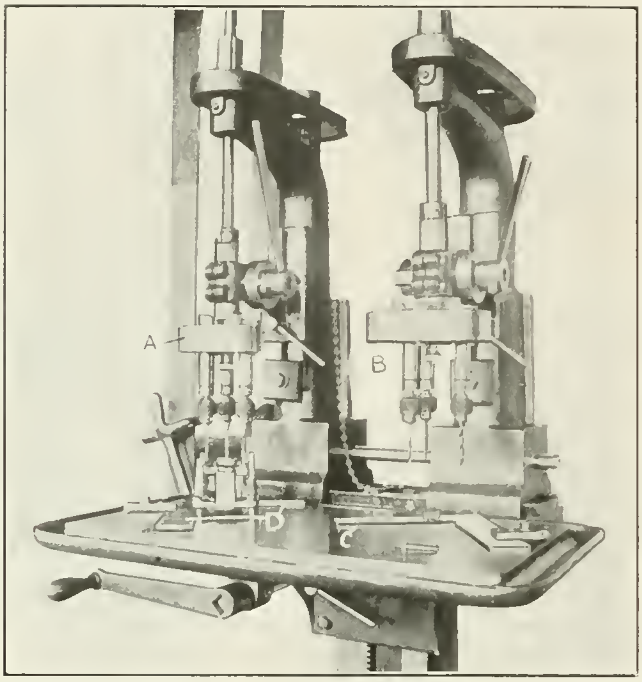


Fig. 1. Drill Press equipped with Two Three-spindle Drilling Attachments

These are attached to plates with three fillister-head screws. The three-spindle drilling attachments, shown in Fig. 1, were made by the writer to drill the three holes in these plates and the three tapped holes in the sides of the brass rings. The diameter of the hole circle is larger on one side of the ring than on the other, thus requiring two drilling attachments.

Fig. 1 shows a drill press equipped with the two attachments *A* and *B*, and also the right-angle plates *C* and *D*, made from 3/16-inch steel, which are clamped to the table to locate the bushings in the drill jig quickly in line with the drills. The attachment *A* will drill three equally spaced holes in any circle from 2 5/8 inches in diameter up to and including 4 7/16 inches in diameter, while the attachment *B* will handle hole circles varying from 3 3/16 inches up to and including 5 1/2 inches in diameter.

At *A* in Fig. 2 is shown a view of one of these attachments looking directly at the chucks, and by close inspection it will be seen that teeth are cut on part of the circumference of the spindle members. There are 24 teeth, 24 pitch, cut in each spindle member in such a position that when the central knob *B* is revolved, the spindles are moved in toward the center of the attachment. The chuck spindle gear has 15 teeth and just clears the driving gear having 53 teeth, which is fastened to the drill press spindle. The arrangement of the gears can be seen at *C* in Fig. 2, and also in Fig. 3. All gears are cut 24 pitch.

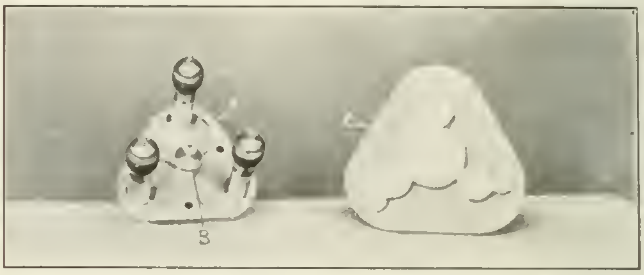


Fig. 2. Views looking directly on the Chuck and Gears

The feed or spindle quills were removed from the drill press, and a special type attached to the fixture as shown at *A* in Fig. 3; then the two drilling attachments *A* and *B* shown in Fig. 1 were put in place, making the machine a permanent multi-spindle drill press. The attachments are made of steel except the quill *A*, Fig. 3, which is made of brass; provision is made to save the expensive parts from excessive wear by making the bushings in the chuck spindle member and the intermediate gear of phosphor-bronze. The ¾-inch cap-screws *B* pass through the two plates *C* and *D* and the ½-inch steel bushings *E*, which are located between the plates. The cap-screws are also fastened into the three projections on the quill *A*, thus holding the three members firmly together.

To change the position of the spindles the three hexagon blind nuts *F* are loosened, and the central knob *G* is turned

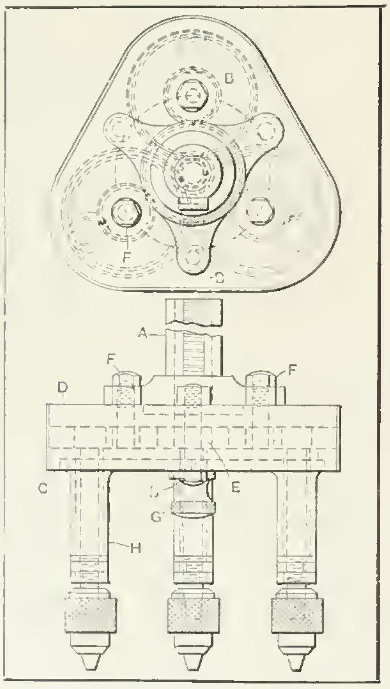


Fig. 3. Elevation and Plan Views of the Three-spindle Drilling Attachment

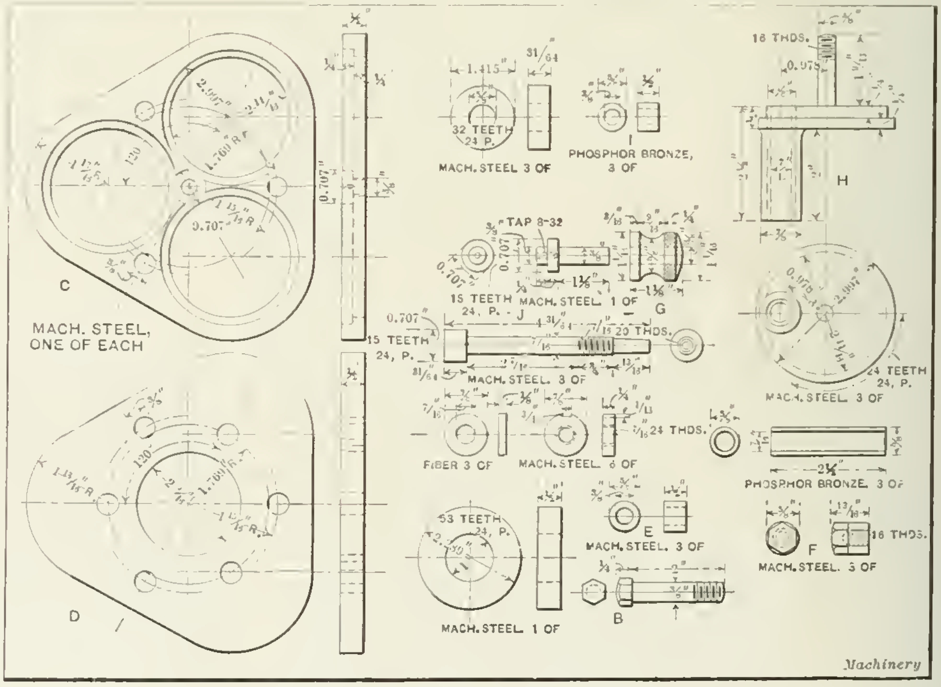


Fig. 4. Details of Three-spindle Drilling Attachment

in the required direction, moving the spindles *H* to the proper diameter, so that the drills will line up with the bushings in the drill jig. When the nuts *F* are tightened, the spindle member is drawn up against a shoulder in the bottom plate *C*, and the phosphor-bronze bushings *I*, see Fig. 4, in the intermediate gear are drawn up against the top-plate *D*, thereby locking each spindle firmly.

The details of this three-spindle drilling attachment are shown in Fig. 4, similar parts in Figs. 3 and 4 bearing the same reference letters. The central knob *G* is forced onto the $\frac{3}{8}$-inch end of the stud *J* after the teeth are cut, and is held in place in the bottom of the plate *C* by a tight fitting screw and washer, which projects into a recess turned in the driving gear on the main spindle. The construction of the other parts are clearly indicated in Fig. 4 so that further references are not necessary.

The fact that three of these drilling attachments have been made speaks well for their efficiency. Besides using these attachments for drilling three holes they are also used for drilling two holes where the distance between centers or the distance across the chord with a 6-inch hole circle comes within the range of the attachments. The capacity of the chucks is from the smallest size drill up to and including a No. 1 drill. The spindles rotate at 1400 R.P.M., and provision is made for oiling the spindles by drilling oil holes in the top plate *D* and tapping it for flat-head screws. Oil grooves are also cut in the drilling spindles, so they are furnished at all times with a copious supply of lubricant. The gears also are well lubricated.

Dorchester, Mass. ALBERT C. SAWYER

TWISTING IRON ON THE BULLDOZER

When it is desired to twist one or both ends of a rectangular bar which is considerably wider than it is thick, the twisting can be done on a bulldozer without the aid of any complicated mechanism. The twisting device may also be used in connection with a former, for bending the bar in the direction of its greatest width. The method employed is illustrated in Fig. 1.

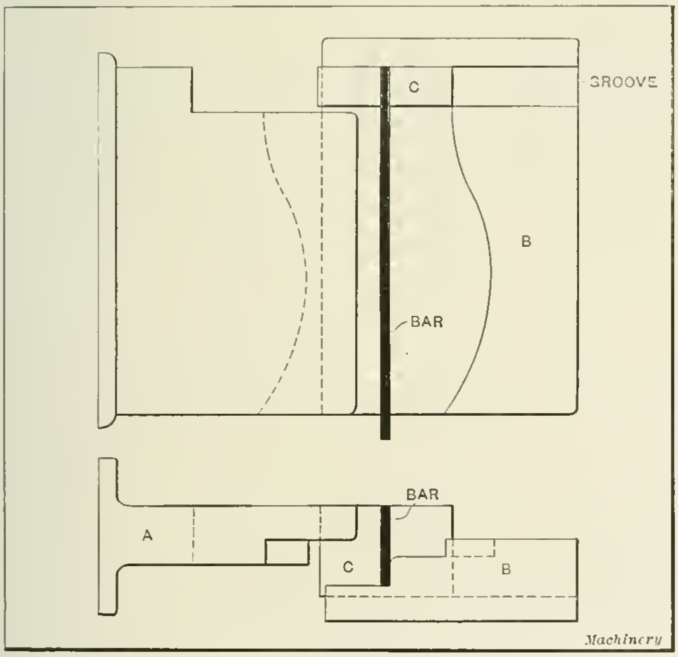


Fig. 1. Formers for Twisting Iron on the Bulldozer

The casting *A* is attached to the crosshead of a bulldozer, and corresponds to the movable die in the ordinary former, while the casting *B* corresponds to the stationary die. It will be seen that if the bar, which is shown standing on edge, is firmly held in this position at one end, it will be twisted when the dies come together. To hold the end of the bar in position, a block *C* is used, provided with a slot to fit the bar. It is evident that this block *C* must move forward with the movable die; otherwise the bar would be distorted at the point of the bend. This is easily done by cutting a groove in the stationary die, into which the block will slide. The curved lines on the formers represent the shape to which the bar is to be bent.

In Fig. 2 is shown some of the work which may be accomplished by formers of this kind. *C* shows a bar which is both twisted and bent, and *B* shows a bar twisted at both ends. Should it be desired to bring the twisted end on either side of the center of the straight portion of the bar, and have the flat surfaces at right angles to each other, as shown at *A* and *D*, this is easily done by lengthening or shortening the projection on the movable die, which bears against the block.

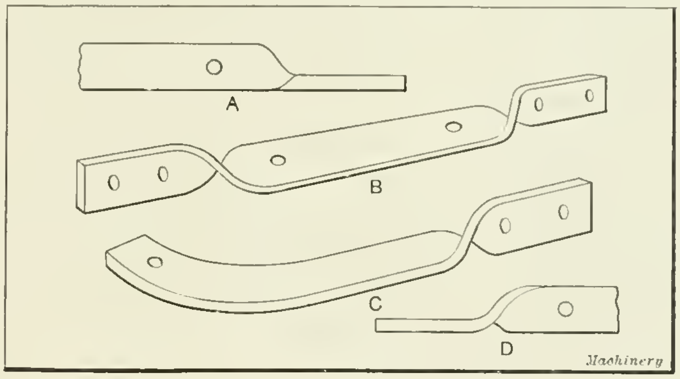


Fig. 2. Examples of Twisted Iron Bars

By the additional provision of a link connecting the block *C* to the movable die *A*, Fig. 1, the block can be brought back to the first position with the backward stroke of the machine. If the block is short, it will be necessary to use a guide or some other means of preventing it from tipping up as the bar twists.

W. L. B.

DIAGRAM OF EFFICIENCIES OF WORMS AND SCREWS

The accompanying diagram shows at a glance the percentage of efficiency of worms and screws when the ratio between the lead of the screw or worm thread and the pitch diameter is known. The inexperienced designer is apt to overlook the question of efficiency, but unless this is considered, it is possible that an apparently ample leverage will be so reduced by the inefficiency of the screw that hand adjustment will be difficult or power adjustment subject to severe wear. The diagram given is similar to one published in a book entitled "Worm and Spiral Gearing," by Frederick A. Halsey, but is easier to apply on account of the introduction of the factor of the ratio of lead to pitch diameter in place of the angle of the thread.

It will be seen that two curves are given, one for the efficiency of the worm alone and one for the efficiency of worm and step. The first curve is used in cases where the end thrust is taken by a ball bearing, while the second curve is used when the end thrust is taken by an ordinary washer, causing friction at the end of the worm. The formulas upon which these curves are based are as follows:

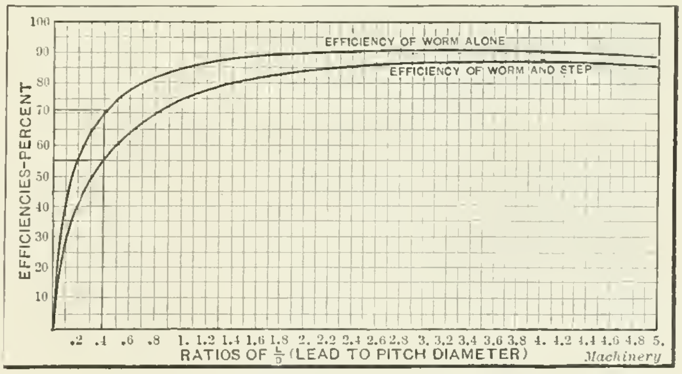


Diagram of Efficiencies of Worms and Screws

$$\text{Efficiency of worm alone} = \frac{\tan a\,(1 - f\tan a)}{\tan a + f}$$

$$\text{Efficiency of worm and step} = \frac{\tan\alpha\,(1 - f\tan\alpha)}{\tan\alpha + 2f}$$

In these formulas α = angle of thread.

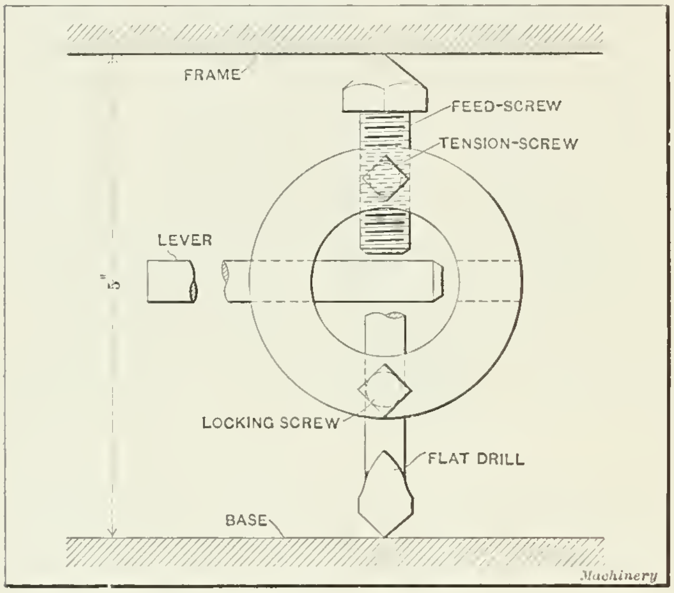
f = coefficient of friction, assumed as equal to 0.05.

As an example of the use of the diagram, find the efficiency of a worm with ½-inch lead, single thread, and 1¼-pitch diameter; the ratio of lead to pitch diameter is $0.5 \div 1.25 = 0.4$. From the curves we find that the efficiency is 71 per cent for the worm alone, and 55 per cent for the worm and step.

Scottdale, Pa. F. D. Buffum

AN IMPROVISED DRILL AND FEED

It was at one time necessary to drill two 1/2-inch holes in the base of a machine where there was only 5 inches of space available, as shown in the accompanying illustration. Our shortest ratchet drill was 7 inches over all, so that it could not be used. The job was in a hurry, so the man doing it picked up an old collar, drilled a few holes in it, arranged the two set-screws as shown, the lower one bearing against a flat spot on the drill, and the upper one screwed against a copper plug and the feed-screw. The latter set-screw provided a tension to prevent the screw from feeding too fast. A piece of 7/16-inch iron was then applied as a lever to turn the drilling device, and a wrench was used to work the feed-screw, which was a common set-screw with the head ground to a sharp point.



An Improvised Drill and Feed

Newark, N. J. H. E. Wood

[The tension-screw was unnecessary if the feed-screw was properly pointed on the outer end. The resistance to turning of the screw in its nut, under ordinary conditions, is always greater than that of a pivot of smaller mean diameter when both are carrying the same load.—Editor.]

STRAIGHTENING SHAFTING

There is one operation in machine shop practice to which even the best mechanics look forward with dread, *i. e.*, straightening a screw or shaft. This is due largely to the lack of understanding of the principles of straightening on the part of the majority of mechanics. While some shafts require more time to straighten than others, the operation becomes comparatively simple if approached with the proper understanding and appliances.

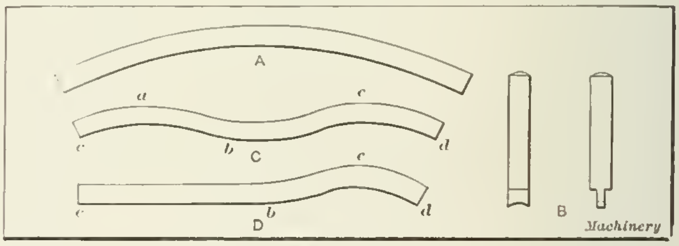
Every shop worthy of the name should have some good straightening devices. These, as a rule, can be made cheaply and are so simple that they need not be discussed. If nothing else is at hand an I-beam, a couple of V-blocks and a jack-screw serve the purpose, and these are especially good for straightening long shafting. A shaft becomes bent through various causes, *e. g.*, it may be strained beyond its elastic limit, as when overloaded; or it may be subjected to too much heat, causing unequal internal strains, as when taking a cut over a piece of rough iron or steel, or when keyseating a shaft especially when it is made from commercial cold-rolled steel.

By referring to the accompanying illustration it will be seen that the shaft which is shown at *A* has a single bend and is considerably longer on the top side than on the bottom. In order to produce this effect the fibers on one side were stretched and those on the other, compressed. Now to bring the shaft back to its normal state, this condition of the fibers must be reversed.

If through some accident a shaft is strained beyond its elastic limit it should never be used for the same purpose even though it be made to run practically true, unless the load is not excessive in proportion to its size. A shaft once distorted will never have the same resisting qualities that it had before the accident. Shafts running at a high rate of speed having keyways cut between the journals, even though splined on both sides, give trouble on account of the vibration caused by the shaft being out of balance. This can be avoided either by designing the shaft stronger than necessary, to give it additional stiffness, or by cutting a slot in each side one-half the proper width for that size of shaft. For instance, a ½-inch keyway being standard for a 2-inch shaft, cut a ¼-inch slot on each side of the shaft in diametrically opposite positions. This leaves the shaft strong and easy to straighten.

Shafts which have to withstand suddenly applied loads, such as the crankshaft of a gasoline engine, can be made to hold the flywheel so that it will not loosen by making the keyway wider than the standard width and having the key a good fit sideways. Crankshafts turned by the ordinary method in the lathe will invariably be found to spring slightly. This is caused by clamping too tightly the screw that is placed between the arms when turning the journals, so that when the screw is removed, the arms spring in, causing the shaft to bend. To remedy this, place a small jack-screw between the arms and by repeated trials, applying a little more pressure each time, spring the arms outward until the journals run true.

Shafting, arbors, lead-screws, etc., are straightened in three different ways. First by means of hammer blows, second, by steady pressure, and, third, by peening. To straighten a shaft by the first method support it upon its ends or between the ends, as the case may be, and strike it with a hand hammer or sledge, depending on the size of the shaft, upon the high or tension side. This forces the long side inward and the short side outward. The second method consists in supporting the shaft near its ends or between centers in the lathe (this is not good for the lathe) and applying pressure upon the high side by means of a lever or screw. The third method is a combination of the first and second and consists in stretching the low or compression side by tapping with a hammer at the same time that pressure is applied to the high side.



Methods of Straightening Shafting

At *B* in the accompanying illustration is shown a tool for straightening shafting having a square thread cut on it. This tool can be made from an old chisel and will not mar the threads. It is placed between the threads, and while pressure is being applied underneath the shaft, the top of the tool is struck with a hammer. A shaft which is badly bent should be heated and straightened as true as possible. If worked when cold, the shaft will crystallize and break easily.

To straighten the shaft shown at *C*, center each end true, or, if it is too long to go between the centers of the lathe, rest each end upon V-blocks. Now rotate the shaft, and with a piece of chalk find the high spots which would be at *a* and *c*. If the shaft is rough and not very large, it can be quickly straightened by placing it upon an anvil or hollow block and striking the high spots with a hammer. If the shaft is finished—having a smooth surface—commence at one end, the left-hand end, for example, and work towards the other end. To proceed, fasten end *e* and part *b* with the high side down, apply pressure at *a* and tap the opposite or low side with a hammer, care being taken to use some soft metal, such as sheet copper on both sides to prevent bruising the shaft. A point which should not be overlooked is this: While straightening a shaft by any of the methods given, the pressure or blows should be gradually increased. If it is found upon trial that the shaft is still sprung in the place where the pressure has been applied, the pressure has not been enough. If unfamiliar with the kind of steel, use very little pressure at the first trial.

If the part of the shaft between *e* and *b* shown at *C* is straight, as shown at *D*, fasten the shaft at *b* and *d* with the side *c* down, and apply pressure at *c*, proceeding in the same manner as before described until that part is straight. If the shaft is made from cold-rolled steel or common machine steel, it will be found that some of the bend has returned in the other end of the shaft previously straightened. In this case go over the shaft from the right-hand end in the same manner, and with a little patience and judgment it will be found that what was at first considered drudgery will become an interesting task. John W. Brandle

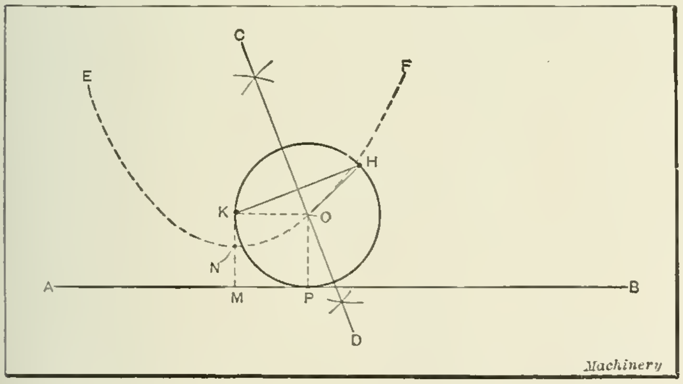
Nashville, Tenn.

A GEOMETRICAL PROBLEM

The following geometrical problem and its solution will probably be of considerable interest to the readers of Machinery. If this problem were given unaccompanied by its solution, it is probable that many good mathematicians would spend some time trying to obtain a solution. As far as the writer knows, this problem and its solution are original with him.

Given a straight line *AB* and any two points without it, but on the same side of it, as *K* and *H*. Required a circle passing through *K* and *H* and tangent to *AB*.

Draw *KH*, and bisect it by line *CD;* then the center of the required circle will be somewhere on line *CD*. From *K* draw a line *KM* perpendicular to *AB*; bisect line *KM* as at *N*. With *K* as the focus and *A B* as the directrix, construct a parabola *ENF*. The point where the parabola intersects line *CD* is the center of the required circle.



An Interesting Geometrical Problem

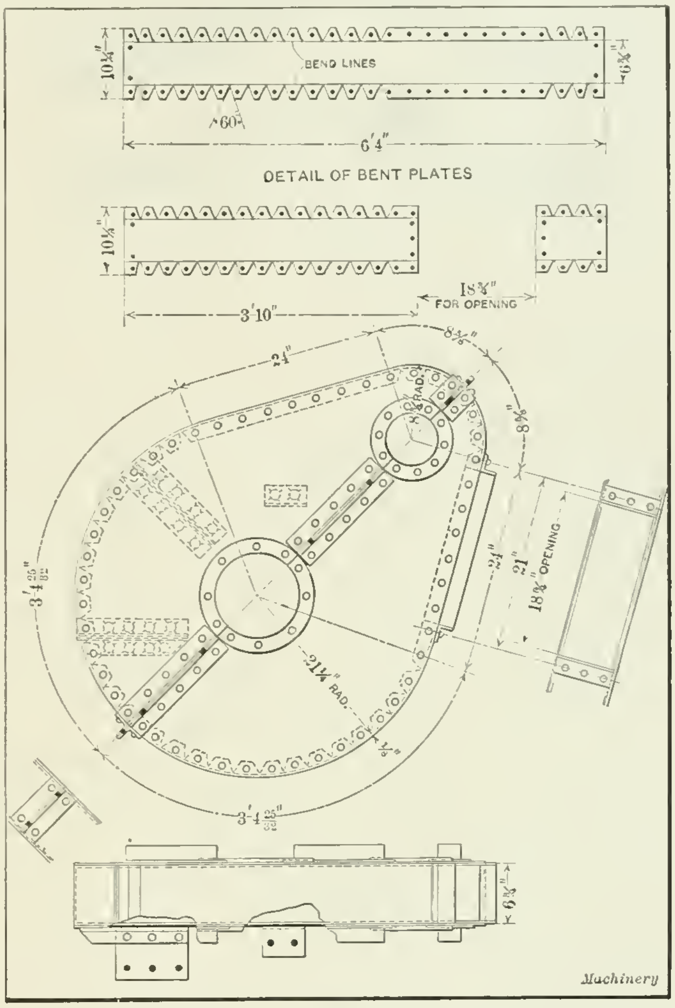
The proof is very simple. In any parabola, any point on its curve is always at an equal distance from its focus and its directrix, hence, $KO = OP$; but *KO* also equals *HO*; hence *O* is the center of a circle which satisfies the given conditions.

Chicago, Ill. C. W. Hinman

SHEET-STEEL GEAR CASES

All gears should be provided with cases that will permit them to run in a bath of oil or grease. We provide carefully for oiling all bearings, slides, etc. Why should we then expect gears to run with haphazard lubrication? A gear case prevents spattering and waste of the lubricant, and it deadens the noise. It also keeps dust out of the teeth, and most important of all, it prevents accidents more efficiently than any guard which does not entirely encase the gears. The day is rapidly approaching when the unguarded or unencased gear will be a thing of the past, and purchasers of machinery ought always to specify gear cases when ordering new machines. It will save money in the end, in addition to all the other benefits mentioned.

The gear case construction shown in the accompanying engraving may be of interest. The rigidity of such cases is surprising and their cost is very small; moreover, they weigh but a small fraction of what a cast-iron case would weigh in any given instance. If they are bent, they can be easily repaired, and they are hardly liable to any more serious injury. The accompanying engraving shows the construction of the gear case somewhat in detail, but an ordinary sheet metal worker has made at least one hundred of these gear cases, nearly all of different sizes, with no information except the sizes of the gears and shafts. The case should fit over the hub of the gear, or over the box, instead of over the shaft, wherever this is possible. A large hand-hole is always a convenience, and there should be an inch or so of clearance between the teeth and the cases in the radial direction. Even in cramped quarters, inside clearance is sometimes of more importance than clearance on the outside, and it leaves room for various articles that might fall into the case and prevents them from being picked up by the teeth. There is no comparison in cost between the construction shown and one with bent corner angles. There is no trouble about making this case tight enough to hold grease or heavy oils.



General Design of a Sheet-steel Gear Case

Scottdale, Pa. F. D. Buffum

[The opening in the case should, of course, be in an upper side and not in a lower side, as erroneously shown in the engraving.—Editor.]

COMBINATION BENDING AND TWISTING DIE

Fig. 1 shows a latch for a go-cart which was formed and twisted in the die shown in Fig. 2. This latch is first cut off and formed to the shape shown at *A* in Fig. 1, after which it is placed in the die shown in Fig. 2, and bent and twisted to the final shape shown at *B*.

The lower bending die *A*, Fig. 2, is held in a cast-iron base *B*, and pins *C*, driven into the former, extend down through the base and come in contact with a pressure plate *D* operated by a rubber pad *E*. The top forming die *F* is held by screws and dowels, as shown, to the holder *G*, which has a shank to fit the hole in the ram of the press. This holder *G* is lined up with the base *B* by standards *H*, and holds two pins *I* which operate the lower twisting dies *J* and *K*. The twisting dies *J* and *K* correspond in shape to the dies *L* and *M*, which are provided with shanks and are held in the holder *G* by screws and dowels.

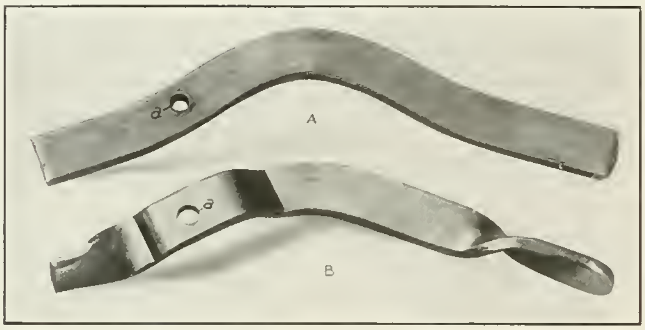


Fig. 1. The Go-cart Latch before and after Bending and Twisting

The lower twisting dies *J* and *K* are given a slight upward movement by means of the pins *I*, which come in contact on the downward stroke of the ram with fulcrumed levers *N* held on pins *O*. These fulcrumed levers are connected to the twisting dies by pins, as shown more clearly in Fig. 3, where the operation of the twisting dies *K* and *M* is illustrated.

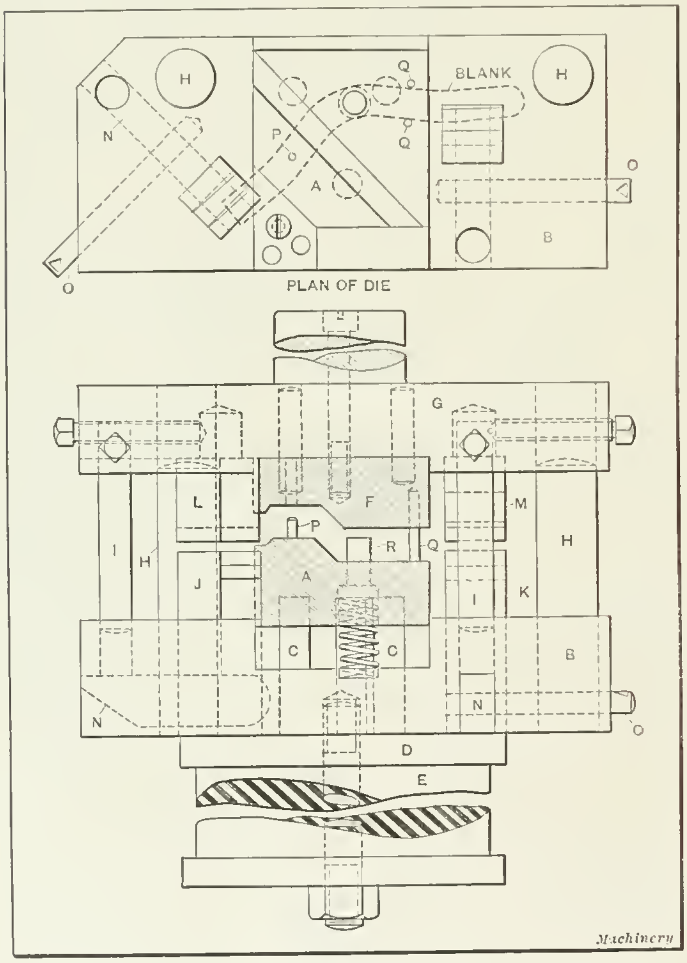


Fig. 2. Elevation and Plan Views of the Combination Bending and Twisting Die

In operation, the blank shown at *A* in Fig. 1 is placed on the lower die *A*, Fig. 2, the hole *a* fitting on the pin *P* and the blank being located between the pins *Q*. A spring plunger *R*, operated as shown in Fig. 2, prevents the blank from dropping down, holding it flush with the highest surface of the lower forming die. As the ram of the press descends, the upper former forces the blank down, bending it to the shape shown at *B* in Fig. 1, and as the ram still continues in its downward movement, the pins *I* operate the lower twisting dies through the levers *N*. The combined action of the upper and lower twisting dies forms both ends of the blank to the shape shown at *B* in Fig. 1. The lower die *A*, while the twisting operation is taking place, has been forced down to the lowest point of its travel, compressing the rubber pad *E*, which returns it to its former position when the ram of the press ascends.

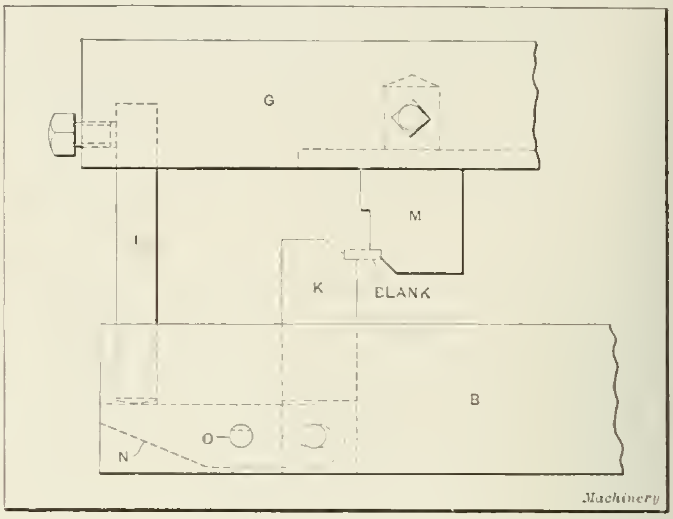


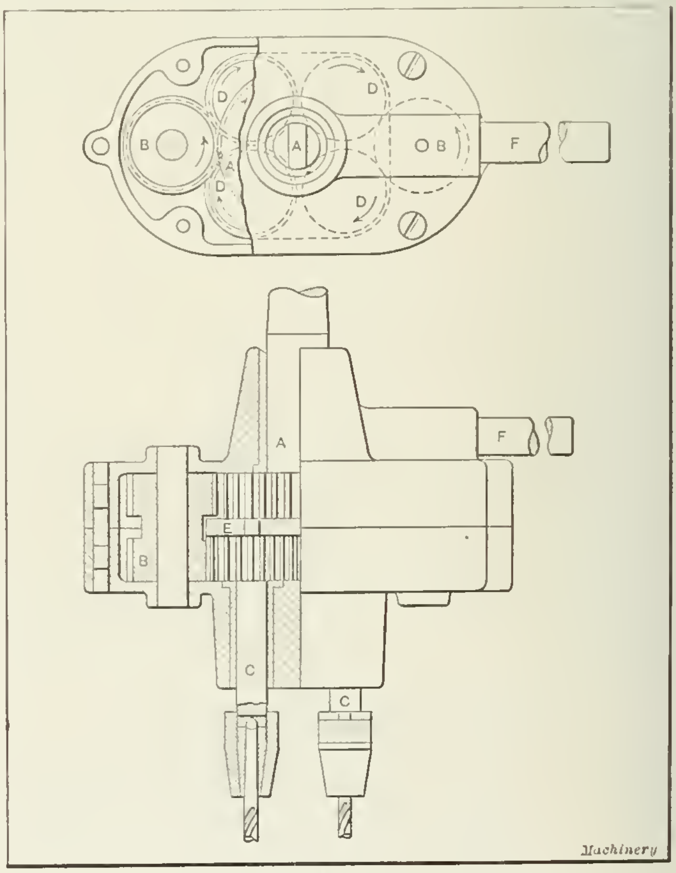
Fig. 3. Part View showing how the Twisting Dies K and M are operated

F. W. Jonas

Sturgis, Mich.

A FOUR-SPINDLE DRILLING HEAD

Having a large number of pieces to drill, each with four 3/16-inch holes, spaced 1 1/2 inch apart on a square, we designed this fixture to drill the four holes simultaneously. On account of the small space between the gears, and to avoid the necessity of making special left-hand drills, the arrangement of the gears shown in the accompanying illustration was adopted. The driving gear and shank *A* are made in one piece, and the intermediate gears *B* drive the four spindles *C* through the gears *D*. The thrust of the four spindles is taken by a bronze plate *E*, and the intermediate gears *B* are cut out to clear this plate. The whole mechanism is enclosed



A Four-spindle Drilling Head of Compact Design in two cast-iron covers, and is prevented from turning by the handle *F* which comes in contact with the column of the drill press. The intermediate gears *B* run on pins which are driven into one side of the case, and all of the spindles are provided with bronze bushings.

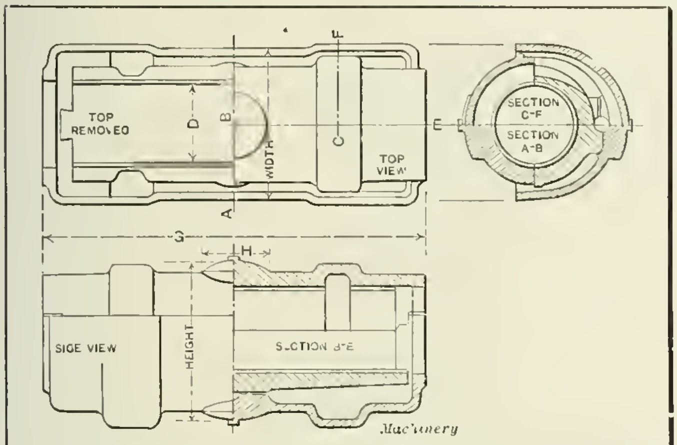
Stamford, Conn. KINGSTON FORBES

RING OR CHAIN OILING SELF-ALIGNING BEARINGS

The illustration shows side, plan and section views of a ring- or chain-oiling self-aligning box that I designed in eighteen standard sizes for 1 3/16-inch to 5 15/16-inch diameter shafts.

The table gives the length of bearing, length over-all, approximate weight complete, diameter of the spherical part *H*

RING OR CHAIN OILING BOXES



Size of shaft D	1 3/16	1 7/16	1 11/16	1 15/16	2 3/16	2 7/16	2 11/16	2 15/16	3 3/16
Length of bearing	6	6	7	8	9	10	11	12	13
Length over-all, G	8	8	9 1/4	10	11 1/4	12 1/4	13 1/4	14 1/4	15 1/2
Height	4	4 1/8	4 3/8	4 7/8	5 1/8	5 3/8	5 5/8	5 3/4	6 3/8
Width	3	3 1/4	3 1/2	3 7/8	4 1/8	4 1/2	4 7/8	5 1/4	5 7/8
Approx. wt., lbs.	11	12	14	20	22	26	30	36	48
Dia. of boss, H	1 1/2	1 3/4	1 3/4	2	2	2 1/4	2 1/2	2 1/2	3
Thickness of babbitt	5/32	5/32	5/32	5/32	3/16	3/16	3/16	3/16	3/16
Size of shaft D	3 7/16	3 11/16	3 15/16	4 3/16	4 7/16	4 11/16	4 15/16	5 7/16	5 15/16
Length of bearing	14	15	16	17	18	19	20	22	24
Length over all, G	16 3/8	17 1/2	18 1/2	20	20 1/2	22	23 1/2	25	27 1/2
Height	6 5/8	7 1/8	7 1/2	7 3/4	8	8 1/4	8 5/8	9	9 3/8
Width	6 1/8	6 1/2	6 3/4	7	7 1/4	7 5/8	8	8 1/4	8 3/4
Approx. wt., lbs.	60	65	70	75	78	86	95	105	120
Dia. of boss, H	3	3 1/4	3 1/4	3 1/4	3 1/4	3 1/2	3 1/2	3 1/2	3 1/2
Thickness of babbitt	3/16	3/16	3/16	3/16	1/4	1/4	1/4	1/4	1/4

and other data necessary for the patternmaker and machinist.

The advantages of the ring-oiling self-aligning type of bearing should commend it to every designer of machinery, and I hope that these standard sizes may be of as much use to others as they have been to my friends and myself.

San Antonio, Texas. A. W. WINTERBORNE

NEAT'S-FOOT OIL AS A CUTTING LUBRICANT

Some time ago we had a lot of small iron nuts to tap. This job was done by boys in a lathe using taps about 5 inches long made from drill rod. Considerable trouble was experienced with the taps' breaking, and as an experiment we tried neat's-foot oil as a cutting lubricant. This ended the breakage of taps and they lasted until worn out. Since then we have used neat's-foot oil in the threading and difficult forming of steel, and it has always given good results.

We are now broaching soft steel pieces, and using this oil as a lubricant with success. The holes being broached are enclosed on three sides, the fourth side being open. This work has always given trouble because of the seizing of the broach which necessitated sawing the piece in two in order to remove the broach. Since using this oil we have not spoiled a piece, and the holes are smooth and correct to size. While a great many know that neat's-foot oil makes a good, if not the best, belt dressing, I have not met anyone who used it as a cutting oil.

New Haven, Conn. FRANK K. LOVELAND

PHYSICAL HEALTH AND DRAFTING

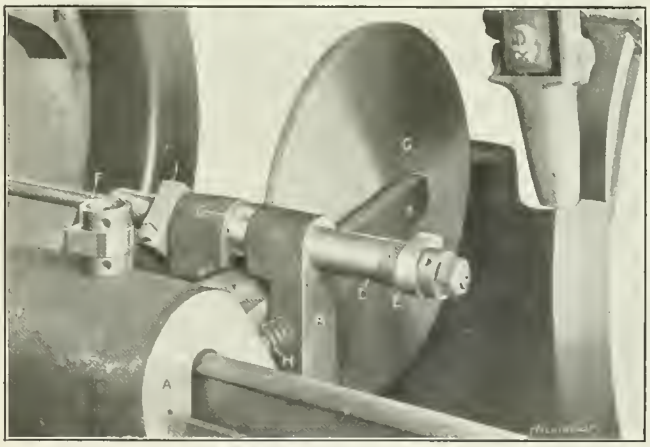
The question of physical health is of prime importance to draftsmen, and it has been freely discussed of late, but it still remains open. We do not all agree with L. R. W. A., in the November number of MACHINERY, in his denunciation of the "apron" type of draftsmen. It is practically, if not absolutely, impossible to avoid pressure on the abdomen in working. You must "get there" and produce, and the only way to reach the top of the board one moment and the bottom the next, is to use the body. There are, of course, extremes in this as in all other cases. I call to mind one "knight" of the board who used his abdomen as a pivot, (he was possessed of a fair-sized bay window) to enable him to roll to the top of the board. This "feat" in time will produce disastrous results—indigestion and its companion ailments. A moderate use of this part of the body, however, can have no very bad effects. If it were possible to avoid this altogether, why does not the instructor show the pupil the "only correct position" to assume when drawing? In teaching penmanship, stress is laid on the importance of proper posture, and why not in drafting? That is the time to correct the evil if it exists, as life-long habits are hard to break.

Exercise seems to me to be the one important factor in a draftsman's health. He needs something to take the kinks out of his system which are acquired in the "daily grind." A few simple bending and breathing exercises practiced morning and night will work wonders. Ventilation is also important. A stuffy steam-heated room is more of a health destroyer than anything else. Right here arises a difficulty: A opens a window and B growls, "Shut that window! Were you brought up in a barn?" That is human nature, but a draftsman should get all the fresh air he possibly can. It seems that a little more attention paid to details would eliminate all of this "slow death" idea and make drafting an attractive proposition, as it should be.

New Britain, Conn. J. M. HENRY

A CAM GRINDING FIXTURE

The accompanying illustration shows a cam grinding fixture applied to a Norton plain grinder. The base *A* of the fixture is clamped to the bed of the grinder, and carries a rocker arm *B*, which is hinged to it. The master cam *C* is keyed to the shaft *D* on which the cam *E* to be ground is held. This shaft is revolved by a flexible coupling *F* driven from the regular driving mechanism, and is held against the center in the grinding head by a spring located in the shaft. The master cam *C*, when revolved, is kept in contact, by springs *H*, with the roller *G*, which is pivoted to the base *A*. These springs *H*, only one of which is shown, force the master cam against the roller, thus imparting an oscillating movement to the rocker arm, which controls the shape of the cam to be ground. A brake *I* is used to prevent the work from jumping away from the wheel on the relieved side of the master cam. With this attachment, which was designed and built in the apprentice department of the General Electric Co., we are able to make cams at the rate of one every ten minutes to within 0.002 inch of the master cam.



A Cam Grinding Fixture applied to a Norton Plain Grinding Machine

West Lynn, Mass. CHARLES K. TRIPP

REMARKS BY THE ONLOOKER

In reading the interesting article on ball making in the February number of MACHINERY, I recall one of my first jobs in an American shop—the finishing of a number of balls for a floating crane. I was quite proud of my achievement when after much labor the work was done. At noon some of the boys began to caliper the balls, the polish of which was of a considerably higher standard than their uniformity of size, and I suddenly began to lose my pride; in fact, what little remained after they were all calipered, quite disappeared when an old Scotchman said, "Well, my lad, the first one is alike anyway." The present perfection in ball making shows what can be done in the manufacture of great numbers, with proper application of energy and thought.

For years I have had an idea in my mind of some kind of a coating to protect certain parts of a piece when being hardened. Enamelite, as described on page 482, engineering edition, meets with the requirements. Time and time again I have wished for just such a preparation, and it seems to me that it ought to sell like the well-known "hot cakes."

The new design of milling cutter shown by the National Twist Drill & Tool Co., on page 97 of the advertising section, is something that interests me a great deal. It is not an easy thing to combine solidity and simplicity in an inserted tooth milling cutter, and to me it seems that this is almost, as they say down East, "the end of the asking"—just a turned up disk, a few drilled holes, some plain milling, a few pins, and there you are.

If Mr. F. B. Jacobs' article on "Sharpening Milling Cutters" could not only be read, but also acted upon, by those that have to do with the sharpening of these tools, the output of milling machines, I believe, could be increased by 25 per cent. I recall an old man once who, when taking charge of the milling department of a shop, remarked, "Yes, they have got a lot of millers up there that hiccough and grunt the stuff off," and that, I fear, is too often a true description of the way in which milling machines are allowed to do their work.

For years, drill press tables have been weak on account of their overhang, and many a careful mechanic has blocked up the table for heavy drilling or for heavy pieces by means of a screw-jack, or by some other means if no screw-jack was available. To-day this is not often required in modern machines, as drill makers are providing a support as indicated in the Barnes drilling machine, shown on page 480, and in the Taylor & Fenn radial, shown on advertising page 184, which, by the way, is a most convenient tool, although I think it would be an improvement if a slotted tie-rod were provided from the arm to the table. This would stiffen the tool and add but little to the cost. In the Gang radial drill, advertising page 162, a support for the table is also provided, and in some makes of shapers the idea is introduced to advantage. To a very large extent, this stiffening of machine tools is called for by the heavy cuts taken by high-speed steel tools, but the added accuracy of the work produced on solid machines has also acted as an incentive for tool builders to produce something which is not only strong enough, but also "non-vibrating" enough, to produce accurate work. The Lees-Bradner Co. says that "overhanging is a vital error in design," and mechanical designers are beginning to recognize this fact to a marked degree.

To change the subject, let us talk of twist drills. Just look at the row of "maimed soldiers" on advertising page 31. Of course the number of drill presses and collets now in use, scattered all over the world, could not be thrown away or changed without great expense, but the advertisement referred to shows a way to help matters. I do not believe that all the trouble with twisted tangs is due to their actual weakness, but very largely to neglect in seeing that the slots in the collets of drill presses are in proper order. I have often asked a foreman or superintendent if he ever inspected the slots in the drill-press spindles, and have seldom been answered in the affirmative. I feel sure that if the taper is a proper fit, and the tang also, the latter will rarely twist off with regular work.

Your editorial on the "efficiency engineer" is just to the point. That expression is a slur on the engineering profession, as it intimates that an "inefficient" engineer is also a calling. In my experience, the aim of all conscientious engineers has been the production of high quality at low cost—to get all that was possible out of the plant under the existing conditions. What is that if not efficiency?

I cannot quite join you in your time-saving idea mentioned in the editorial entitled "Saving Time in Machine Work." It is safe to say that we will find, if we analyze the operation of drilling a single piece, that not over 10 per cent of the total time is actually used in cutting metal. Drawing down the lever and throwing in the feed are not operations which require much time, and it is my belief that great time saving could be accomplished in securing the work rather than in handling the machine. Often the appliances for securing work on drill presses consist of a number of bolts and straps in a box which have to be dumped on a bench or on the floor in order to find the desired bolts. Usually a trip to the store-room for missing nuts is required, unless they can be conveniently appropriated from the very carefully guarded collection of the planer hand, who is generally the autocrat of the machine shop. To cut a long story short, I believe that time saving in drill press work is in the direction of appliances to quickly get the drill to do its actual work, and not in automatic adjuncts to the press. However, the reciprocating motion in the drill press shown on page 471, is certainly a very convenient addition. We have all worked the hand-feed lever at times to cut a keyway on a drill press, and wished for just such an attachment as this.

It is perhaps not difficult to understand why a drill press has so few appliances, and why those that are provided are so poor. Most likely it is because this machine is especially everybody's tool, unless the shop is a very large one. All hands do work on it, feeling no responsibility towards it, and only considering it their duty to get the job done, and the sooner they can get away from the machine the better. Unless a man is caught "red-handed," the drill marks on the table are done at night when it is positively known that the drills play "tag," and just get into the drill-press sockets all by themselves, which, of course, accounts for the disreputable appearance of the table. This curious night behavior of tools needs scientific investigation. I have known milling cutters or special tools to be taken in perfect condition to a tool-room at night, only to be found in bad shape the next morning, and even when a broken piece is found with the work done by it, it is merely a strange coincidence.

It seems strange to me that the multiple drill makers do not provide some kind of adjustable drill guides, as it would greatly enhance the value of these tools.

In answer to D. A. H.'s question as to rejected parts, my advice would be to destroy them at once, so that they cannot be used, or else you may be tempted to make use of them to the detriment of your reputation. Just be a Pharaoh and harden your heart, but do it at once, and make it part of your system.

"Amateur," judging from his letter on page 464, certainly is in trouble. The explanation of using a lathe for fine drilling "beats" anything that I have so far seen in print, and it is somewhat on a par with the advice given in a celebrated hand-book of engineering, where the following appears: "Boring.—For brass the speed is *one-half* that for cast iron." This shows the truth of the statement of the school-boy who said, "If it wasn't for books, we wouldn't know nothin'." W. D. F.

* * *

The development of electric rock drills of the percussion type has imposed the most severe requirements on steel used for the drills and hammers, but the economy of electric installations has made the development worth while. It is claimed that the electric drill using from one-half to two horsepower will equal the work of a compressed air drill using twelve to eighteen horsepower at the compressor. The changing of line wires is simple as compared with the shifting of pipes. Countervailing disadvantages are the dangers of short circuits and sparks and the lack of the fresh air that is a feature of the exhaust of compressed air drills of some importance.

NEW MACHINERY AND TOOLS

THE COMPLETE MONTHLY RECORD OF NEW DESIGNS AND IMPROVEMENTS
IN AMERICAN METAL-WORKING MACHINERY AND TOOLS

WIGGLESWORTH BORING, DRILLING AND TAPPING MACHINE

The Western Machine Tool Works, of Holland, Mich., has recently placed on the market a boring machine especially adapted for heavy boring, drilling and tapping operations. This machine is capable of driving 4-inch drills in steel and will operate an 8-inch pipe tap in cast iron. The general features of the machine may be seen by referring to Figs. 1 and 2, of the accompanying illustrations, which show views of each side. When the machine is in operation, the spindle remains in a fixed longitudinal position with relation to the driving mechanism and spindle-head and the latter is automatically fed downward on the face of the column. The machine has nine changes of positive geared feed, ranging from 0.006 inch to 0.042 inch per revolution of the spindle, and, in addition, three positive geared "leads" for tapping eight, eleven and one-half and fourteen threads per inch. These tapping leads are independent of the feed changes and any desired lead may be obtained by means of extra change gears.

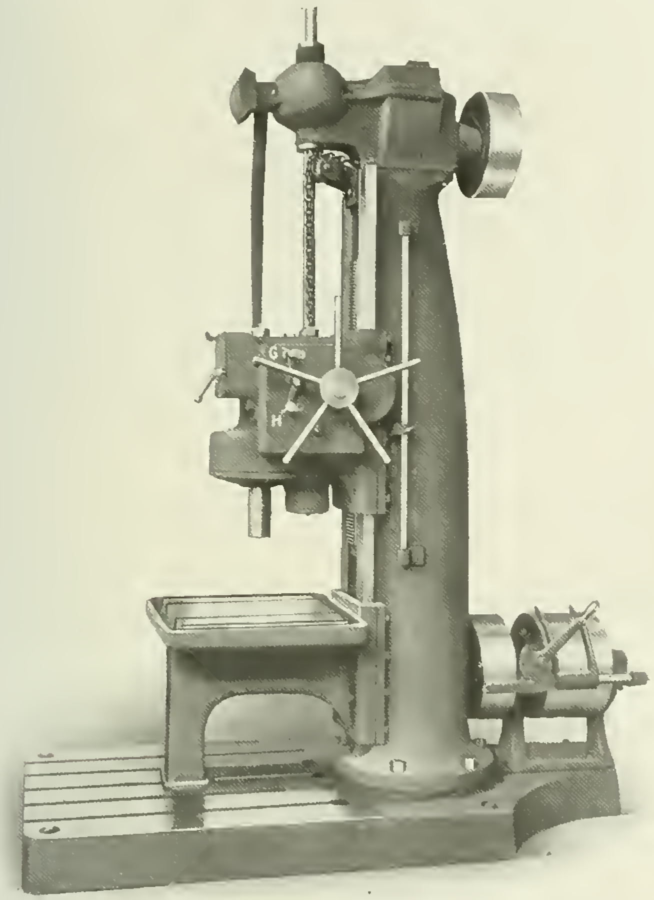


Fig. 1. Boring, Drilling and Tapping Machine, built by Western Machine Tool Works

As will be noted, a belted connection is made between the countershaft on the base and the quick-change speed gear-box on the top of the column. By means of the speed change gears, eight different spindle speeds are obtained and this number is doubled by back-gears located in the head, thus giving a total of sixteen speeds, ranging from 25 to 400 revolutions per minute. From the gear-box the power is transmitted to the spindle head through horizontal and vertical shafts connected by bevel gears. There are three of these bevel gears and a friction clutch, which form the reverse mechanism for tapping. The lever *D*, Fig. 2, for operating this friction clutch, is located conveniently on the left-hand side of the head.

The spindle is driven by a large gear in the head. This gear is located in a fixed position near the lower end of the spindle and close to the work. This arrangement reduces the torsional strain on the spindle and tends to eliminate the chattering incident to heavy cuts. The automatic down-feed to the head is derived from a spiral gear located near the upper end of the spindle, the power being transmitted through feed change gears (as explained later) and a pinion which meshes with a rack in the face of the column. With this arrangement, the feed operates in conjunction with the spindle movements.

Figs. 3 and 4 show the construction of the quick-change gear-box which is located on top of the column and governs the spindle speeds. Shaft *A* is keyed to the belt pulley and, consequently, rotates at a constant speed. A cone of four gears, *B*, is splined to shaft *A* and can be shifted longitudinally by fork *C* which slides on a fixed stud in the gear casing. To the rear of this fork there is a straight rack engaging gear *D*, which is keyed to the vertical shaft *E* so that rotating the latter shifts the cone of gears *B*. The variable speed is transmitted to shaft *F* on which is mounted a rocker arm *G* having pivots *H* and H' supporting two sets of intermediate gears *J* and J'. Gears J' are directly geared to pinion shaft *F*, whereas *J* is connected by compound gearing as shown. On the upper end of rod *E* there is a circular rack which engages corresponding teeth in the sector face of rocker arm *G*. This rod may be raised or lowered and it can also be rotated to the right or left. Any vertical movement rocks arm *G* and permits either *J* or J' to mesh with one of the gears on shaft *A*, whereas rotating *E* to the right or left shifts cone *B* on shaft *A* to bring any one of the four gears into engagement with *J* or J'. By varying the gear combinations in this way, eight spindle speeds are obtained. The vertical and rotary movements of rod *E* are effected by the two levers *B* and *C*, Fig. 2,

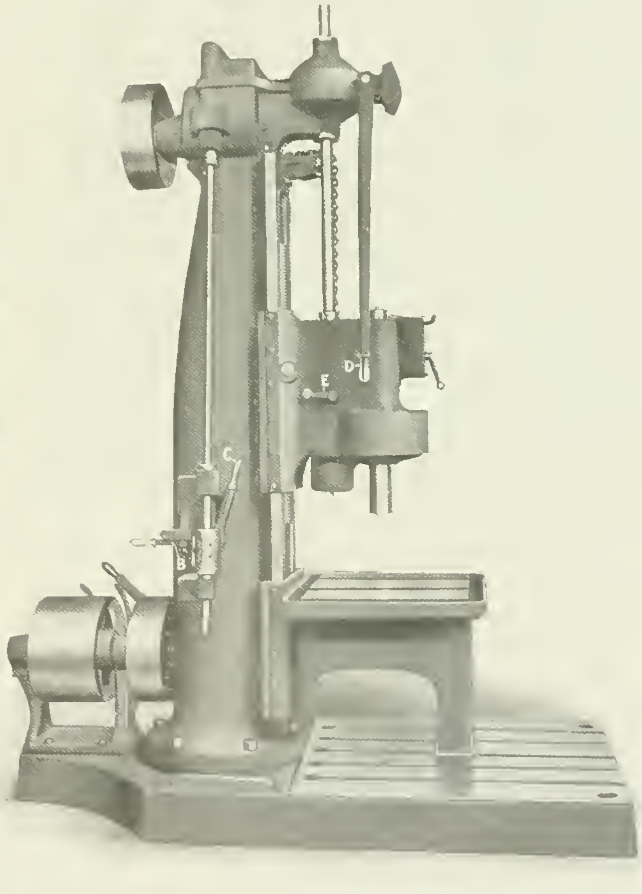


Fig. 2. Another View of Wigglesworth Boring Machine

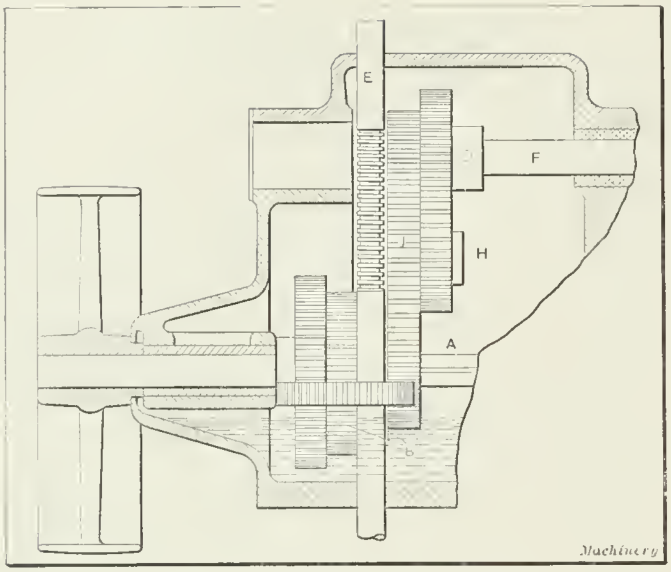


Fig. 3. Side View of Speed-changing Mechanism

which operate through the medium of a cylindrical part attached to the rod.

The method of driving the spindle either directly or through back-gears, is clearly shown in Fig. 5. The vertical shaft *P*, which receives its motion at the top of the column, carries gears *B* and *X*, and the spindle carries the mating gears *Y* and *Z*. Gear *B* is splined to shaft *P* and when in the position shown, the spindle is driven through back-gears. To obtain a direct gear drive, gear *B* is dropped down inside gear *X* (which is bored out to receive it) by means of lever *E*, Fig. 2. Gear *X* has a large hub on its lower side and on the inside of this hub a two-jaw clutch is cut. This clutch is engaged by the corresponding clutch on gear *B* when the latter is lowered, and then the drive is direct from *X* to *Z*.

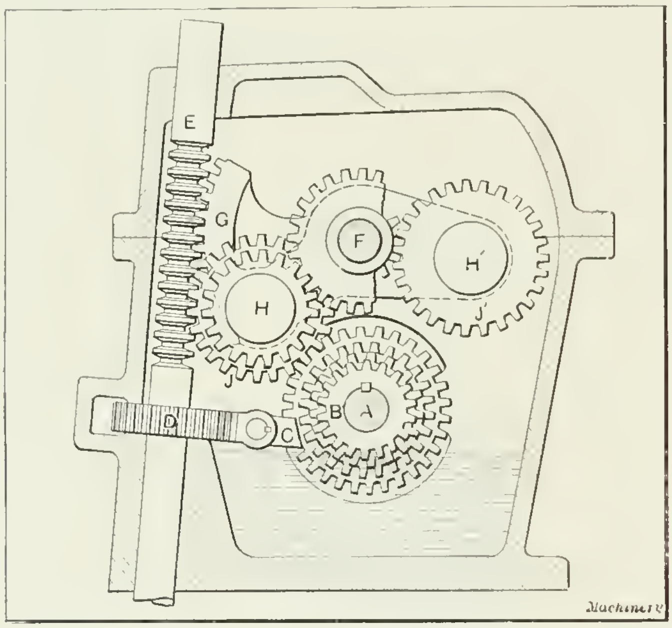


Fig. 4 End View of Speed-change Gears

The details of the positive geared feed mechanism are shown in Figs. 6, 7 and 8. The power is derived from the spindle by a spiral gear *Q* which drives shaft *C*. The latter transmits movement to shaft *D* through three spur gears located in the small box seen on the front of the head in Figs. 1 and 2. (Incidentally, the different tapping leads are obtained by replacing gear *T*, Fig. 9, with another size). Shaft *D* carries five gears as shown in Fig. 7, all of which run loose on it excepting gear *X*, which is attached by a key. The two gears to the left on *D* are locked together and any one of the three middle gears may be keyed to the shaft by a diving key mechanism. This diving key is operated by lever *G*, Figs. 1 and 8, located on the right-hand side of the head. Above the three middle gears referred to, there is a cone of mating gears *E* (Figs. 6 and 7) which run loose on their shaft and are all joined together. Shaft *F* also carries three gears and the one to the extreme right is attached by a key. Gear *Y* runs loose on the shaft and gear *Z* has a positive clutch formed on the hub and is splined to the shaft. When tapping is being done, the drive is from shafts *D* to *F* through gears *X* and *Z* and when the regular spindle feeds are desired, gear *Z* is shifted to the left (by lever *H*, Fig. 8) until its clutch engages a corresponding clutch on gear *Y*, thus locking the latter to shaft *F*. The feed movement is then transmitted from *D* to *F* either directly through gears *V* and *Y* or indirectly through the cone of gears *E*, depending on the position of the dive key. Three feed changes are obtained by shifting the dive key and, by the use of two change-gears at *T*, six

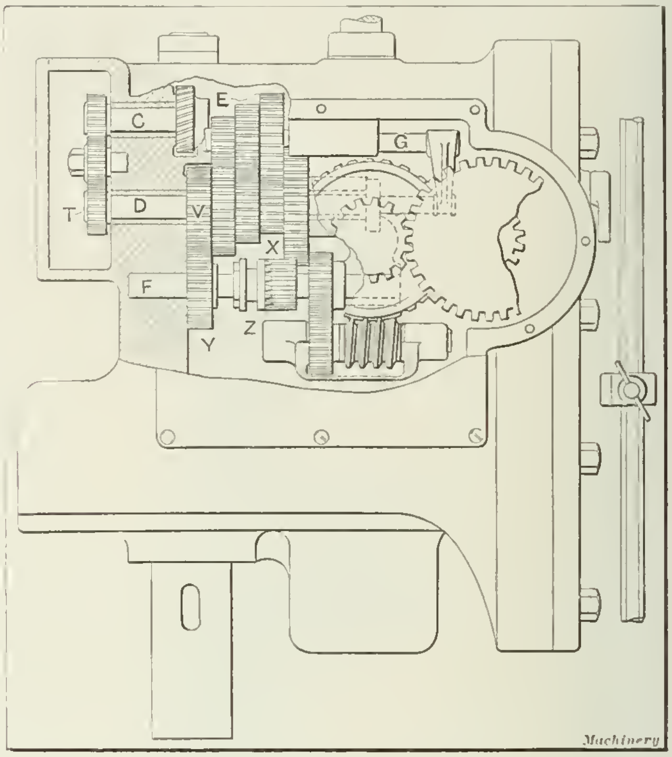
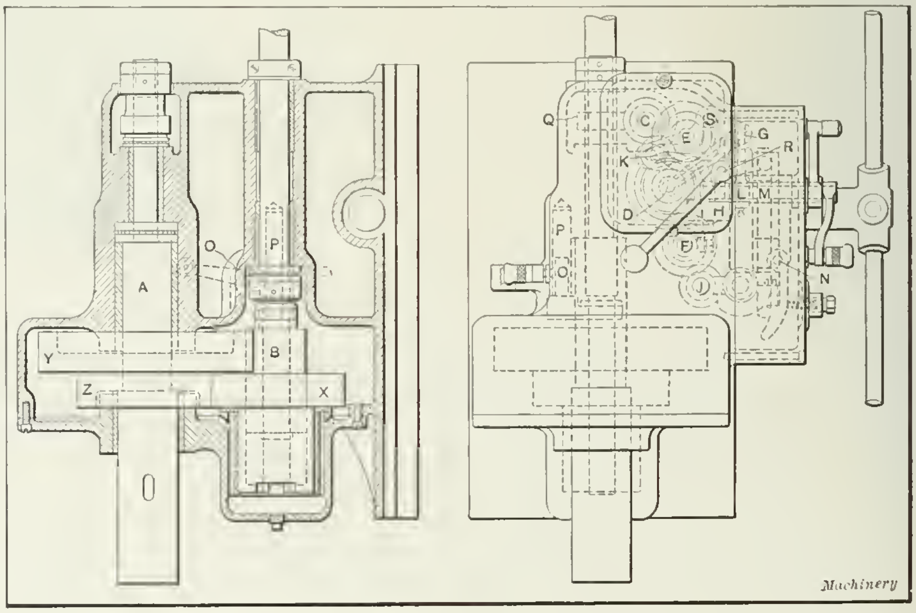


Fig. 7. The Positive Geared Feed Mechanism



Figs. 5 and 6. Spindle Driving and Feeding Mechanism additional variations are secured. From shaft *F* power is transmitted to the feeding worm by a spur gear on shaft *J*, Fig. 6. The worm is hung in a bracket pivoted around shaft *J* and it can be raised into mesh with the worm-wheel by lever *F* (see Fig. 9) on the front of the head. When the worm is in mesh, it is secured by a finger *f* (Fig. 8). The feed is transmitted from the worm-wheel through the spur gearing shown in Fig. 7, to a rack secured to the face of the column which gives the vertical movement. The power feed can be automatically tripped at any point by means of an adjustable stop *t*, Fig. 8, which engages with lever *r*, thus releasing trigger *f* and allowing the worm-wheel to drop out of mesh. The spindle-head has an automatic down-feed on the column of 40 inches, and the distance from the column face to the center of the spindle is 14½ inches.

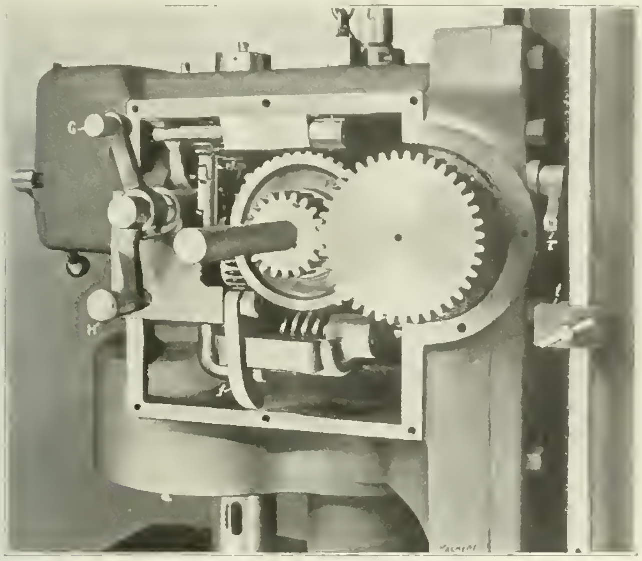


Fig. 8. Feed Box with Cover Removed

The design of this machine is compact and extremely rigid throughout. In case it should be desired to bore open-end cylinders or similar work, provision has been made for steadying the lower end of the bar, it simply being necessary to drill and bore a hole through the table into a hub on the under side and insert the necessary bushing. The lower end of the boring-bar can then be passed through this bushing which forms a rigid support.

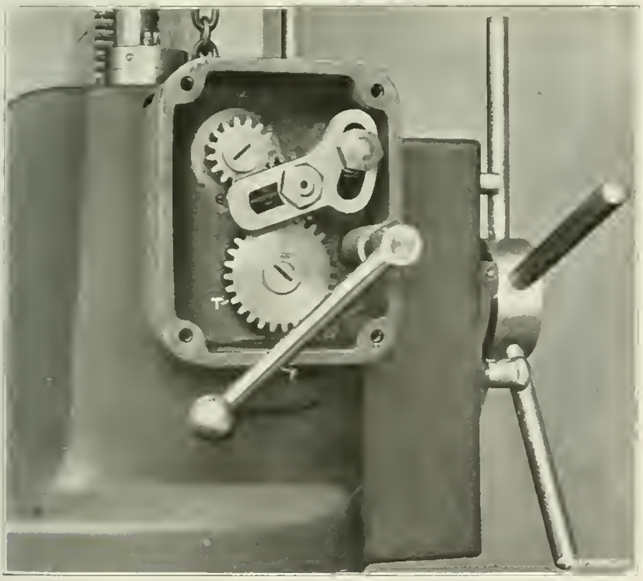


Fig. 9. Front Gear Box with Cover Removed

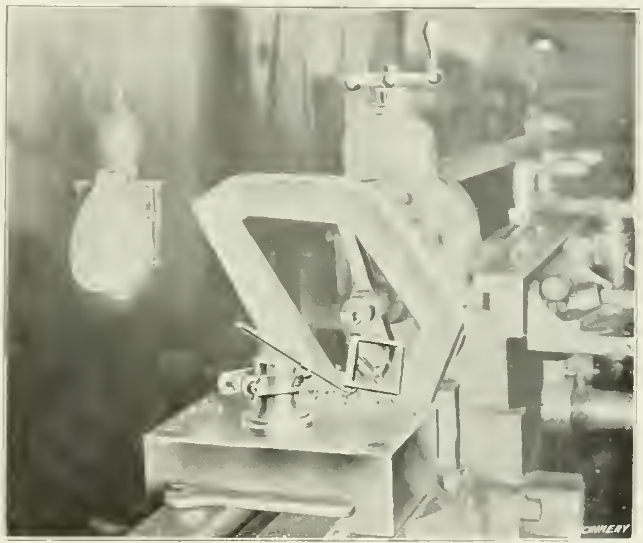
The lubrication of this machine has received careful attention. All gears in the head and quick-change box run in a bath of oil, and the head alone will hold seven gallons of lubricant. The bearings are made self-oiling by means of wicks fitted into slots milled in the bearings, the ends of the wicks dipping into oil reservoirs. The loose pulley on the countershaft also has a wick, the end of which dips into a reservoir cored out of the hub. These reservoirs hold enough oil to last for several months.

In case a motor drive is desired, the motor can be mounted on the back of the column in place of the countershaft. The weight of the machine is about 8500 pounds. It may be seen in operation at the demonstration shops of Hill, Clarke & Co., Inc., in Boston and Chicago, and in the branch offices at New York, Philadelphia, Cleveland, Milwaukee and Rochester.

UNIVERSAL CHIP GUARD

In the department of New Machinery and Tools for April, 1911, we illustrated a lathe chip guard manufactured by the Universal Stamping Co., 47 Poultney St., Buffalo, N. Y. This guard is now equipped with a stationary base block as shown in the accompanying illustration to adapt it for use on the shaper. The bottom of this block is covered with rubber, which prevents any slipping from the jar incident to the shaper's motion. Either a plain glass or a magnifying glass may be inserted in the holder. The magnifying glass not only protects the eyes of the operator but magnifies the layout lines on the work, which is often desirable, especially in connection with toolmaking.

The utility of a guard of this kind is shown by a report on the cause of shop accidents. From a total of 670 accidents in connection with lathe work, 127 were caused by flying chips, or by the flying out of articles being turned. Of course, most of these accidents were not very serious and did not result in permanent injury, but the figures show that the protection afforded by a chip guard is very much needed for certain classes of work.



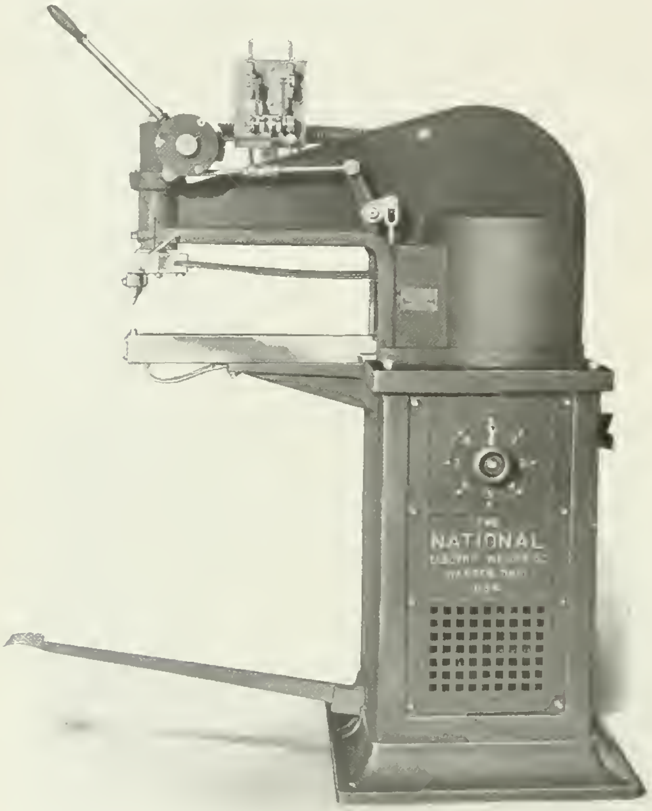
Method of using Chip Guard in Connection with Shaper Work

NATIONAL ELECTRIC SPOT WELDER

The use of the electric welding process, especially in connection with sheet metal work, is rapidly superseding the older method of riveting, in the manufacture of a great many parts. Many articles formerly made of wood are now constructed of sheet steel, which has resulted in still further increasing the use of the electric welding process. The spot welder not only gives an increased production, but a neater finish, which is an important feature in connection with many classes of work.

The electric spot welder shown herewith is a product of the National Electric Welder Co., Warren, O. This is a 24-inch size, which means that it will weld to the center of a 48-inch sheet. When this machine is equipped with points or dies not more than ⅜ inch in diameter where they bear on the work, it is said to make 1000 spot welds in 16 gage steel or iron for ten cents, with current costing four cents per kilowatt hour, or three cents per horsepower hour. An alternating current is used, and the 12- and 24-inch standard spot welders have an improved shell-type transformer of 15 kilowatt capacity, designed to reduce the line voltage to 4½ volts, which is the highest voltage required. The machine also has a regulating coil which gives eight different voltages at the welding points. These variations are indicated by a dial at the side of the machine, which is placed in the proper position by the handwheel shown. This feature is necessary, as the voltage required to spot weld varies with the thickness of the material.

This machine is equipped with an automatic switch so designed that it is absolutely impossible to turn on the operating current until the welding points are brought firmly into contact with the metal to be welded. The act of releasing the pressure on the points also immediately opens the switch, which prevents burning the work or destroying the copper points. The welding points are cooled by a continuous stream of water flowing through them, which increases their durability.



Electric Spot Welder, built by National Electric Welder Co.

The machine can be operated either by hand or independently and without making any changes or adjustments. The use of the foot-lever permits the operator to hold and adjust the work between the welding points with both hands. The use of the foot-treadle, however, gives exactly the same results as when the hand lever is employed. When the machine is operated by the hand lever, the foot lever does not move and it can be removed readily if desirable. The extended hand lever can also be easily taken out as it is fitted into a socket in the clutch plate.

The switch is a new design of the double-pole, double-break type, having four points of contact. This switch opens both sides of the primary circuit in two places, which avoids excessive flashing with currents of high amperage and voltage. This switch is placed on top of the machine and it has the advantage of being stationary, which avoids any trouble from the crystallizing and breaking of the flexible leads. The contacts of the switch are so designed that they can be removed readily. A complete set of contacts costs only a few cents and will ordinarily last from six months to one year.

Two pieces of ⅜-inch boiler plate can readily be welded together with this machine. Sheet steel 1/16-inch thick can be welded at the rate of thirty spots or welds per minute, and ⅛-inch steel stock can be welded at the rate of twenty spots per minute. This machine is designed to be "fool-proof," which not only minimizes the cost of maintenance, but increases the output.

BARNES DRILLING MACHINE

The Barnes Drill Co., 814 Chestnut St., Rockford, Ill., is now manufacturing a 26-inch all-geared drill of the sliding-head type. This machine, with the exception of the sliding head, is designed along the same general lines as the all-geared type formerly built by this company. Fig. 1 illustrates a standard machine, and Fig. 2 is a view showing the opposite side of a machine equipped with a motor drive.

This design is said to have the power of an ordinary 36-inch, cone belt driven type. There are eight geared speeds and a similar number of geared feeds, all of which may be controlled from the front of the machine. The feed for any position of the controlling lever is shown by plain figures, and the feeds range from 0.005 inch to 0.086 inch per revolution of the spindle. The spindle is 1 15/16 inch in diameter in the sleeve and it is double splined. The crown and pinion gears are of extra large diameter and have teeth of four pitch, thus giving a strong drive. The head and spindle are counterbalanced by a weight inside the column which is suspended on a roller-bearing sheave wheel. The head is securely locked to the column face at any point within its travel, by two quick-acting clamp screws, and it is raised and lowered by a crank pinion and rack which may be seen in Fig. 2.

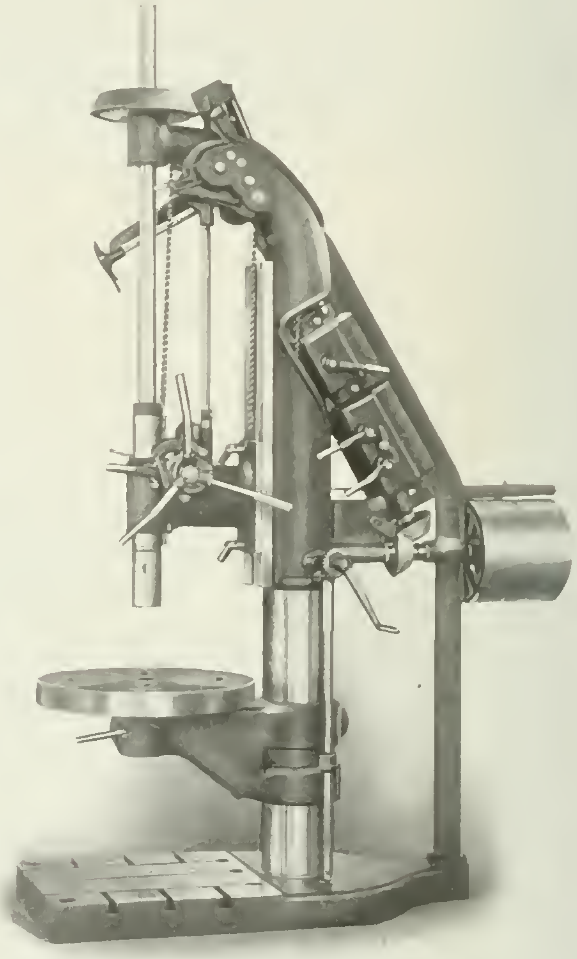


Fig. 1. Barnes 26-inch All-geared Drilling Machine, with Sliding Head

This machine is guaranteed to drive a 2-inch high-speed twist drill with a feed of 0.041 inch per revolution of the spindle and at the rate of 6½ inches per minute, in cast iron without using the back-gears. A drill of this size has been driven at the rate of 8¼ inches per minute during tests. A 1-inch high-speed twist drill can be driven through cast iron at the rate of 13½ inches per minute, provided the drill itself will stand this pace.

Suitable feeds are available for boring-bar work, and the machine will bore holes 8 inches in diameter or even larger.

The machine illustrated in Fig. 2 is equipped with a special boring-bar which is used for boring and reaming the exhauster bodies of vacuum cleaners. The holes are 6 inches in diameter and 6½ inches deep, and the work is said to be done very accurately. The sliding head is necessary in connection with this work, in order to remove the tools. The adjustment of the head can be easily effected by the rack and pinion movement, previously referred to. It will be seen that the boring heads, two of which are shown on the base of the machine, are equipped with pilot bars. This same machine is also used for boring the bearings, one of which is shown at the foot of the column.

Some of the general dimensions of this machine are as follows: Distance from column to center of table, 13¼ inches; diameter of column, 7½ inches; diameter of table, 23 inches; vertical travel of table, 20 inches; vertical travel of spindle for one position of the head, 14 inches; adjustment of the sliding head, 23 inches; maximum distance from spindle to base, 54 inches; minimum distance, 18½ inches; maximum distance from spindle to table, 40 inches; ratio of back-gearing, 4 to 1; diameter of the crown gear, 10 7/16 inches; diameter of bevel pinion, 5 inches; net weight of machine, 1750 pounds.

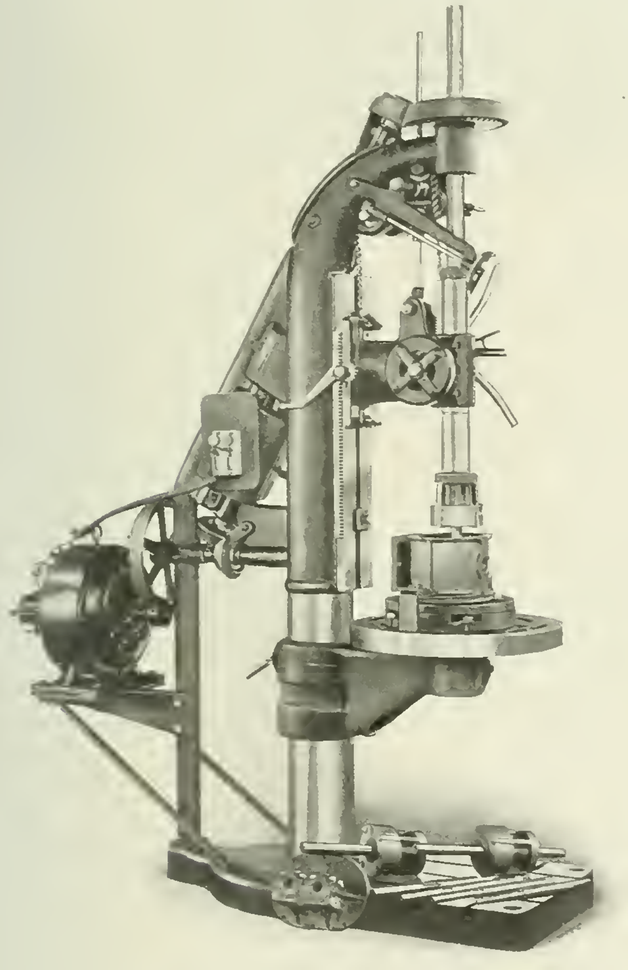
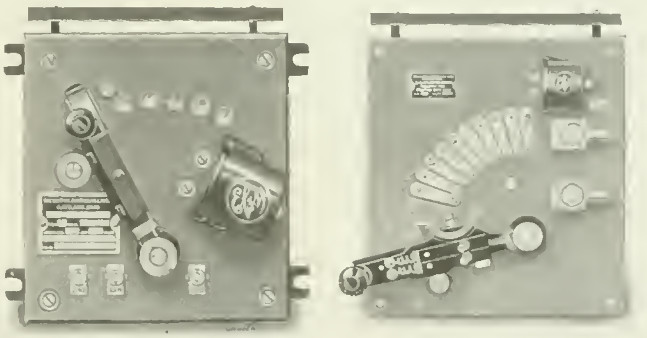


Fig. 2. Barnes Drill equipped with Motor Drive

MOTOR-STARTING RHEOSTATS

The Electric Controller & Mfg. Co., Cleveland, O., has brought out a new line of starting rheostats for series, shunt or compound wound, direct-current motors. The contacts on all sizes of these rheostats, can be removed from the front without disassembling or interfering in any way with the wiring or resistance. The retaining magnet is iron-clad, thus being protected from mechanical injury. The resistance wire, the capacity of which is liberally proportioned, is wound on asbestos-covered, metallic tubes through which a draft of air flows. This draft of air conveys the heat away from the resistance, but does not at any time touch the hot resistance wire; the result is an unusual freedom from oxidization of the resistance wire.

These rheostats are regularly furnished in sizes varying from ¼ horsepower to 35 horsepower for 110 volts, and from ¼ horsepower to 50 horsepower for 220 and 550 volts. Starters similar to the style shown in Fig. 1, are supplied for motors up to and including 7½ horsepower with 110 volts, 15 horsepower with 220 volts and 20 horsepower with 550 volts. For larger sizes, the type shown in Fig. 2 is used.



Figs. 1 and 2. Rheostats made by Electric Controller & Mfg. Co.

BROWN PYROMETER WITH ILLUMINATED DIAL

The Brown Instrument Co., of Philadelphia, Pa., has added to its line of electrical pyrometers, a new illuminated-dial indicator having an exceptionally long scale. Frequently an instrument is desired which can be read easily by the operator of a furnace or kiln, at some distance, and this pyrometer with an illuminated dial is particularly desirable for just such conditions. This instrument has a scale 12 inches long and it can be furnished without the illuminated dial if desired. Where the illumination is sufficient, the instrument does not require an illuminated dial, as the long scale affords very open graduations and accurate readings. In many plants, however,

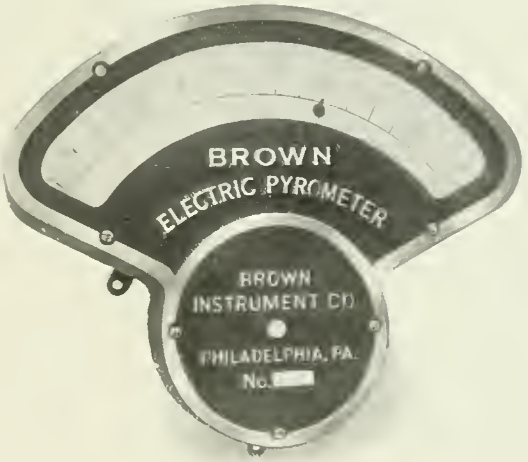


Fig. 1. Brown Pyrometer

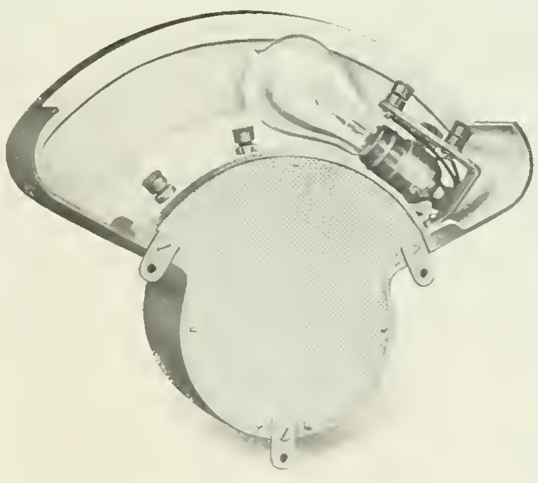
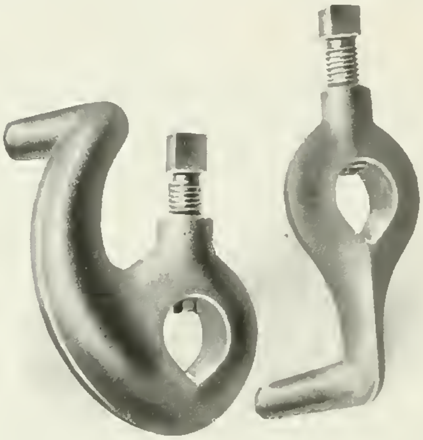


Fig. 2. Rear View of Pyrometer showing Method of Illuminating Dial

where there are dark rooms for hardening and heat treating steel, and where work is carried on day and night, the illuminated instrument is preferable. The scale is drawn on opaque glass, and a sixteen candle-power lamp is placed behind the scale, which makes the graduations and the pointer stand out clearly at a distance. Better results are often secured with this instrument because more accurate readings of the temperature can be obtained.

SAFETY LATHE DOG

Every machinist who has operated a lathe realizes the danger connected with the use of the ordinary lathe dog with its unguarded set-screw which tends to catch in the clothing, especially when filing. A safety lathe dog has been brought out by Elmer J. Michaud, S. Windham, Conn., which is so shaped that the set-screw is guarded. This new dog and also the ordinary type is illustrated herewith. The "tail" of the safety dog is curved around in front of the set-screw on the leading side—as determined by the direction of rotation—thus affording protection. This feature does not affect the convenience of loosening or tightening the set-screw.



Safety Dog and Ordinary Type

UNIVERSAL EMERY WHEEL GUARD

The emery wheel guard illustrated in Fig. 1 is designed to be applied to practically any make of shop tool-grinder. It will cover emery wheels up to 8 inches in diameter and $1\frac{1}{2}$ inch thick. This guard covers the outside of the wheel and also the end of the spindle and retaining nut. The inner side of the wheel is left open to permit using the full width in case this is necessary. The application of this guard to a tool-grinder of the bench type is illustrated in Fig. 2. The guard proper is supported by a steel rod which, in turn, is held by a clamp attached to the spindle bearing box. This clamp, the form of which is clearly shown in Fig. 1, is made in two pieces which are held together by two cap-screws. It is clamped over the bearing boxes by two set-screws, which are locked with jam-nuts. By loosening the rear cap-screw on the clamp and the two binding posts seen above and below the guard, the supporting rod can be raised or lowered or swung to the right or left, thereby allowing the guard to be adjusted as the wheel wears. The water pan is located just below the grinding rest and is attached to the guard proper by a screw. This pan is not only useful for cooling purposes, but aids greatly in settling the dust. It can be attached or removed quickly for cleaning or filling. When this guard is properly adjusted there is no chance of emery or grindings flying into the eyes of the workman. It is manufactured by the Universal Stamping Co., 47 Poultney St., Buffalo, N. Y.

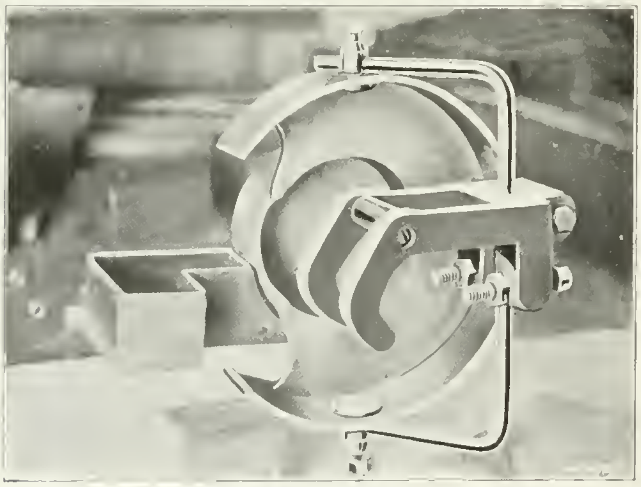


Fig. 1. Emery Wheel Guard made by Universal Stamping Co.

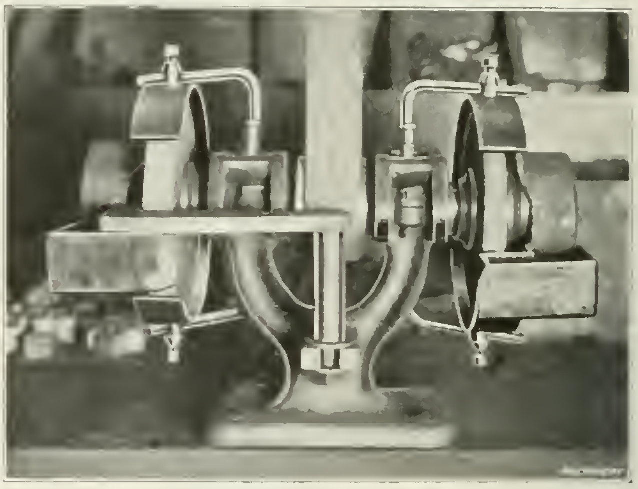


Fig. 2. Tool-grinder equipped with Universal Wheel Guards

SENECA FALLS 12-INCH QUICK-CHANGE LATHE

The Seneca Falls Mfg. Co., 330 Water St., Seneca Falls, N. Y., has just placed on the market a 12-inch quick-change lathe of the same design as the 14-inch size described and illustrated in the department of New Machinery and Tools for December, 1910. The quick-change feed mechanism of this lathe provides forty-eight changes for the lead-screw, which is also used as a feed-rod. All standard threads from $1\frac{1}{2}$ to 92 per inch, including $11\frac{1}{2}$, can be cut, and feeds varying from 0.0023 to 0.142 inch per revolution of the spindle are available.

The index plate shows clearly how to obtain any thread or feed. There is a micrometer stop for the cross-slide by means of which minute adjustments can easily be made. The stop is adjusted by a worm-gear operated by a screw having a knurled knob. The graduations on the micrometer barrel are about $\frac{1}{8}$ inch apart and represent 0.00025 inch. The stop mechanism is thrown in or out of engagement by a knob inside the handwheel. The reverse mechanism for the cross and longitudinal feeds and lead-screw consists of a set of spur gears and clutch in the headstock. The reverse mechanism is operated through levers connected by a rod with a hand lever arm on the apron. An automatic stop for the carriage operates in either direction by means of adjustable stops on the reverse rod. The headstock is a deep web pattern and has a forged crucible steel spindle revolving in large bearings provided with oil rings. A draw-in chuck with collets up to $\frac{3}{4}$ inch can be furnished. A new binding device secures the plain and compound rest to the cross-slide. An automatic safety device prevents engaging opposing feeds, and the feed gearing is disengaged when cutting threads so that the longitudinal handwheel does not revolve.

POLISHING STAND OR JACK

The general appearance and interior arrangement of a new polishing stand or "jack" built by F. E. Wells & Son Co., Greenfield, Mass., is shown in the half-tone engraving, Fig. 1, and the line illustration, Fig. 2. This machine was first built for the company's own use and proved so satisfactory that it has been placed on the market. By referring to Fig. 1, it will be seen that the machine is intended to be driven from beneath the floor. With this form of drive any chance of accidents from the driving belt is eliminated and all of the mechanism is self-contained. The enclosed construction also furnishes an ideal protection for the bearings from dust.

The interior mechanism is shown by the sectional and side views Fig. 2. The driving belt which connects with a driving pulley beneath the floor, runs over pulley *C* on the main shaft *D* of the machine. This shaft runs in bronze boxes the bearings of which are lubricated by means of ring oilers *L*. The driving belt normally runs slack and then the spindle or polishing shaft *D* is at rest. The machine is started by simply depressing the hand lever *H* at the side of the column. This lever controls the movement of an idler pulley *F* which is mounted on shaft *E*, contained in a yoke that fulcrums about shaft *G*, so that when lever *H* is depressed, the idler pulley is forced against the driving belt thus tightening it. Lever *H* has an adjustable weight *I*, and when the idler pulley is thrown into contact with the belt it is retained in that position by the engagement of pin *J* with a projection *K* on the frame of the machine. As soon as the idler is swung away from the belt, the spindle *D* is quickly stopped by a brake *M*, which is automatically applied by the backward movement of the idler yoke. This machine can be equipped with a special shaft for carrying two wheels in case this is desirable. A swinging arm with a table for disk grinding can also be furnished.

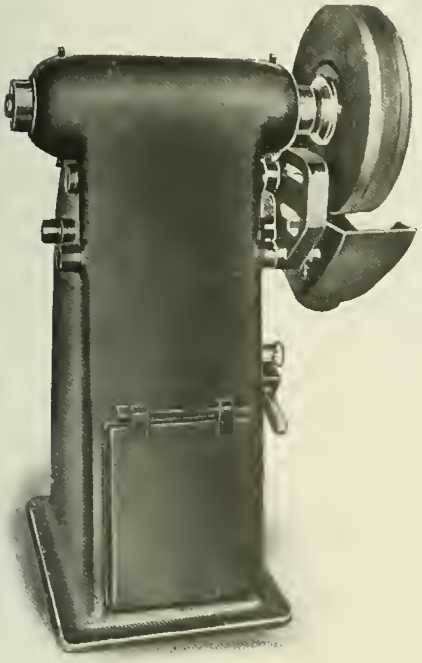


Fig. 1. Polishing Jack built by F. E. Wells & Son Co.

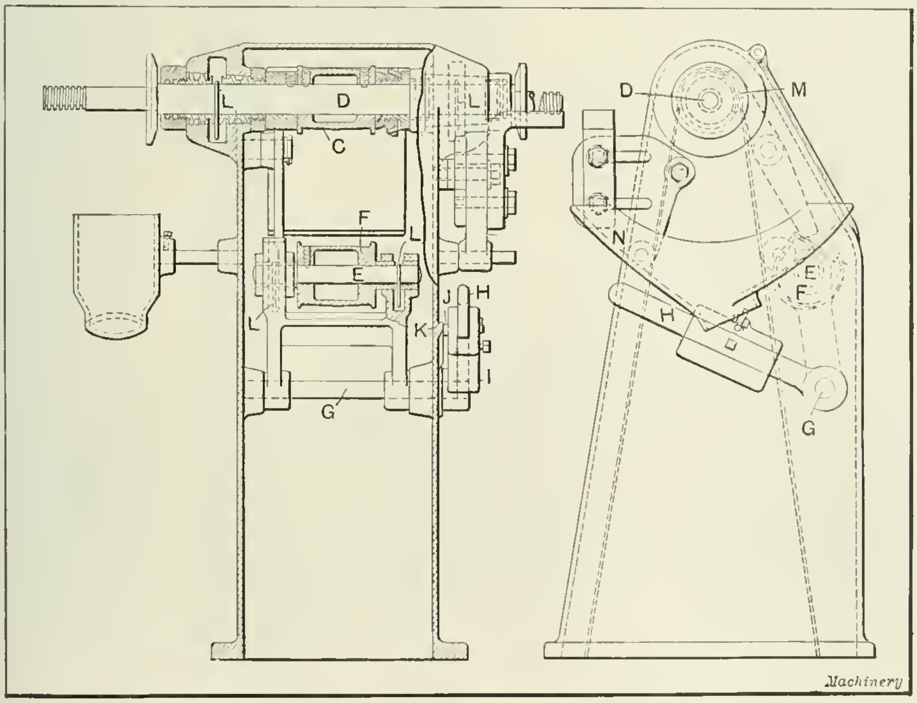


Fig. 2. Views showing Idler Belt-tensioning Device of Wells Polishing Jack

FARWELL UNIVERSAL GEAR HOBBING MACHINE

The Adams Co., 874 Market St., Dubuque, Iowa, has added to its line of gear hobbing machines, a No. 4 size adapted to the cutting of spur or spiral gears, worm-wheels and worms, up to 24 inches in diameter and with 3 diametral pitch in cast iron and 3½ pitch in steel. This machine, a general view of which is shown in Fig. 1, has such a wide range of feeds and table speeds as to make it universal.

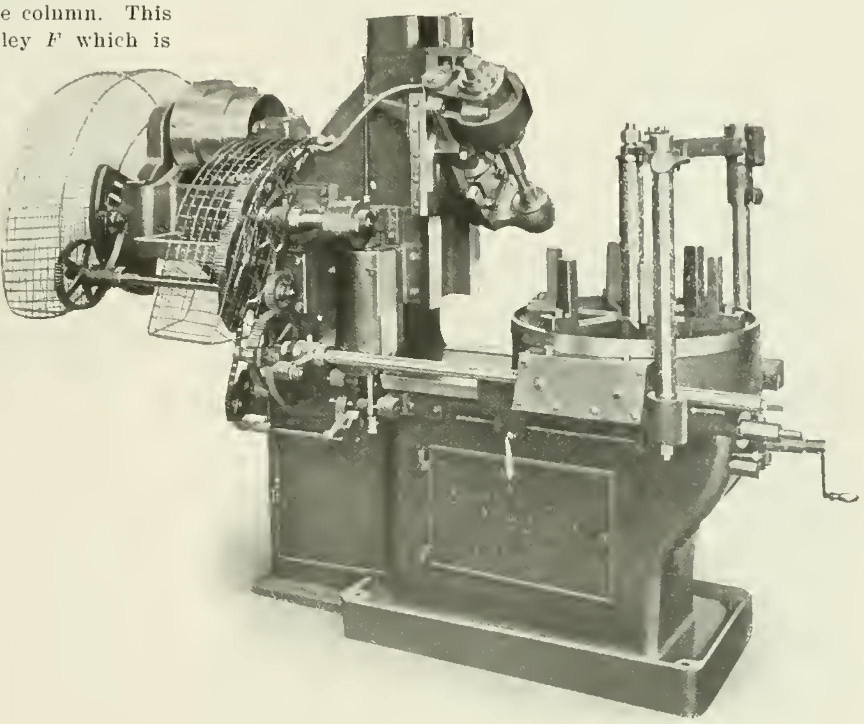


Fig. 1. Farwell Universal Gear-hobbing Machine

Change gears can be furnished for cutting a single-thread worm or a screw of fine pitch and, in addition, worm, spiral or spur gears, having a wide range as to the pitch and number of teeth, can be hobbed. The vertical feeds of the cutter head range from 0.002 to 0.500 inch per revolution of the table. The table may be geared to make one revolution to two revolutions of the cutter, or it may be geared to make one revolution to a thousand or more revolutions of the cutter. This wide range of feeds and table speeds is, of course, unnecessary for ordinary spur, spiral and worm-gear cutting, but no additional complication was incorporated in the design to obtain this range. The drive for the table and feeds is such that the compounding of a comparatively small number of moderate size gears enables this range to be obtained.

This machine is especially designed for gear- and worm-hobbing, but the slow table travel relative to the cutter speed, which is available, enables the machine to be used also as a continuous or circular milling machine. A special spindle and bracket, such as is shown in Fig. 3, may be secured for this purpose. The cutter-head has been made as rigid as possible by using a wide saddle and swivel of heavy construction. The cutter spindle is large and has a hole through which the arbor proper passes. The arbor is driven by a long key, and adjusting nuts on the arbor at each end of the spindle provide a longitudinal adjustment of the hob. The spindle is driven by a steel spur gear and pinion, and both the spindle and pinion shaft run in adjustable bronze bearings located on each side of the gears, thus equalizing the strain.

There is but one pair of bevel gears in the spindle drive. A reducing gear of large diameter is interposed between the cone-pulley shaft and a universal-joint shaft which transmits power to the spindle. This is the same drive which has been satisfactorily used on the No. 3 machine. The universal joints are of special design and are provided with large wearing surfaces of steel bearing on bronze. Wear can be compensated for readily, and there are felt oil retaining pads to facilitate lubrication. The cutter-head has an automatic stop and a rapid power return movement.

The table saddle has a power inward feed ranging from one-quarter thousandth to three-eighths inch for each revolution of the table. An automatic depth stop is provided for worm-wheel hobbing. The table may be geared to cut anything from a single-threaded worm to a gear having a thousand or more teeth, including all prime numbers. A regular set of change gears (120 in number) will give all the feeds mentioned and will enable gears having any number of teeth up to 200, to be cut, and many composite numbers above the figure mentioned. Special gears can be furnished to cut all other numbers including prime numbers.

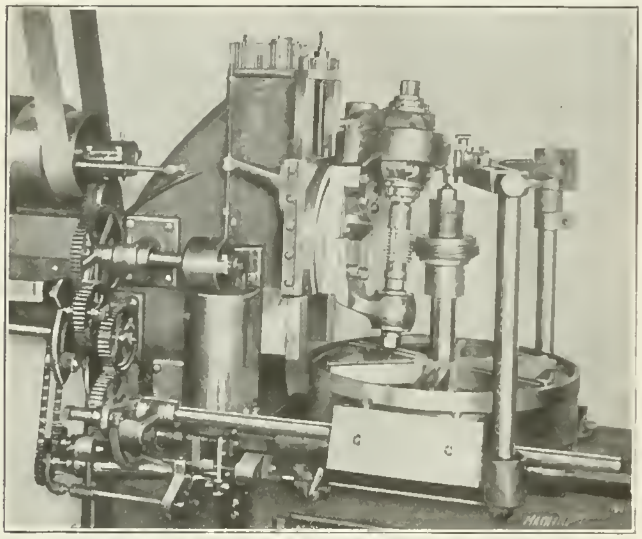


Fig. 2. Farwell Machine cutting Spiral Gear having Tooth Angle of over 80 Degrees

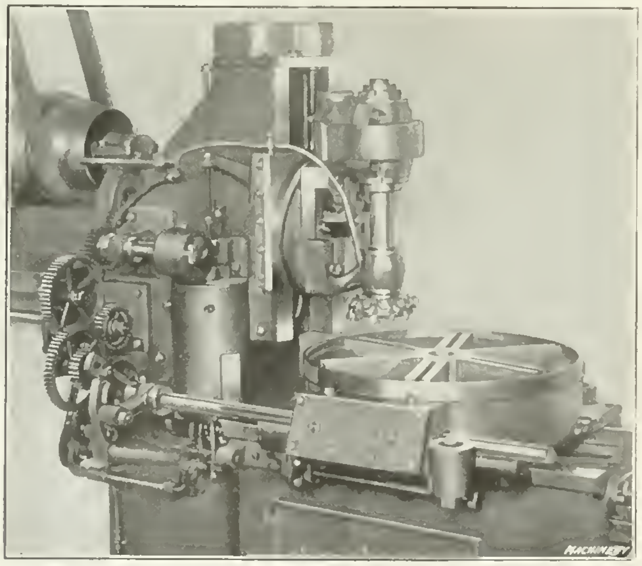


Fig. 3. Gear-hobbing Machine arranged for Continuous or Circular Milling

The countershaft furnished is provided with three clutch pulleys, giving a hobbing speed in both directions and a slow speed for driving milling cutters. The lubricating pump is arranged to run in the right direction when the direction of the spindle is reversed. The table is driven by a steel worm engaging a bronze ring worm-wheel. This worm-wheel is 20 inches in diameter which is within four inches of the machine's maximum capacity. Provision is made for easily taking up any wear, either in the mesh or end motion of the worm. The table is of heavy rib or spoke-and-rim construction, and the top between the ribs, instead of being level, is depressed to a cone shape. This conducts all chips and lubricant into a pan in the base of the machine. The lubricant drains out of the pan into a tank below. The pan may be removed easily through the door shown, when necessary. The weight of the machine, complete, is about 3900 pounds.

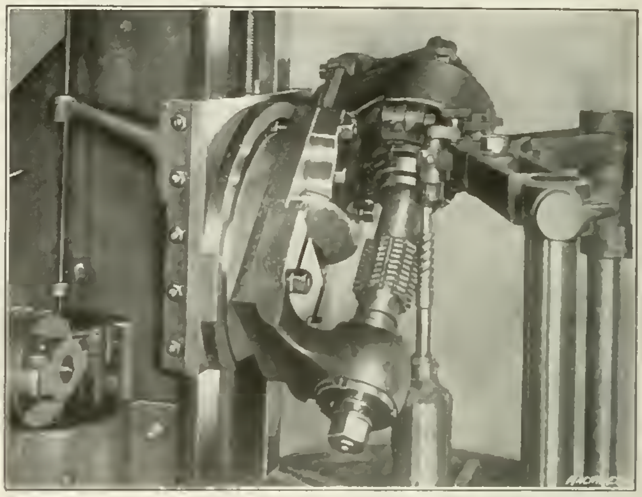


Fig. 4. Hobbing Small Five-threaded Worm on Gear-hobbing Machine

NIAGARA POWER DOUBLE SEAMER

The machine shown in Fig. 1 of the accompanying illustrations, is made by the Niagara Machine & Tool Works, Buffalo, N. Y., and is especially designed for double-seaming the heads of drums and other sheet-metal packages. The heads must be previously stamped to the proper shape by means of a press and dies. The work to be double-seamed is clamped between the top disk and the lower double-seaming chuck, which is shaped to suit the work. The chuck is driven by means of bevel gears, and the spindle carrying the chuck

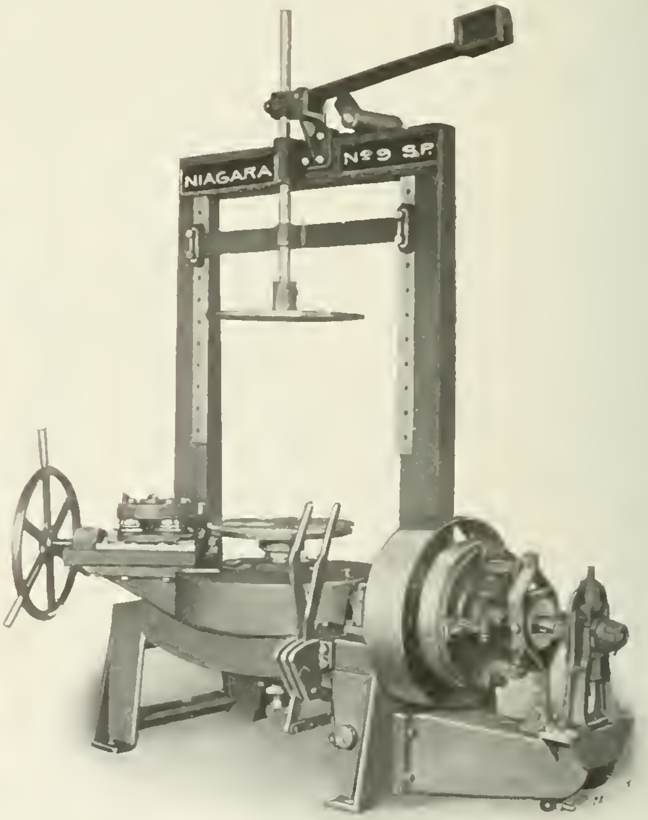


Fig. 1. Niagara Power-driven Double Seaming Machine

has an adjustable end thrust bearing. The carriage with the double seaming rolls mounted in a turret head, is actuated by means of a screw and the handwheel shown. Either two or three rolls are used according to the type of the seam and thickness of the material. The motion is controlled by a friction clutch actuated by one of the hand levers seen at the right side of the lower chuck. The other lever is used to bring down the upper clamping plate, which is counterbalanced.

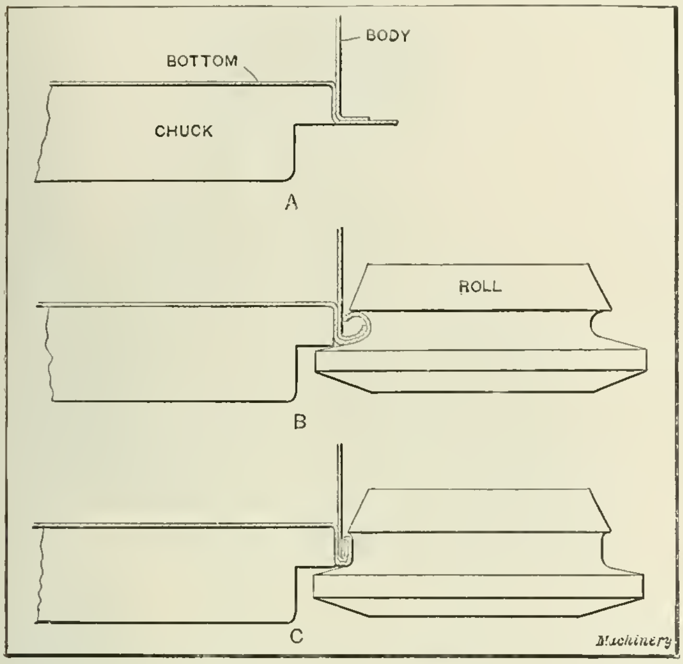


Fig. 2. Forming a Double Seam

The successive steps connected with forming a double seam are illustrated in Fig. 2. The first view at *A* shows the body and bottom of the work assembled and ready for seaming. The first seaming roll is then brought up against the flanges on the work which are turned over as indicated at *B*. The turret is then indexed, thus bringing the finishing roll in position. This roll is then moved in against the work, thus flattening and locking the seam together as indicated at *C*. This seamer has a capacity for work varying from 10 to 32 inches in diameter and not exceeding 45 inches in height.

TURNER HOT BLAST TUBULAR TORCH

The Turner Brass Works, Sycamore, Ill., has designed a hot-blast gasoline torch, which is about five feet long, two inches in diameter and is made of heavy gage brass tubing. This new torch produces a very hot blast flame which is easily controlled by the gasoline valve. There is a powerful burner at one end, and the gasoline valve and pressure pump is located at the other end, as shown in the accompanying illustration. The long tube forming the body contains the gasoline that is delivered to the burner. This tube holds about three quarts. A controlling valve inside the tube regulates the flow of fuel in such a manner that the torch can be used in any position, the flame being pointed up or down, as required. Air pressure for the blast is pumped into the gasoline chamber, the same as in any other torch, by means of a pump at the end of the tube. The flame is about two inches in diameter at the burner and approximately twelve inches long.

Turner Hot-blast, Tubular Gasoline Torch

This torch is intended for foundry use in connection with drying and baking sand molds, and it can also be used for preheating purposes, burning paint (especially on a large scale) thawing out frozen pipes, melting ice, and for heating the ground in advance of general construction work. Other uses for a torch of this form will readily suggest themselves. The weight of the torch is about seven pounds.

UNIVERSAL VISE AND SURFACE TABLE

The vise illustrated in Fig. 1 has a universal adjustment which makes it possible to hold odd-shaped parts, as well as ordinary shapes in the best position for the workman. The swiveling base gives an angular adjustment and the vise can be raised or lowered to the most convenient height. The vise can also be turned about the axis of its supporting column. These various adjustments enable the workman to secure the best light on lines or prick-punch marks indicating finished surfaces, and they also prevent stooping or working in an awkward attitude as is often necessary with the ordinary fixed vise. The vise is rigidly held in any position by a single clamping lever, and when a vertical adjustment is made, the vise is held automatically until the lever is tightened by a locking collar on the stem. These vises are made in four styles and four sizes.

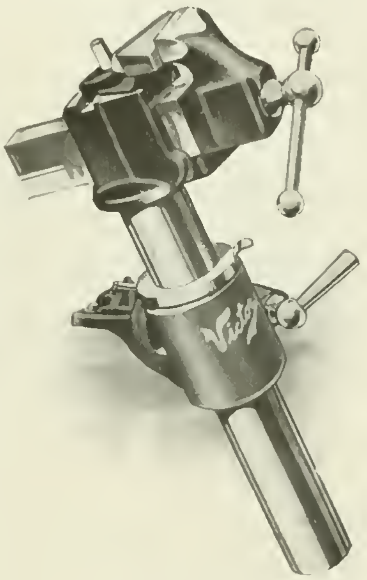


Fig. 1. Vise having Universal Adjustment

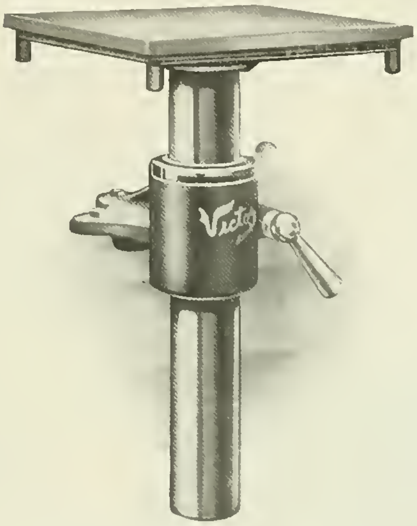


Fig. 2. Surface-table mounted on Vise Base

An accessory to this vise is illustrated in Fig. 2. This is a surface-table or plate which can be mounted in the base as shown. This plate can also be detached from the stem and used on the bench, the same as an ordinary surface-plate. The sizes of these plates are made to suit individual requirements. These vises and surface tables are the product of the Victor Vise Co., 15-19 W. Washington St., Springfield, O.

ROCKFORD HAND MILLING MACHINE

The No. 3 hand milling machine built by the Rockford Milling Machine Co., Rockford, Ill., is now equipped with a power longitudinal feed whenever such a feed is desirable. The arrangement of the feed mechanism is very simple. The power is derived from the rear end of the main spindle, which carries a three-step cone-pulley. This pulley connects by belt with a lower pulley mounted on the end of a universally-jointed shaft which transmits motion, through gearing, to the work-table. By reversing the cone pulleys, six changes of feed can be obtained. This machine has the regular combination screw and lever feed. These two feeds do not interfere, and the change from one to the other can be quickly made. The advantage of this double feed arrangement is obvious. This machine can be used for either horizontal or vertical milling, and, by means of special attachments, it is adapted to a wide range of work. There is a longitudinal power feed of

11 inches, a transverse feed of 4 inches and a vertical movement of 6¼ inches. The working surface of the table measures 18 by 4¼ inches.

BRADFORD GEARED-HEAD MOTOR-DRIVEN LATHE

The Bradford Tool Co., Cincinnati, O., has brought out a geared-head, motor-driven lathe, which is a departure from conventional designs, as will be seen by referring to Fig. 1. This lathe is designed to eliminate top-heaviness and vibration, and, at the same time, secure a more compact machine by locating the motor as indicated in Fig. 2. The lathe has a ,mechanical reverse movement and mechanical speed changes which are easily and quickly made. If a constant speed motor is used, eight spindle speeds varying from 12 to 398 revolutions per minute, are available, and an indefinite number of speeds can be obtained by using a 1½ to 1 variable speed motor, having a simple starting and regulating rheostat.

An effort has been made to arrange the speed controlling levers so conveniently that the operator will always use an efficient speed. A selective type, automobile design of speed-box is incorporated in the drive and provides four of the speed changes. The revolutions per minute of the lathe spindle are plainly marked on a plate which shows the four positions of the speed-box lever and the right and left positions of the lever seen on the head. All of the changes are obtained by these two levers, and the speed-box lever is locked automatically when the lathe is running, thereby preventing breakage. The lower gear-box shaft is continued to the left of the gear-box and is in driving connection by means of a pair of gears as well as by a pair of Morse silent chain gears, with a short countershaft driven direct by a pinion on the end of the motor shaft. Either the gear or chain drive is engaged by friction clutch members controlled by the long shifter handle seen above the lathe. This feature enables the lathe to be run forward or backward and also provides an effective brake for stopping quickly when working up to shoulders. A shot-bolt in positive operating connection with the main clutch operating lever, prevents shifting the gears under load. The peripheral speed of the gears is very low. All parts are of easy access, and particular attention has been given to the matter of lubrication.

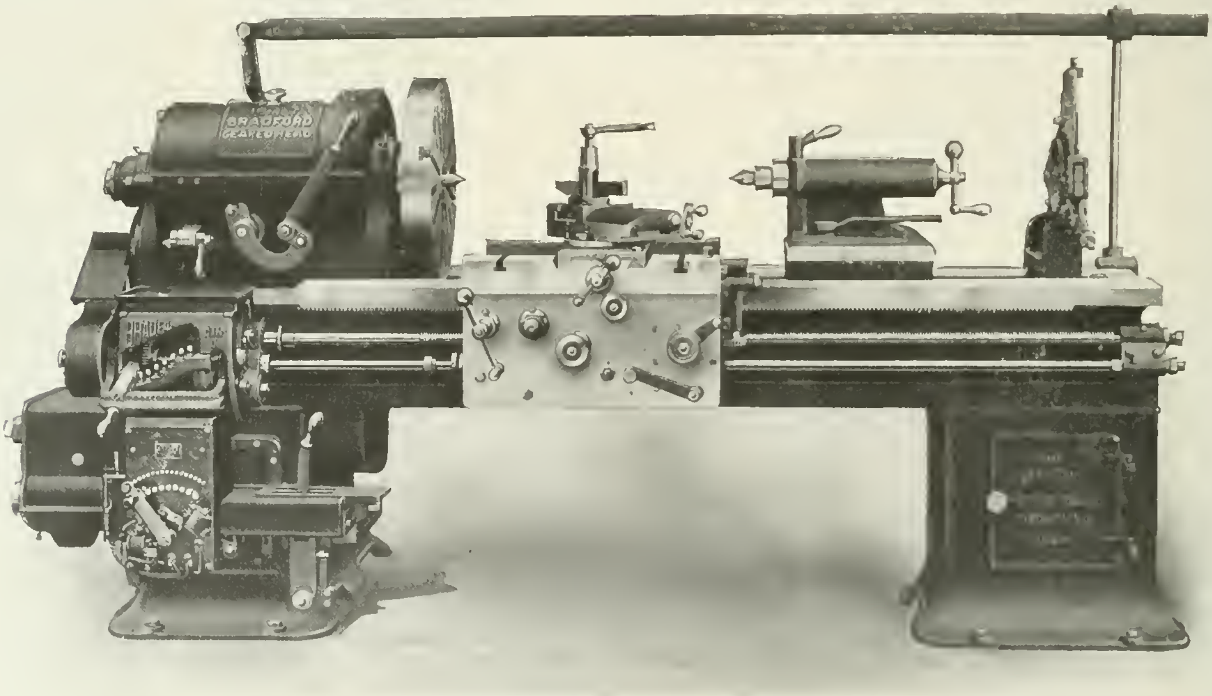


Fig. 1. Bradford Geared-head Motor-driven Lathe

The head has for its first driver a short shaft carrying a Morse chain-wheel and a gear-wheel, both of which are in driving connection, respectively, with a chain-wheel on the right-hand upper gear-box shaft and a friction-clutch-operated gear on the main spindle. The latter gear is in driving connection with a gear on the back-gear shaft. This shaft also carries another gear which is, in turn, in driving connection back again to the lathe spindle by means of a second positive clutch-operated gear on the spindle. The lever seen on the head is in operative connection with the friction and positive clutches which respectively engage the high- and low-speed gears with the spindle. All supplementary speeds are obtained by the simple regulating rheostat, which is located just below the quick-change gear screw-cutting mechanism.

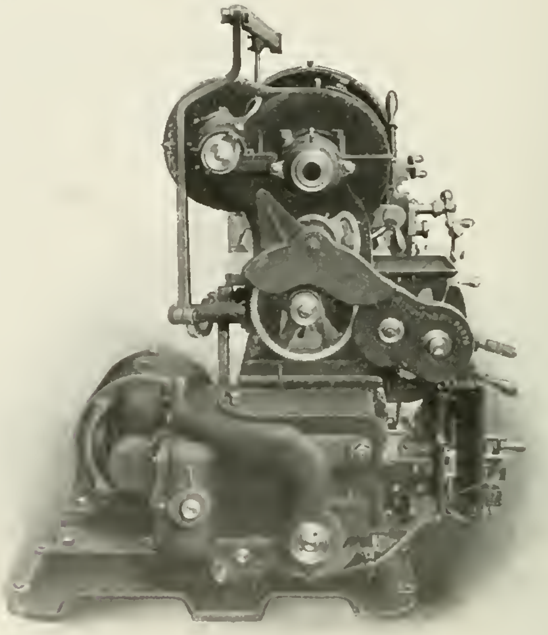


Fig. 2. End View of Bradford Lathe showing Location of Motor

The quick-change gear device is of the well-known Bradford type and enables the cutting of all standard and pipe threads, including 11½ per inch. The gears are of forged steel, and ordinary change gears can be used direct between the spindle and lead-screw for cutting any odd thread. An automatic stop for the longitudinal feeds is provided regularly. The apron is equipped with a thread indicator and chasing dial, the worm-wheel of which can be disengaged from the lead-screw by a cam and knurled knob, thus avoiding unnecessary wear. All exposed gears are carefully guarded as the illustrations show, thus protecting both the operator and machine.

The spindle is made from high carbon crucible steel and it is mounted in adjustable, taper, bronze bearings. The bed is of extra weight and depth and is webbed in two-foot sections. The carriage has a full bearing on the vees its entire length and is gibbed front and back. The apron is of the double-plate pattern and has a non-interfering device to prevent the feed-rod and lead-screw from being engaged simultaneously. The pinions and studs are of high-grade steel, hardened and ground. The feeds cover a wide range and they are all positive geared. This lathe can also be arranged for a single-pulley drive instead of a motor drive. If a two-speed countershaft is used in conjunction with the selective speed-box and geared head, sixteen forward speeds may be obtained. The drive can be direct from the lineshaft if the latter is suitably located. The motor-driven and single-pulley lathes are made in 18-inch heavy pattern, 22- and 26-inch sizes.

HENDEY RELIEVING ATTACHMENT

The Hendey Machine Co., Torrington, Conn., has brought out an improved form of relieving attachment which can be used to relieve hobs or taps having spiral flutes. This new attachment can also be employed for relieving any of the work for which the design formerly built is adapted. The advantage of the spiral flute is that it gives a cutting edge that is square with the body of the tooth, which is conducive to better and faster cutting. This attachment is shown applied to a lathe in Fig. 1.

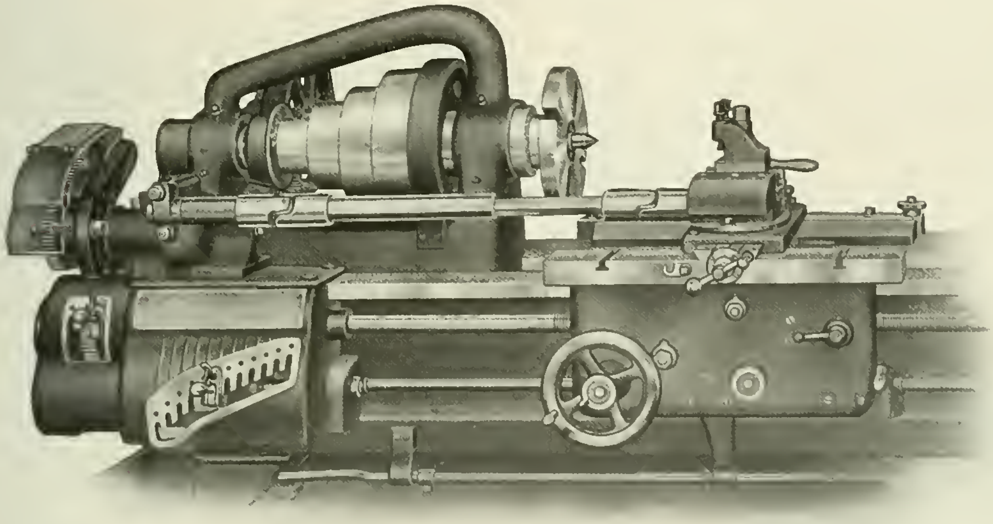


Fig 1. Hendey Relieving Attachment applied to Lathe

The actuating mechanism is mounted on the main gear-box, the tool pan or cover of which is removed. The tool-slide interchanges with the compound or other rest on top of the cross-slide, and it can be swiveled to different angular positions for side and end relief work, as will be explained later. The mounting of the complete attachment requires but a few minutes. The amount of relief can be varied in a simple and easy manner, by means of a toothed coupling at the ends of the oscillating shaft and cam-lever, which permits the relative position of the eccentric on the tool-slide and the cam-lever to be changed, thereby lengthening or shortening the reciprocating travel of the tool. This adjustment gives the tool-slide a movement varying from zero to 5/32 inch on the 14-, 16- and 18-inch lathes, and the movement is increased to 3/16 inch on the 20-inch lathe, and to 1/4 inch on the 24-inch size.

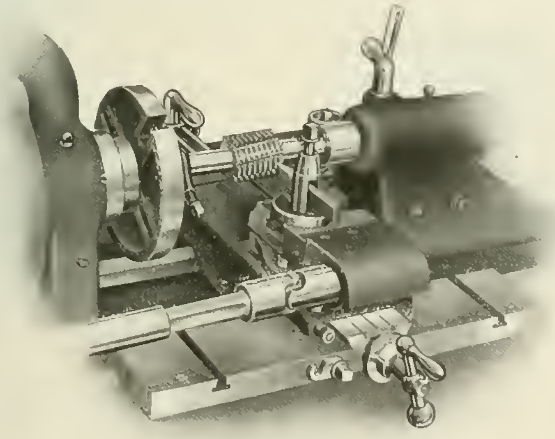


Fig. 2 Relieving Spirally-fluted Hob

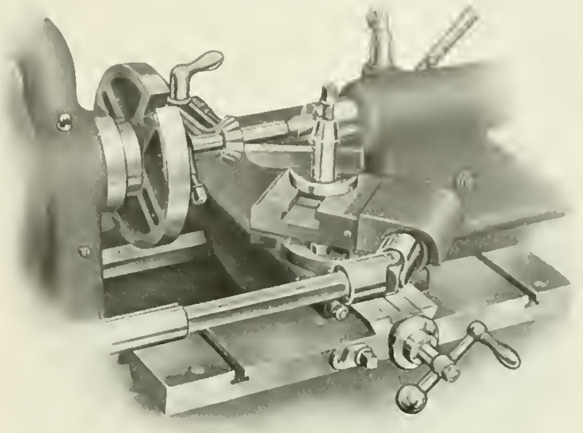


Fig. 3. Relieving Sides of Angular Cutter

If a hob or tap having spiral flutes is to be relieved with this attachment, the pitch of the spiral and the gears necessary to drive the attachment, are first determined. After the attachment is geared to suit the spiral and number of flutes, the lead-screw is engaged and the backing-off operation is performed the same as for straight flutes. The lead-screw should not be disengaged but the carriage is reversed by power, the lever at the right of the apron being used for that purpose. When determining the pitch of the spiral, it should be remembered that quite a variation in length can be made without any serious drawback. Fig. 2 shows the attachment relieving a spirally fluted hob.

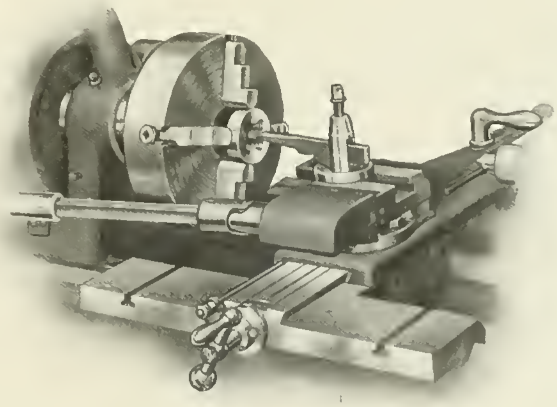
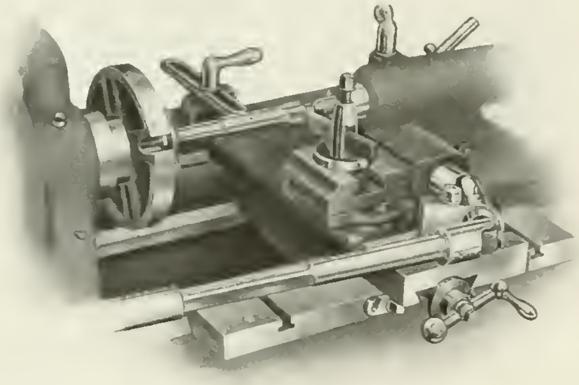


Fig. 4. Attachment arranged for Inside Relieving

Fig. 3 shows the method of relieving the side of an angular cutter. This application is made possible by means of the swiveling tool-slide which enables the tool to be placed in the proper position. By the use of an additional universal joint and bearing to permit the tool-slide to be swung to a 90-degree angle, counterbores can be relieved as indicated in Fig. 5.

When the attachment is used for relieving inside work such as hollow mills and threading dies, the eccentric which controls the travel of the tool-slide is set so that the relieving movement is away from the axis of the cutter instead of toward it. This change is made by the toothed coupling connecting the cam lever and oscillating shaft, the latter being turned beyond the zero mark in a clockwise direction as far as is necessary to get the desired amount of travel. It is also necessary, for internal work, to change the position of the opposing spring in the tool-slide, so that it will press against the end of the slide and prevent the tool from "jumping" into the work. Fig. 4 shows an example of internal work.



ig. 5. Relieving a Counterbore

When relieving a right-hand tap, the ordinary practice is to first set the tool as for cutting a thread. The tool is then accurately set with reference to the thread space by rolling the work in the dog or by disengaging the gears in the gear-box. The motion of the tool-slide is then adjusted so that the forward movement of the tool will meet the front of the tooth and the return movement begin promptly after leaving the end.

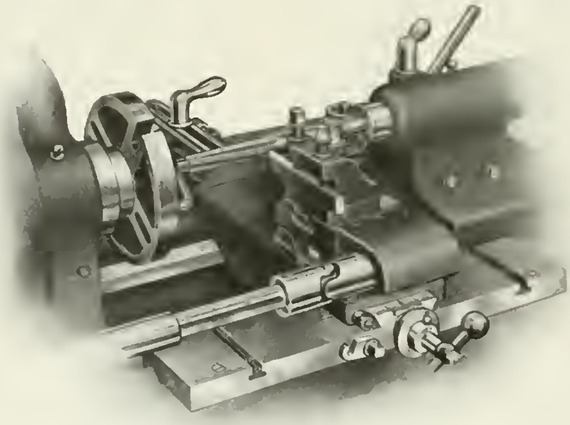


Fig. 6. Relieving Left-hand Tap having Spiral Flutes

Left-hand taps can be relieved by two different methods. By the first, the cut is started at the cutting edge and ends at the "heel," and by the second, the start is made at the heel and discontinues at the cutting edge, the tool being drawn out from the work during the cut. When the first method is employed, the tap is placed with the point towards the headstock spindle and the shank end is supported by the tail-center as indicated in Fig. 5. An extension or blank end long enough to take the driving dog, is provided at the point of the tap. With the second method, the tap is held between the centers the same as a right-hand tap, but the travel of the tool-slide is set as for inside relief. As will be recalled, the necessary adjustment is made by the toothed coupling, and the opposing spring, in this case, is left in the same position as for right-hand work.

When work is being relieved, it should be revolved much more slowly than when turning, to give the tool-slide time to operate properly. A maximum of 180 teeth per minute is recommended, and if wide forming tools are used, the speed may be reduced to as low as 8 teeth per minute. It is also essential to use tools having a keen edge, and the tool-slide should work freely but without undue looseness. After a cutter has been formed, it is a good plan to color it either by heating or dipping it in a strong solution of copper sulphate. The operator can then plainly see the work done by the relieving tool and stop at the proper time. Re-milling after the backing-off operation, insures a sharp edge and reduces the amount of grinding necessary after the cutter is hardened.

D. & W. FUSE CO.'S MAGNETIC CHUCKS

As a labor saver, there is probably no form of electrical device which has proved of greater benefit in the machine shop and tool-room than the magnetic chuck. When a large number of pieces are to be machined, the time and labor saved by the use of a magnetic chuck, as compared with the old methods of clamping, or holding one piece at a time in a vise, will often pay for a chuck within a short time. Magnetic chucks of the flat and rotary types now being manufactured by the D. & W. Fuse Co., Providence, R. I., are illustrated in Figs. 1 and 2.

The flat chucks (see Fig. 1) have a horizontal face and are equipped with adjustable end and side stops, providing convenient means for locating and steadying the work. This form is particularly useful for holding such work as file blanks, scale blanks, thickness gages, punches, dies, accurate shims, gibs, or practically any part on which it is necessary to grind flat surfaces. Milling operations can also be performed with great facility, if the shape of the work is such that the end stop of the chuck can be raised to take part of the thrust. When used in this way, the smallest flat chuck built by this company will hold a 1- by 2- by 6-inch bar of tool steel, tightly enough to permit milling 0.050 inch from a surface 2 inches wide, and with a feed of 1 inch per minute. This chuck is also useful for holding stock requiring light planing and shaping operations.

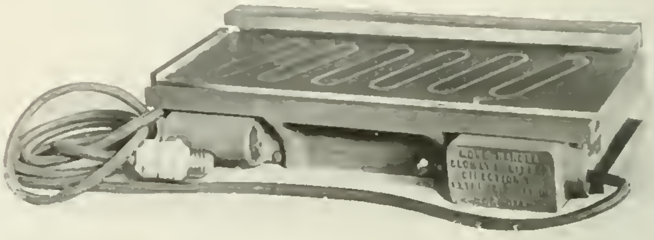


Fig. 1. Magnetic Chuck of Flat Type, built by D. & W. Fuse Co.

The rotary chucks have been used effectively in plants manufacturing ball and roller bearings, for holding ball races during the grinding operations. Rotary chucks are also used for holding pistons and piston rings which must be accurately ground. The rotary chuck illustrated in Fig. 2 is equipped with an auxiliary plate.

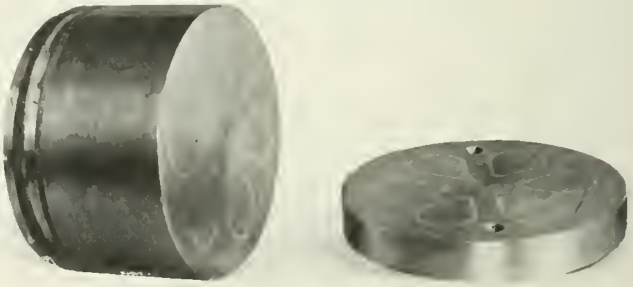


Fig. 2. Rotary Magnetic Chuck and Auxiliary Plate

This company also manufactures vertical chucks which have a perpendicular holding face when clamped to a horizontal machine platen. They are especially adapted for grinders having a cup-wheel mounted on a horizontal spindle. The chuck proper is similar to the flat type. The magnet coils of these chucks are wound with "Deltabeston" wire, having a special heat-proof insulation of pure asbestos. This insulation can safely withstand temperatures as high as 400 degrees F. In addition, the coils are wound by a special process which still further protects them from heat and moisture. This construction prevents burning out of the magnet coils when subjected to variations of voltage, moisture or prolonged service. The coils are rigid units which are interchangeable, and the arrangement of the chuck is such that they can be replaced readily. Auxiliary plates, which are made to fit these chucks, are used as jigs or fixtures for holding special pieces of irregular shape. By means of these plates, one chuck can be made to cover a wide range of operations, as any number of plates can be used.

Both the flat and vertical chucks have their ends machined true so that several of them can be lined up end-to-end for holding long work, or for machining many small parts at one operation. This feature permits the units to be used separately on different machines, or to be assembled into one long chuck controlled by a single switch. With the exception of the smaller sizes, the chucks are designed for use on direct-current circuits of 105 to 125 volts. If it is desirable or necessary to energize them on circuits of higher voltages, such as 210 to 250 volts, or even 550 volts, a convenient form of auxiliary resistance is supplied, which can be inserted at any suitable point in the circuit. The small chucks are equipped with standard external resistance units for use on 105- to 125-volt direct-current circuits.

The chucks are both oilproof and waterproof and are equipped with demagnetizing switches for readily releasing the work. When possible, a special switch is used, which is attached directly to the chuck. This switch, by a simple movement of the hand, automatically and positively demagnetizes the chuck. Where it is not practicable to mount this device on the side of the chuck, an independent control base is provided on which is mounted a knife switch with the demagnetizing unit. When the switches are mounted directly on the chucks, they are entirely enclosed in water-tight iron boxes. This affords thorough mechanical protection and serves to keep emery dust from cutting out the moving parts. Magnetic chucks can only be operated on direct-current circuits, and under no conditions can alternating currents be used. Where direct current is not available, direct-current generators are supplied.

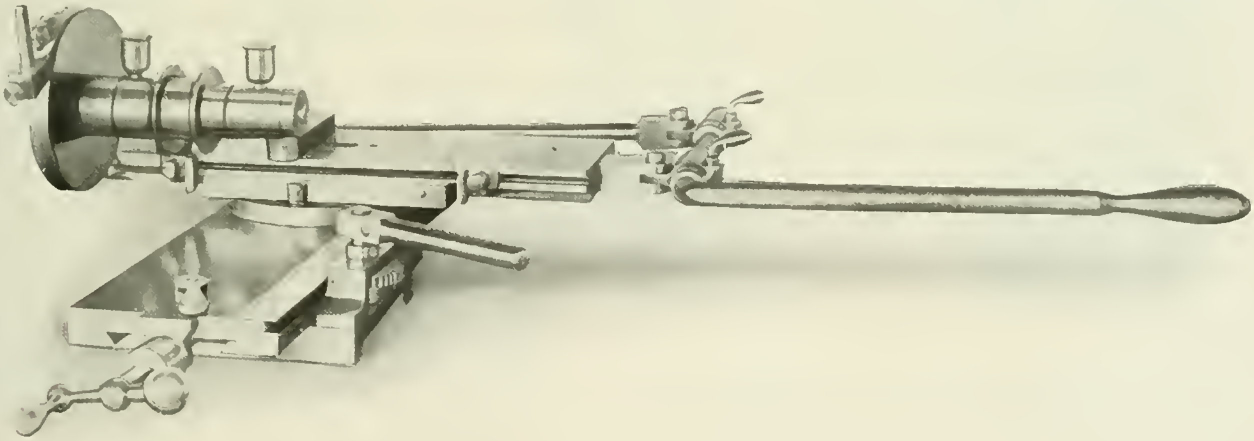


Fig. 1. Remington External Grinding Attachment for Bench Lathes

REMINGTON GRINDING ATTACHMENTS

The external grinding attachment illustrated in Fig. 1 is for bench lathes and is of rigid design with a capacity for grinding wheels 4 inches in diameter and ½ inch face width. The grinding head may be removed and a head for internal grinding substituted if desired. The spindle of the internal grinding attachment is capable of speeds up to 30,000 revolutions per minute. The circular swivel base is graduated in degrees for grinding taper work. The lever movement is novel in that it is adjustable for quick short strokes, as well as for longer strokes. The method of making this adjustment is clearly shown by the illustration. There is a cross-movement of 7 inches from the center. The small lever just above the micrometer feed-screw, serves to release the feed so that the grinding head may be quickly moved to or from the work by means of a rack and pinion actuated by a lever. This feature facilitates the fitting of gages and replacing of the work. The grinding wheel is covered and is provided with an adjustable tube to direct the flow of water for wet grinding.

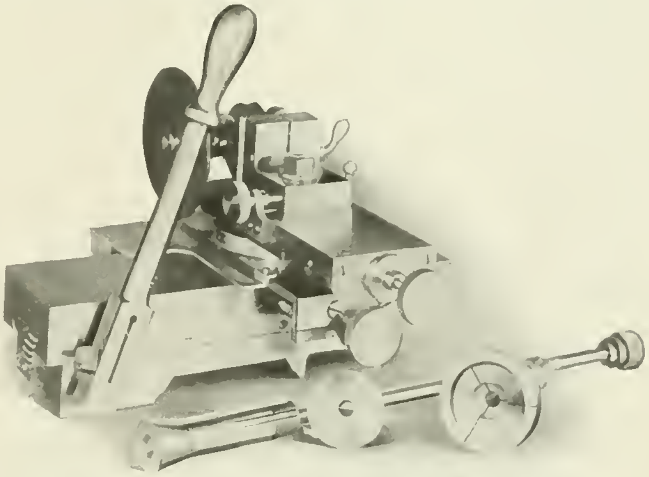


Fig. 2. Another Remington Grinding Attachment

Fig. 2 shows another external grinding attachment for bench lathes, which can be used in connection with the grinding of irregular forms without the necessity of re-setting the work for different angles. This attachment is particularly adapted to grinding hardened steel paper cutters. The illustration shows a paper cutter which has been ground on the plane, concave and bevel sides at one setting. Fine adjustments are provided throughout, both for setting the wheel and to compensate for wear. The circular swivel base is graduated in degrees for obtaining different angular adjustments.

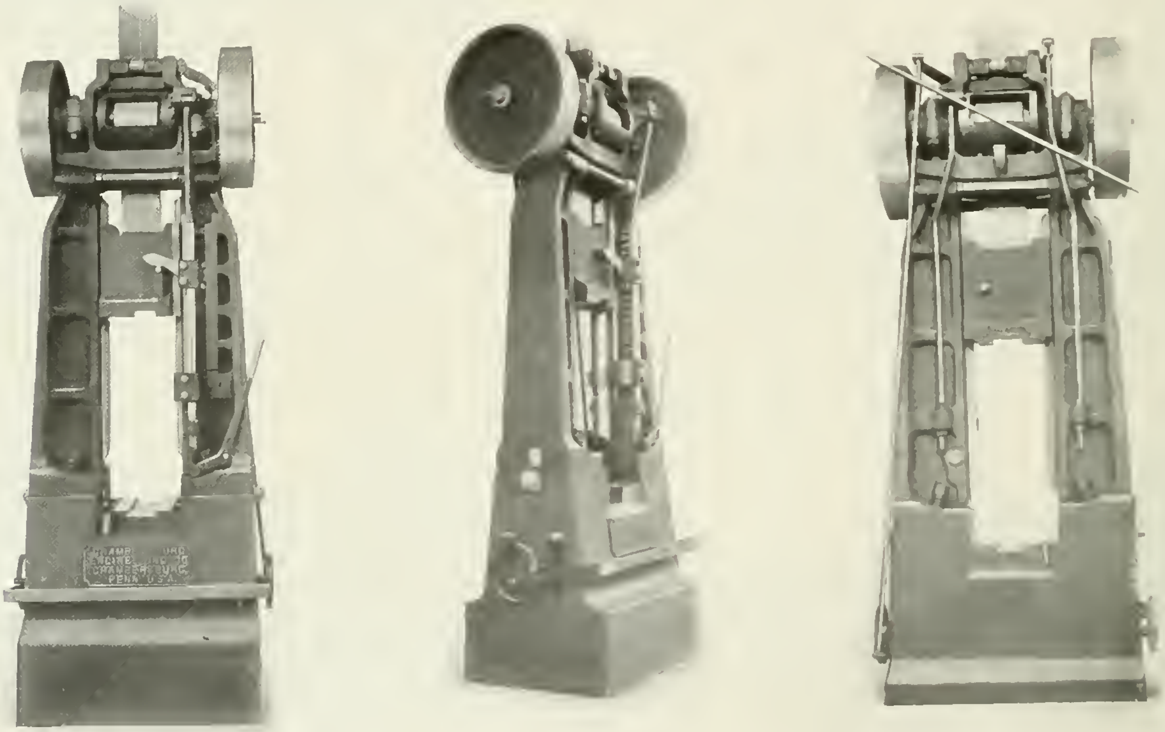
Both of these attachments are recent developments of the Remington Tool & Machine Co., Woburn, Mass., and are designed to be used with the bench lathes manufactured by this company.

CHAMBERSBURG BOARD DROP HAMMERS

A new line of board drop hammers made in capacities from 400 pounds to 3000 pounds falling weights has recently been brought out by the Chambersburg Engineering Co., Chambersburg, Pa. A hammer of the new design is shown in the accompanying three engravings, illustrating the front, side and back views, respectively. The principal features of the new design are the manner of adjustment for lining up the dies, the manner in which the front rod is lifted up into place, and the knock-off construction. All the features incorporated have been subjected to most rigid and exacting tests in regular service.

The head or lifter is securely held in place on the top of the frames, by four through bolts, which pass through drilled holes and which have spiral springs to absorb shock. The rolls are furnished either plain or geared, as desired. Together with their driving spindles they are located in hooded eccentrics—the front eccentric being used for operating, while the rear eccentric is for adjustment only. These eccentrics are made from steel castings, in one piece, this method insuring exact alignment. Provisions are made for preventing oil getting onto the rolls where they bear against the boards. The spindle bearings are made of ample size; they are bronze bushed and provided with oil reservoirs.

The board clamps are located at the extreme top on double eccentrics. A permanent alignment of both rolls and board clamps is insured, even if the operator is careless. When the ram is suspended the board is so gripped that it hangs free of both rolls. The board clamps are so designed that they will grip instantly the heaviest rams in any position without sliding, even if the board is badly worn. When the treadle is fully depressed, the board falls freely, no matter how worn it is at the point of pick-up. The trouble of drag through the clamps just before the blow is struck, which is a common difficulty, is thus overcome.



Figs. 1 to 3. Front, Side and Rear Views of Board Drop Hammer built by Chambersburg Engineering Co.

The adjustments necessary to the back roll and board clamp to take up the wear of the board, are quickly made from the floor by means of adjusting bars led down the back of the machine to within easy reach of the operator, as shown in the rear view of the hammer, Fig. 3. Adjustments can be made for wear of the board up to 7/16 inch. The pulleys may be either Rockwood compressed paper pulleys, or pressed steel pulleys, as desired.

The frames are of reinforced I-beam section to withstand the heavy strains imposed on them in "break-down" work. They are about 2 feet shorter than is the general standard, although the extreme fall of the ram is greater than the average. This feature of design insures greater rigidity. The frames are free from cores, and are of uniform section throughout. They are deeply pocketed in the anvil, having a bearing on their outside edges for the entire length of the tongue, and also bearing on the entire bottom surface, thus insuring satisfactory and permanent alignment of the frames and ram. The tops of the frames are tongued and fitted to the lifter head. The frames are spaced, and held in line with the lifting rolls, by steel tie-bolts with distance pieces. The bearing surface of the V-guides has been made especially large, so as to provide amply for wear.

The frame adjustment to align the top and bottom dies is made by large tension bolts, the construction being such that in case of fracture the bolts can be passed out into the die space and quickly replaced without dismantling the machine. In the usual construction it is necessary to dismantle the entire superstructure to make such repairs. The bolts are supported for their whole length in bored holes. Lock washers are provided to positively hold the adjusting nuts in any position. The frames are designed for the minimum adjustment of 0.0026 inch. The ram or hammer is of 40-point carbon open hearth steel, properly balanced, and made deep enough from front to back to insure the alignment of the dies. The lifting boards are of well seasoned maple, let into the ram and secured by an under-cut plate with teeth on one side so as to enable the use of a straight board, and at the same time prevent the board from pulling out.

The anvil is made of cast iron in one piece, and the anvil cap is made from 40-point carbon open hearth steel. Anvils weighing from fifteen to twenty times the rated falling weight of the ram can be furnished, and can be made of steel, if desired. The anvil is secured to the frames by four bolts, spiral springs being provided to reduce the shock. These bolts are set at a slight angle in order to locate the pocket for the bolt head on the compression side of the anvil, so as to prevent the possibility of breakage due to bolt-head pockets on the tension side.

The front rod lever has a safety stop, which will positively prevent accidents while adjusting dies, etc., as it automatically drops and locks the front rod release when the hammer is not in use, or when the operator is adjusting the dies. This provision prevents many accidents that occur from this source. As indicated in the engravings, the foot treadle does not extend across the back of the anvil, but leaves this space free for forgings.

The stroke is adjusted by means of a rack and segment lever, and the adjustment can be quickly and easily made. The front rod, due to the eccentric construction, is practically straight, and is lifted up into place without the usual shock and jar, as the releasing lever is rolled along in the rack, and gives the front rod a direct and gradual "pick-up." The adjustment for various heights of dies is made by means of a knock-off, clamped to the lower part of the front rod, this adjustment allowing the use of any thickness of dies. The incline for the knock-off is so laid out that no impact is imparted to the front rod. The breakage of the front rod, due to crystallization, which has been a constant source of trouble in this class of machines, is thus obviated. This design permits the hammer to run at a higher speed than is ordinarily used, thus increasing the output.

RELIANCE SPEED DIAL FOR MACHINE TOOLS

As the output of a machine tool depends to a great extent on the use of the most efficient cutting speed, it is very important to have some accurate method by which the operator can easily adjust the driving mechanism, so as to obtain the prescribed speeds for the cutting tool under different conditions. When the speed changes are effected by means of cone-pulleys or gears, the spindle has a definite number of revolutions per minute and the speed for different gear combinations is usually shown on a plate attached to the machine. It is a comparatively easy matter to embody in a blueprint specified instructions showing the step of the cone-pulley, or the gear combination, which will give the most efficient speed for each operation to be performed. With an individual adjustable-speed motor drive, the number of speed changes is, of course, greatly increased and it is more difficult to indicate the proper combination for a given cutting speed. Consequently, the speed adjustment is usually a matter of guesswork, with the result that the efficiency of a given machine depends largely on the judgment of the operator.

The Reliance Electric & Engineering Co., 1056 Ivanhoe Road, Cleveland, O., has developed a speed dial which enables the operator to obtain the required cutting speed under different conditions. This dial is calibrated for use with the Reliance adjustable-speed motors, and can be applied to shapers, drills, lathes, milling machines, boring mills or any machine tool having speed variations. The Reliance adjustable-speed motor is of the armature shifting type and has an infinite number of gradual speed changes, so that it is always possible to obtain a given cutting speed, provided the operator has some means of accurately adjusting the speed of the motor in accordance with the cutting speed required. The function of this speed dial, one form of which is illustrated in Fig. 1, is to enable the proper adjustment of the motor to be made. The dial can be mounted on the machine at any convenient place and it is simply necessary to provide a positive connection with the means employed for shifting the armature of the motor. Fig. 2 shows one of these dials applied to a drilling machine. As the illustration shows, positive connection is made with the motor by a chain and sprockets. The upper sprocket is mounted on a shaft carrying a handwheel which is used in making the adjustments. As the armature of the motor is shifted and a gradual change in speed is obtained, a pointer moves on the speed dial and shows what adjustment must be made to obtain the desired cutting speed. The scales on the dial are, of course, graduated differently for different types of machines, and take into account the different gear ratios between the driving motor and the cutting tool. Therefore it will be seen that this speed dial is not a means of indicating the speed at which the motor is running, but is an automatic calculator which enables the operator to quickly adjust the motor speed so as to obtain any desired speed at the cutting tool and, as previously stated, the dial is arranged to take care of all the variable factors which would affect the problem. All the operator has to do is to set the dial for the cutting speed required and then shift the armature of the motor, in the usual manner, until a pointer indicates the diameter of the cut to be taken (in the case of lathe work) on the proper scale for the gear combination used.

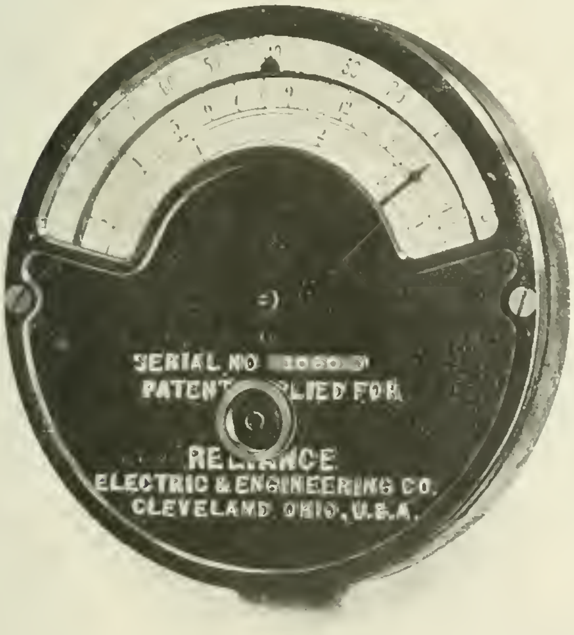


Fig. 1. Reliance Speed Dial for obtaining Proper Cutting Speed--This Particular Dial is intended for a Back-geared Crank-shaper

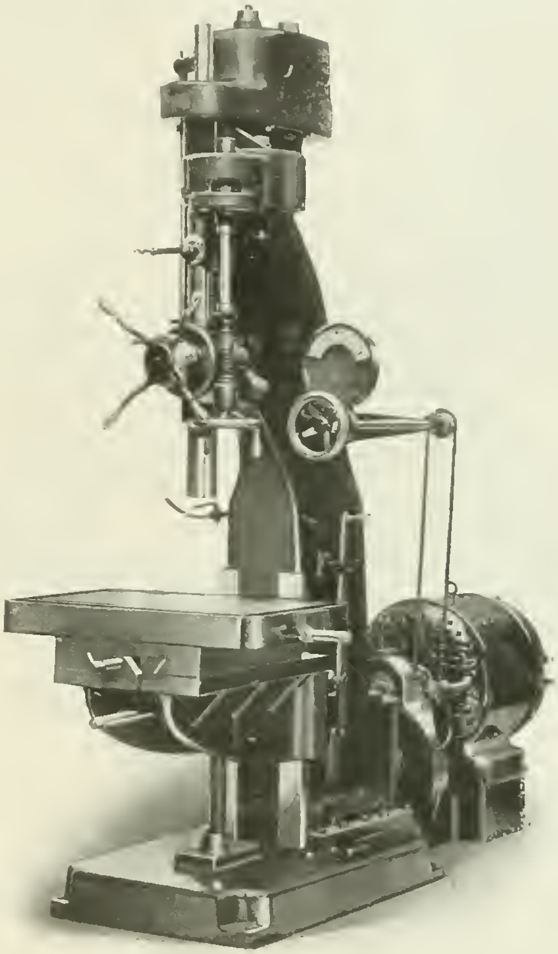
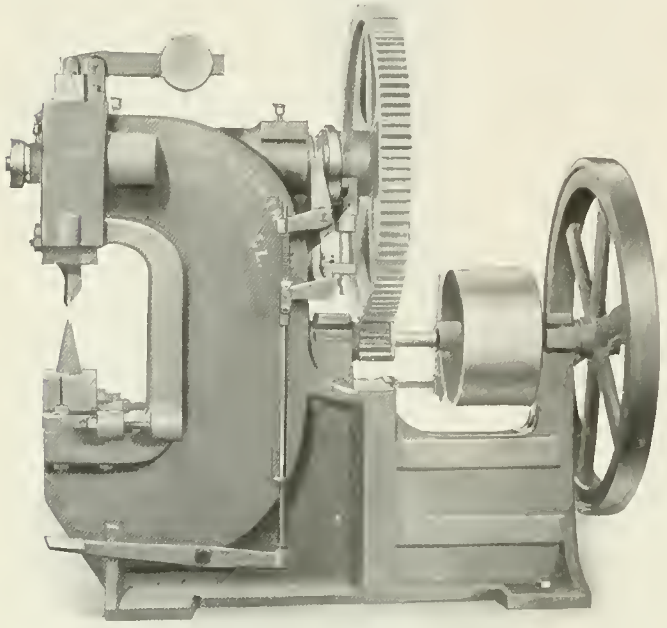


Fig. 2. Foote-Burt Drilling Machine equipped with Speed Dial which is positively connected to Reliance Adjustable Speed Motor

The particular dial illustrated in Fig. 1 is intended for use on a crank-shaper. This dial has an upper scale which shows the cutting speed in feet per minute, and two lower scales indicating inches of stroke. The upper scale for the stroke is used when the back-gears of the shaper are engaged, and the bottom scale is used when the back-gears are out and the drive is direct. The scale showing the cutting speed in feet per minute, is stationary and the small pointer seen opposite figure 40, is mounted on revolving disks with the two lower scales. When mounted on revolving disks with the two lower scales. When the shaper is to be set for a given cutting speed, the lower scales and the pointer referred to, are turned, by means of the small knurl seen just below the center of the dial, until the pointer is oposite the desired cutting speed. The armature of the motor is then shifted by turning the handwheel seen in Fig. 1, until the pointer over the lower scales (which is geared to the handwheel rod) is opposite the stroke to be used. Of course when making this adjustment, the operator uses the lowest scale if the back-gears are out, and the one above it if the back-gears are in mesh. The illustration shows the dial set for a cutting speed of 40 feet, with a stroke of 20 inches, and the back-gears engaged. It should be remembered that the cutting speed of a crank-shaper depends on the length of the stroke for a given motor speed, and that is why the scales are graduated for the different lengths of stroke. The convenience and advantage of this dial and its effect on the efficiency of a tool, are obvious. It not only serves as a guide in setting the speed accurately, but is always in plain sight so that the foreman can see what speeds are being used.

WHITING GEARED SPRUE CUTTER

A geared sprue cutter recently designed and built by the George Whiting Co., 1701 Elston Ave., Chicago, Ill., for use in steel foundries, is illustrated herewith. The knives on the particular machine illustrated are intended for cutting off risers, gates and sprues up to the capacity of the machine, but if desired, an extra pair of cutters can be furnished for trimming light fins from steel castings. These cutters are made so that the cutting edges come as close to the casting as practicable. The knives can be set either at right angles to the throat or with the cutting edges parallel to the throat.



Geared Sprue Cutter for Steel Foundries

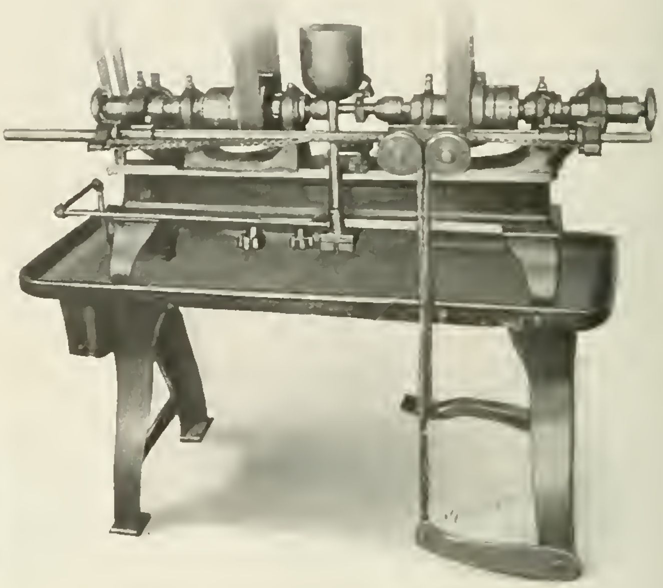
This machine is fitted with an automatic stop and is equipped with tight and loose pulleys. The large flywheel at the rear is crowned for a belt in case a motor drive is desired, and provision is made for attaching a motor directly to the machine. There are means of compensating for the wear of the lower blade, and the knives have been designed so that they can be re-ground economically and, at the same time, have serviceable edges for general work.

The machine is made in different capacities and either with or without the geared drive. The geared type runs about thirty strokes per minute and the quick-acting machine makes about ninety strokes per minute. The lower block which holds the cutter, is provided with an adjustment for aligning the blades to secure accurate cuts. The upper head can also be adjusted vertically for setting the top cutter in the proper position. This machine is designed to enable the operator to work as close to the casting as possible.

DUPLEX DRILLING AND COUNTERBORING MACHINE

A special drilling and counterboring machine built by the F. E. Wells & Son Co., Greenfield, Mass., is shown in the accompanying illustration. This machine operates on both sides of the work simultaneously, by means of opposed horizontal spindles. The particular machine illustrated is used for drilling and counterboring wrench parts. One spindle carries a combination drill and counterbore and the opposite spindle a counterbore only, so that a hole is drilled through the work and counterbored on each side.

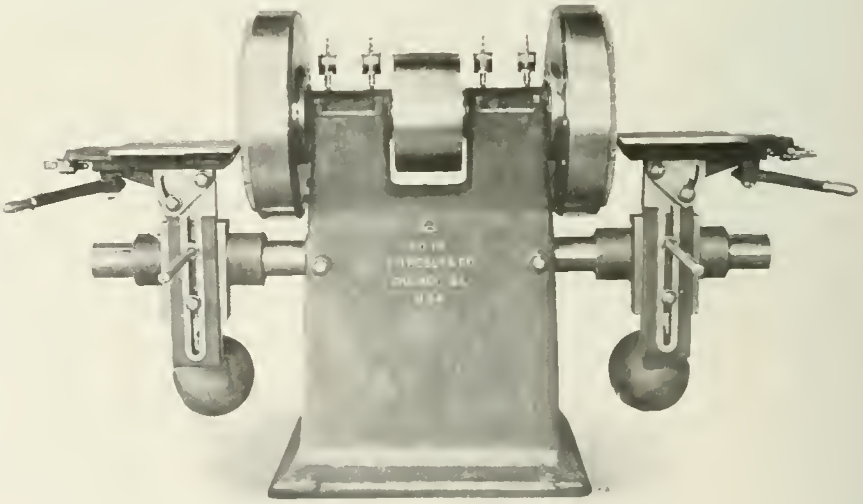
The construction of the machine is very simple as the illustration indicates. The two spindles are moved toward each other by means of a foot-treadle. This treadle is connected with the spindles by chains which pass over sheaves and are attached to arms connecting with the spindles. A guide rod at the rear of the machine takes up the torsional strain on the spindles when the drilling and counterboring tools are at work. Stops are provided for limiting the depth of the drilling and counterboring. When operating the machine, it is simply necessary to hold the work in position and apply foot pressure to the treadle for feeding the spindles. A drip tank is provided for supplying a cooling compound to the tools when machining steel or other metals requiring a coolant.



Drilling and Counterboring Machine

BESLY RING-WHEEL GRINDER

Charles H. Besly & Co., Chicago, Ill., have recently placed on the market a new grinder of the ring-wheel type, which is heavier and more powerful than any grinder heretofore built by this company. This machine, which is illustrated herewith, is equipped with two, geared lever-feed work-tables and two pressed steel ring-wheel chucks holding ring or cylinder grinding wheels 24 inches in diameter. This grinder is intended for larger and rougher work than is ordinarily done on disk grinders. The vitrified grinding rings naturally will stand



Large Ring-wheel Grinder built by Charles H. Besly & Co.

more severe service than the emery-cloth-covered steel disk wheels. The design is massive and rigid, and the machine, as illustrated, weighs over 3500 pounds.

The geared lever-feed table weighs about 600 pounds and has a leverage of 18 to 1. The spindle pulley is 15 inches in diameter. It will take an 8-inch belt and transmits over 30 horsepower. The spindle is $3\frac{1}{4}$ inches in diameter and each bearing is 12 inches long. The rockershaft is $4\frac{1}{2}$ inches in diameter and 7 feet long. The end thrust is taken on hardened and ground collars of over 20 square inches area. Each pressed steel ring-wheel chuck weighs 275 pounds and with a new grinding ring in place, weighs 415 pounds. A new grinding ring is 24 inches in diameter, 5 inches deep and has an 11-inch hole.

This machine will rough 1/16 inch stock from the bottom of a sad iron casting in about ten seconds, and the feeding pressure on the surface being ground is approximately 100 pounds per square inch of area. On a machine of this type, with hand-lever feed, the ratio of the leverage (18 to 1) is an important feature as it enables the workman, without undue exertion, to put sufficient pressure on the work to secure the maximum efficiency of the grinder. This large ratio of leverage is obtained through a gear and rack with a lever only 20 inches long. This geared motion gives the necessary table travel with a maximum ratio of leverage for the length of lever used. A longer lever would not be convenient for the workman. The lever is clamped to the pinion stud, and its position, relative to the stud, may be changed to suit the convenience of the operator.

RECENT DEVELOPMENTS IN LARGE PRESSES

A few years ago presses having more than two cranks and measuring over four or five feet between the housings, were rarely built, but at present the multiple-crank type having three or four cranks and varying in width from three to ten feet between the housings, is quite common. The accompanying engravings show several different types of large presses that have recently been built by the E. W. Bliss Co., 17 Adams St., Brooklyn, N. Y.

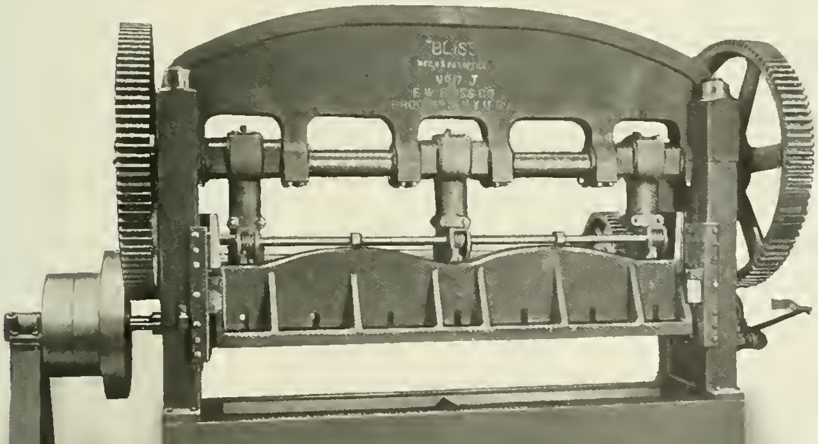


Fig. 1. Double-geared Triple-crank Press

Fig. 1 shows a multiple press having a triple crank. This machine has a width of 11 feet between the housings and a slide movement of 4 inches. Owing to the great width, it is equipped with a twin drive, a driving gear being mounted on each end of the crankshaft. This method of driving reduces the torsional strain on the crankshaft and also equalizes the pressure on the journals and gears. The action of this press is controlled by a hand-operated friction clutch. The flywheel is 40 inches in diameter and has a 6-inch face. The total weight of the machine is 59,000 pounds.

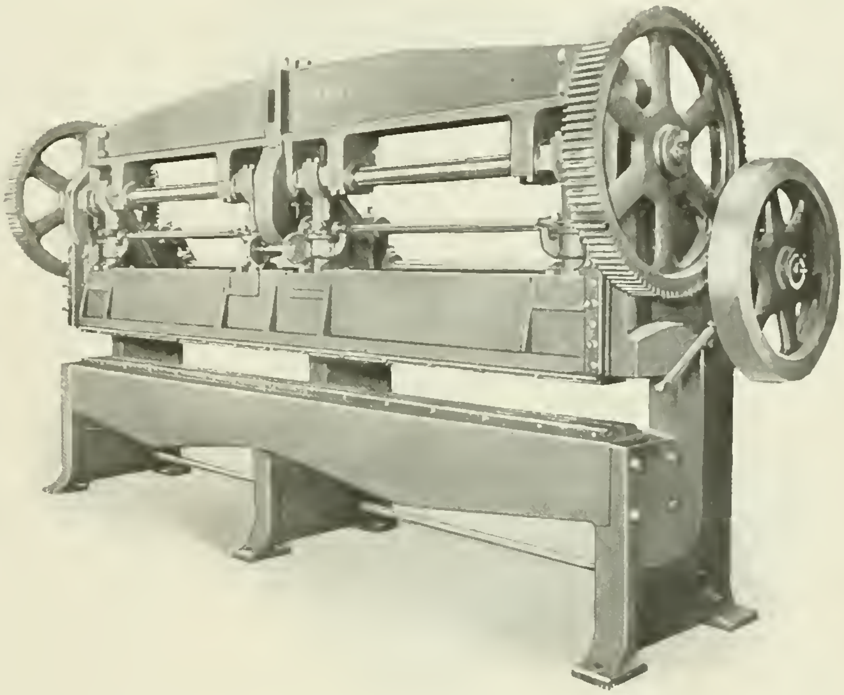


Fig. 2. Four-crank Press having Width of 14 Feet between Housings

A four-crank press is illustrated in Fig. 2. The capacity of this machine is comparatively small, but it is extremely wide, the width between the outer housings being 14 feet. The construction is of the built-up frame type with gap or overhanging housings. This press also has the twin drive, and the ratio of the gearing is 15 to 1. The crankshaft is 4 inches in diameter and has a 2-inch stroke. The flywheel weighs 600 pounds, and the weight of the complete machine is 25,000 pounds.

Fig. 3 shows a rear view of a large double-crank press. It usually takes from two to four men to operate large presses of this type, and, ordinarily, it is necessary to have at least one man back of the machine to handle the work. This is a dangerous position when the gearing is exposed and low enough to come within the workman's reach. For this reason all the large presses built by the E. W. Bliss Co. have the gearing mounted on the housings above the crankshaft, as shown in Fig. 3. With this arrangement of the driving shaft, the gearing is above the operator's head, where it is entirely out of the way. This machine and also the one illustrated in Fig. 1 are commonly known as the straight-sided, tie-rod type. The bed and crown are each a separate casting, and all the strain is taken by steel tie-rods which pass through the side housings so that the latter simply act as a guide for the slide. Machines of this type are used for blanking, forming and drawing operations on large sheets such as are used for steel range bodies, automobile parts and similar work.

The large press shown in Fig. 4 is a combination of the tie-rod and gap-frame type. The bed and crown are each a separate casting and the side housings are of box section and have a gap or opening at the front, as shown. The bed and crown are held in place by two large steel rods which pass through the housings just back of the crankshaft and take all the strain. There are also two smaller steel rods in front of the crankshaft. These do not go below the gap and are to prevent the crown from rolling. There are also two additional rods that pass through the bed and prevent the housings from springing away at the rear as they would tend to do when the main tie-rods, which pass close to the front, were shrunk in place. This construction is said to make a machine of the gap type as strong as a straight-sided press, as all the strain is taken by the steel rods instead of by the cast-iron housings. This press measures 6 feet between the housings. The crankshaft is 8 inches in diameter, has a 6-inch stroke, and is driven through gearing having a ratio of 22 to 1. The flywheel is 50 inches in diameter, has a 7 inch face and weighs 1300 pounds. The total weight of the machine is 63,000 pounds.

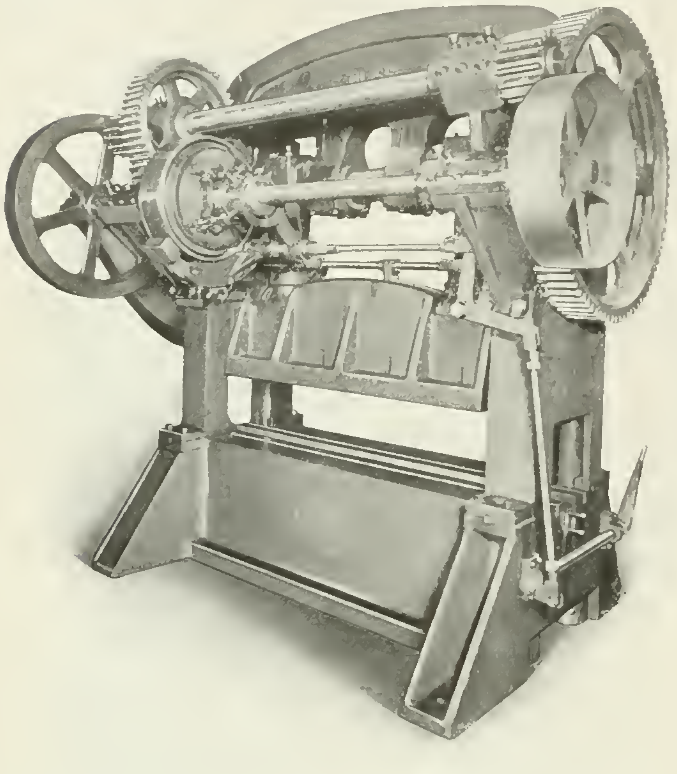


Fig. 3. Rear View of Double-crank Press

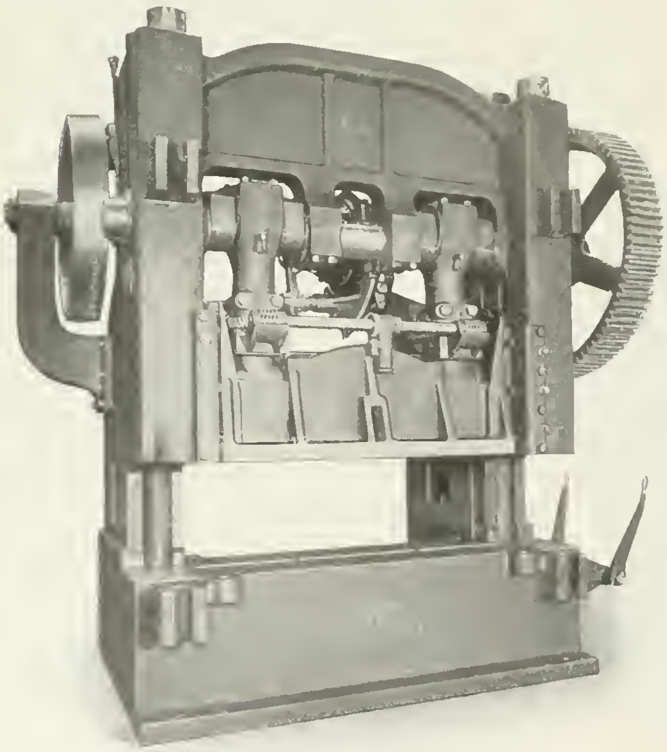


Fig. 4. Press of Combination Tie-rod and Gap-frame Type

NEW MACHINERY AND TOOLS NOTES

Light Holder: Ryede Specialty Works, Rochester, N. Y. Adjustable light holder which can readily be attached to the ceiling, wall or floor, and has universal adjustment which permits placing the light in the best position. The entire bracket is made of steel and is either nickel plated or oxidized.

Stock and Tool Trays: F. O. Weydell, 224 S. Jefferson St., Chicago, Ill. Cast-iron tool and stock trays made in different styles and sizes and intended for holding taps, drills, chisels and other tools. These trays consist of independent units which can be hung under a bench like a drawer or arranged in stacks, as required.

Shim for Bearings: Lindhe Shim Co., New York City. Shim or liner for bearings composed of a series of brass layers 0.002 inch thick which are firmly held together by a very thin film of solder. The thickness of the shim is varied by peeling off one or more layers. This shim is applicable to all classes of machinery having split bearings.

Pipe Threading Machine: Oster Mfg. Co., Cleveland, O. Machine for threading straight or bent pipe. The work is held in a swivel vise which can be adjusted to any angle for threading pipe bent to any radius from 6 to 24 inches. The vise is locked in position and the angle is shown by graduations. There is an automatic trip for cutting threads of a standard length.

Tool Grinder: W. W. Oliver Mfg. Co., 1500 Niagara St., Buffalo, N. Y. Tool grinder (No. 8) equipped with Hyatt roller bearings, which are oiled through dustproof cups. The spindle is made of machine steel accurately ground and machined, and the wheels are guarded. The height from the floor to the spindle is 38 inches, and the length of the spindle is 13⅞ inches. The net weight of the grinder is 96 pounds.

Die-plate: Scott-Rose Co., Marquette Building, Chicago, Ill. Die-plate covering a range of sizes from 3/16 to 3/4 inch. The hardened steel removable die blocks are fitted in parallel jaws. The distance between these jaws can be varied by a calibrated ratchet wheel which, through the medium of a cam, adjusts the jaws by small variations. This die-plate is 15 inches long overall, and it is furnished with U. S. standard threads unless otherwise specified.

Gas Forge: Simplex Tool & Supply Co., 125 Purchase St., Boston, Mass. Gas forge for forging or hardening lathe, planer or other tools made of carbon or high-speed steels. The width of the furnace is 10 inches and the height 8 inches. There are four burners, and 100 cubic feet of gas is consumed per hour. An air pressure of one and one-half pound is required. The advantages claimed for this forge are the facilities for watching the tool, a clean output and elimination of fusing of the tool-point.

Vertical Surface Grinder: Pratt & Whitney Co., Hartford, Conn. Vertical surface grinder which resembles the machine formerly built by this company, but is an improved design of heavier construction. It is adapted to either plain or circular grinding. A cup-shaped wheel 14 inches in diameter and 4 inches high is used. The table has a working surface 11⅜ by 36 inches, and the maximum distance from the table to the grinding surface of a new wheel is 14 inches. The machine can be equipped with a belt or motor drive.

Centering Tool: Robert H. Fay, Chicopee Falls, Mass. Centering tool for use on the lathe or hand screw machine. The body of the tool is composed of two sections which are screwed together and can be adjusted with relation to each other. The forward section carries a combination centering drill and it is beveled on the rear side to an angle of 60 degrees. The other section is in the form of a ring and is also beveled on the inside. By means of this adjustment the conical bearing can be varied to suit the angle of the lathe center, in case the latter should not be ground to the standard angle. The two sections are locked at any point by a small knurled screw.

Rolling Mill: Standard Machinery Co., Providence, R. I. Steel rolling mill designed for the cold rolling of sheet steel. The machine is driven by a sixty-horsepower motor, and there are three rolls to which power is transmitted through spur gears and cast steel herringbone pinions. The top and bottom rolls are 11 inches in diameter and have a 12-inch face. The center roll, which is known as the "baby" roll, is 5 inches in diameter and has a 12-inch face. The mill is so arranged that the 11-inch rolls can be replaced with 14-inch sizes when necessary for special work. The baby or friction roll is hardened, ground and mirror lapped. Both the 11- and 14-inch sizes are of the shell type forced over arbors, the shell part being hardened and ground tool steel. The weight of this mill is 26,470 pounds.

Crank Press: Niagara Machine & Tool Works, 639 Northland Ave., Buffalo, N. Y. Double crank-press, especially adapted to the requirements of sheet metal works manufacturing specialties of heavy and light gages. The frame is built in sections and the bed, the two housings and the arch are held together by four steel tie-rods which are shrunk in place and take the strain. Particular attention has been paid to the design of the slide cross-head and guides to adapt the press for very accurate work. The Niagara automatic jaw clutch is used. This clutch has a safety lock which guards against accidental engagement in case the brake is not properly adjusted. The distance between the housings is 61 inches and the distance from the bed to the slide with stroke and adjustment up, is 25 inches.

Cylinder Boring Machine: Newton Machine Tool Works, Inc., Philadelphia, Pa. Special five-spindle cylinder boring machine having two uprights and a cross-rail. The right-hand upright can be shifted in or out whereas the left-hand upright is bolted to the bed. The cross-rail, which is mounted on top of the uprights, has a fore-and-aft adjustment. There are two vertical spindles on the cross-rail each having vertical and horizontal hand adjustments and a vertical feed. The left-hand horizontal spindle is mounted on a saddle attached to a knee having vertical elevation on the upright. This spindle also has a fore-and-aft hand adjustment as well as a cross-feed. The right-hand vertical saddle carries two spindles which operate in unison. This machine was especially designed for air brake cylinder work.

Safety Device: Benjamin Electric Mfg. Co., 120 S. Sangamon St., Chicago, Ill. Safety device for stamping presses which protects the hands of the operator by necessitating the removal of both hands from the point of danger in order to trip the press. The release of either hand permits the trip to return to its normal position, thus making it impossible for the press to repeat unless both hands are kept on the levers until the downward stroke begins. The operator then will not have time to get his hands back into the danger zone before the operation is completed. The device consists of an operating lever normally made inoperative, though free to move downward. This lever is made operative by an electro retaining magnet through a circuit closer. The press cannot be tripped by the operating lever unless the circuit through the magnet is first closed. This safety device can easily be applied to all standard presses.

Profiler: Pratt & Whitney Co., Hartford, Conn. Semi-automatic profiling machine capable of milling contours of practically any shape. The machine has a heavy base casting to which are bolted uprights and a cross-rail cast in one piece. The head on which the roughing and finishing spindles are mounted is clamped to the cross-rail and remains stationary when the machine is in operation. The rotary work-table is mounted on the front end of a swinging arm, journaled in the bed between the uprights. The table is actuated by worm-gearing and is provided with a change-gear mechanism by means of which any desired feed may be obtained. The table is oscillated by a cam or former under it, which is kept in contact with a roller mounted on a pin fixed to the bed. To generate this cam or former, the roller is removed and a milling cutter of the same diameter is inserted in its place. A model of the work is then mounted on the machine and a former pin of the same size as the cutter to be used, is inserted in the cutter spindle. The cam is then milled by the cutter previously referred to, which is driven independently from the main shaft.

* * *

PERSONALS

Otto R. Winter recently opened an office at 785 Bruck St., Columbus, Ohio, as tool and machine designer.

Robert Wilde has resigned as factory manager of the R. C. H. Corporation, Detroit, Mich., manufacturer of automobile and metal products.

F. H. Brown, formerly with Chas. A. Strelinger Co., Detroit, Mich., has been made sales manager of the W. P. Davis Machine Co., Rochester, N. Y.

W. Nicholson, of W. H. Nicholson & Co., Wilkes-Barre, Pa., sailed in February for a six-week's trip in Europe in the interests of the mandrel department of his company.

Paul J. Smith, assistant foreman of the tool and die room of the Ford Motor Co.'s pressed steel plant, Buffalo, N. Y., has been promoted to the position of chief inspector.

At a meeting of the board of directors of Manning, Maxwell & Moore, Inc., New York, January 26, Mr. James B. Brady was elected vice-president in place of Mr. W. O. Jacquette.

Emory T. Smith, for a long time draftsman for the Waltham Watch Tool Co., Springfield, Mass., has resigned to take a similar position with the Chapman Valve Mfg. Co. of Springfield.

C. R. McCullough, formerly connected with the Packard Motor Car Co., Detroit, Mich., has joined the sales organization of Manning, Maxwell & Moore, Inc., and will make his headquarters in Detroit.

E. J. O'Hayer, Jr., vice-president of the Miehle Printing Press & Mfg. Co., Chicago, Ill., has taken charge of the company's office at 38 Park Row, New York, succeeding Mr. F. L. Montague, resigned.

Frank P. Smith, formerly connected with the sales office of Manning, Maxwell & Moore, Inc., New York, has again become associated with this corporation. His work will be confined chiefly to the railway department.

L. H. Mesker, who has heretofore been connected with the Cleveland branch of Manning, Maxwell & Moore, Inc., has been appointed manager of the St. Louis, Mo., branch of this corporation, succeeding Mr. C. L. Lyle. The St. Louis office is in the 'Frisco Bldg.

Howard W. Evans has taken a position with the Best Mfg. Co., Pittsburg, Pa., as general manager of sales. Mr. Evans will supervise the company's sales, order and engineering departments. He was formerly connected with the Crane Co., of Chicago, in a similar capacity.

James McCrea, president of the Pennsylvania R. R., has been appointed a member of the American Honorary Committee of the International Congress for the prevention of accidents and industrial hygiene to be held in Milan in May, 1912. The Pennsylvania R. R. only recently received a medal from the American Museum of Safety for being the American employer to do the most in the past year for the protection of the lives and limbs of its workmen.

F. W. Boye, Jr. and W. T. Emmes have purchased the interest of Mr. W. A. Schumacher in the firms Schumacher & Boye and Schumacher, Boye & Emmes, and have incorporated a new company under the name of the Boye & Emmes Machine Tool Co., to take over these two concerns. Mr. Emmes is well known in the machine tool world, having been the general superintendent of the company for a number of years. He is the inventor of improvements in quick change gear devices and other features of engine lathes.

* * *

OBITUARIES

William W. Young, purchasing agent of the Union Switch & Signal Co., Swissvale, Pa., died January 21.

S. S. Smith, of Dallas, Texas, manager of the General Fire Extinguisher Co., of Texas, died suddenly at New Orleans, January 20.

Frank D. Smith, for the past ten or twelve years traveling salesman for the Waltham Watch Tool Co., Springfield, Mass., died January 24 at his home in Springfield after a few weeks' illness, aged fifty-nine years.

C. P. Miller, general superintendent of the Weir Frog Co., Cincinnati, Ohio, died suddenly at his office of heart failure, February 9. Mr. Miller had been connected with the company as general superintendent since 1906. He was buried at Hilburn, N. Y., his former home. He leaves a widow and three children.

Walter A. Post, president of the Newport News Shipbuilding & Dry Dock Co., Newport News, Va., died February 12, aged fifty-five years. Mr. Post was a civil engineer, and his connection with the Newport News Shipbuilding & Dry Dock Co. dates back to 1890, when he was put in charge of the erection and equipment of the plant. This work was carried out so satisfactorily that in 1898 he was made general manager. He was elected president in 1911.

S. D. Conover, a prominent citizen of Dayton, Ohio, and founder of the Miami Valley Machine Tool Co., died February 8, aged sixty-nine years. Mr. Conover was president of the company up to about a year ago when he retired from active business on account of ill-health. He was a director of the Gem City Building and Loan Association, and was interested in a number of enterprises. He leaves a widow, daughter and son, the latter being Mr. P. P H. Conover, the present head of the company.

FRANCIS H. STILLMAN

Francis H. Stillman, president of the Watson-Stillman Co., and a prominent figure in machine tool and engineering industries, died suddenly, February 18, of intestinal hemorrhage at his late residence, 105 Rodney St., Brooklyn, in his sixty-second year. The day before his death he was at his office as usual, and apparently in the best of health. Mr. Stillman was born in New York on February 20, 1850, and was graduated from Yale in the class of 1874 with the degree of B. S. He was a member of Hyatt Lodge, F. and A. M., a member of the thirty-second degree in Aurora Grata Consistory, a Knight Templar, a Noble of Kismet Temple, Mystic Shrine, and a member of the Royal Arcanum. He was a member of the Hanover Club of Brooklyn, the Engineers Club, the American Society of Mechanical Engineers, and continuously since its organization a director of the National Association of Manufacturers. He organized the Machinery Club of New York, and was its first president, and was also first president of the National Metal Trades Association. In addition to being president of the Watson-Stillman Co. at the time of his death, he was also president of the Bridgeport Motor Co., and of the Pequannock Commercial Co., and a director in other manufacturing firms. Aside from his continuous activities in various engineering organizations and projects, Mr. Stillman was one of the recognized pioneers and, perhaps, the most prominent American engineer on hydraulic machine and tool construction. On leaving college, Mr. Stillman first associated himself with the Cottrell Printing Press Co., then with his stepfather, Mr. Lyons. In 1883 he organized and became president of the

Francis H. Stillman

firm of Watson & Stillman, which succeeded Lyons & Co. The firm was incorporated in 1904 as The Watson-Stillman Co , Mr. Stillman remaining its president up to the time of his death. Under Mr. Stillman's direction, his firm early became prominent in the hydraulic engineering field, and it has built upwards of 4000 different types and sizes of hydraulic machines, and now has a large and active plant in Aldene, N. J. Mr. Stillman's kindly disposition, high standard of business integrity and kind personal interest in all those with whom he came in contact, won for him a large circle of friends that will keenly regret their loss in his death. He is survived by his widow, formerly Miss Irene A. Bancroft of Boston, and by two sons, Austin Frank and Edwin Arthur Stillman.

* * *

COMING EVENTS

May 13-15.—Triple convention of the American Supply and Machinery Manufacturers' Association. National Supply and Machinery Dealers' Association, and Southern Supply and Machinery Dealers' Association, at Norfolk. Va., Monticello Hotel, headquarters. F. D. Mitchell, secretary-treasurer, 309 Broadway, New York.

May 14-17—Sixth annual convention of the Master Boiler Makers' Association at the Fort Pitt Hotel, Pittsburg, Pa. J. R. Flannery, of the Flannery Bolt Co., Frick Bldg., Pittsburg, Pa., secretary and treasurer of the general committee of arrangements.

June 4-7.—Spring meeting of the American Society of Mechanical Engineers in Cleveland, Ohio. Calvin W. Rice, secretary, 29 W. 39th St., New York.

June 12-14.—Annual convention of the American Railway Master Mechanics' Association at Atlantic City, N. J.

June 17-19.—Annual convention of the Master Car Builders' Association at Atlantic City, N. J.

July 9—Annual convention of the American Railway Tool Foremen's Association in Chicago. H. L. Miller, secretary of the supply association, 835 Monadnock Bldg., Chicago, Ill.

August 20.—Annual convention of the International Railroad Master Blacksmith's Association at Hotel Sherman, Chicago, Ill. J. E. Carrigan, Rutland Railway, Rutland, Vt., chairman of the executive committee.

September 2 7.—Sixth congress of the International Association for Testing Materials at the Engineering Societies Building, 29 W. 39th St., New York. Mr. H. F. J. Porter, secretary, 1 Madison Ave., New York.

SOCIETIES AND COLLEGES

American Society of Engineer Draftsmen, 116 Nassau St., New York, held its regular monthly meeting in the Engineering Societies Bldg., 29 West 39th St., New York, on February 15, at 8:15 P. M. The subject of the meeting was "The Training of Draftsmen." by Prof. F. G. Higbee, head of the department of descriptive geometry and drawing, Iowa State University. Mr. Wm. F. Turnbull of the engineering department of the American Locomotive Co., delivered a lecture on "Some Common Faults of Draftsmen."

National Association of Master Steam and Hot Water Fitters, Wool Exchange Bldg., 260 West Broadway, New York. The 1912 U. S. standard schedule of standard weight and extra heavy flanged fittings and flanges which was lately adopted by the joint committee on standardization of the National Association of Master Steam and Hot Water Fitters and the American Society of Mechanical Engineers. The American Society of Heating and Ventilating Engineers' special committee on standards has reported in favor of recommending its use by members of that society. Copies of the schedule will be sent to architects, mechanical engineers, heating and ventilating engineers, manufacturers, dealers, and others interested, without cost, upon receipt of request.

Inventors Guild, Ralph D. Mershon, 60 Wall St., N. Y., president, has addressed a resolution to President Taft regarding inadequate patent protection given to American inventors. The substance of the resolution is that a patent is in effect a contract between the government and the inventor, by which the government in consideration of the right to publish the invention agrees to secure to the inventor for a limited time the exclusive right to use his invention, and that under present conditions these rights are not properly safeguarded. Under existing methods of trying patent causes, an inventor-patentee of average means cannot at his own expense carry to a conclusion a patent litigation against a wealthy opponent, and, therefore, a few wealthy concerns have acquired many important patents in their field, to the great damage of the nation, because of the restraint of competition and because of the resulting tendency of such inventors to seek protection for their inventions by keeping them trade secrets, or by ceasing to develop inventions.

NEW BOOKS AND PAMPHLETS

Year Book of the American Electrical Institute, 1912. F. L. Hutchinson, secretary, 23 West 39th St., New York.

The Vermont Bulletin. Catalogue 1911-1912. 190 pages, 5 by 7½ inches. Published by the University of Vermont and State Agricultural College, Burlington, Vt.

The Kingdom of Dust. By J. Gordon Ogden. 116 pages, 4¾ by 7 inches. Numerous halftone illustrations. Published by Popular Mechanics Co., Chicago, Ill. Price 50 cents.

Comparative Railway Statistics of the United States, United Kingdom, France and Germany. Published as Bulletin No. 24, by the Bureau of Railway Economics, Washington, D. C.

New Hampshire Highways. Report of an Inspecton of Highways in the State of New Hampshire, August, 1911. By Charles H. Hoyt. Published by U. S. Department of Agriculture, Washington, D C.

Proceedings of the American Electric Railway Engineering Association, 1911, containing a complete report of the ninth annual convention held at Atlantic City, N. J., October 9-13, 1911. H. C. Donecker, secretary-treasurer, 29 West 39th St., New York.

The Modern Submarine Boat. Chart 14 by 28 inches. Published by Norman W. Henley & Son, New York. Price 25 cents.

This chart is printed on heavy paper, suitable for framing, and contains a cross-section showing clearly and distinctly the interior parts of a modern submarine boat. Two hundred parts are numbered and named in a reference list printed alongside of the illustration. The chart is drawn accurately to scale.

The Essentials of Lettering. By Thomas E. French and Robert Meiklejohn. 94 pages, 9 by 6 inches. 119 illustrations. Published by McGraw-Hill Book Co., New York. Price $1.00.

This is the third edition of a manual on lettering for students and designers. Like the previous editions, it contains an outline on the history of lettering, and then contains chapters on letter construction, composition and titles, selection of styles, letters in design, design and composition, monograms, ciphers and marks, and on drawing for reproduction.

Engineering Directory. 1496 pages, 4 by 6¾ inches. Published by D. Crawford Publishing Co., Chicago, Ill. Price $5.00.

This is the 1912 edition of this well known directory, now in its nineteenth year of publication. In the classified section, manufacturers' products are found under 3850 classifications. The directory contains the names of more than 6000 manufacturers, producing over 4000 varieties of engineering goods and having more than 50,000 trade or brand names. The book is bound in leather and has thumb indexes to its fifteen sections.

Hand Forging and Wrought Iron Ornamental Work. By Thomas F. Googerty. 197 pages, 5¼ by 8 inches. 122 illustrations. Published by Popular Mechanics Co., Chicago, Ill. Price $1.00.

This book has been written in order to meet the demand for an inexpensive text-book on the subject of hand-wrought ornamental iron work. It contains numerous examples of ornamental forging, giving explicit directions for doing the work. It contains twelve chapters headed as follows: Introductory; Equipment; Working at the Forge; Various Forms of Welding; Welding (Concluded); Twisting, etc.; Scrollwork; Box Forging; Embossing; Drawer-pulls and Hinges; Doorplates; Iron Lamps.

An Investigation of the Strength of Rolled Zinc. By Herbert F. Moore. 24 pages, 6 by 9 inches. 14 illustrations. 13 tables. Published by the University of Illinois, Urbana, Ill. Price 15 cents.

This bulletin, No. 52 of the Engineering Experiment Station of the University of Illinois, records the results of tests made in the laboratory of applied mechanics of the University on the tensile, compressive and shearing strength of zinc. Comparison is made with results of tests made in Europe. The resisting power of the zinc to stress is shown to be from 30 to 40 per cent of that of soft steel. While normally sold at a price of 15 cents, copies of the bulletin may be obtained free of charge upon application to Prof. W. F. M. Goss, University of Illinois, Urbana, Ill.

Efficiency as a Basis for Operation and Wages. By Harrington Emerson. 256 pages 5 by 7½ inches. Published by the *Engineering Magazine*, New York. Price $2.00.

This is the third edition of this work. It has been revised and enlarged, but, of course, the subject matter is in the main the same as in the previous editions. While, as the author says, when the first edition was brought out, it was almost as the voice of one crying in the wilderness, with a new doctrine and an unusual form of teaching it, the subject is now fairly familiar to the engineering world. The main changes in the third edition consist in the revision which has been due to the rapid change of public sentiment, and the enlargement of the text designed principally to emphasize certain points upon which experience has shown added emphasis to be necessary.

Prevention of Railroad Accidents or Safety in Railroading. By George Bradshaw. 173 pages, 4½ by 6½ inches. Numerous illustrations. Published by Norman W. Henley & Son, New York. Price 50 cents.

The author of this book, a practical railroad man, has for ten years been constantly engaged in the investigation and settlement of claims for personal injuries and death resulting from railroad accidents. This direct experience gives his work especial value. The book is addressed especially to railway employes and is, therefore, confined to that class of accidents that are within the power of the employes to prevent by their own personal efforts. The illustrations in the book show in a graphical manner how dangers may be avoided in railroading, and illustrate also the careless methods which are the cause of many accidents. The book is of considerable interest even to non-railroad men, and some of the general sections would be useful to anyone in the mechanical trades.

Twelve Principles of Efficiency. By Harrington Emerson. 423 pages, 5 by 7½ inches. Published by the *Engineering Magazine*, New York. Price $2.00.

The earlier book—"Efficiency as a Basis for Operation and Wages" by the same author, was essentially the statement of a philosopher. It contains a new view of the industrial problem and defines the relations and proportions of the factors that enter into it This latter volume is in a sense a continuation of the earlier work, but it is more specific in its statements and reduces the doctrine of efficiency to a practical basis. The twelve principles of efficiency the author enumerates are as follows: Clearly defined ideals; common sense; competent counsel; discipline; the fair deal; reliable, immediate and adequate records; despatching; standards and schedules; standardized conditions; standardized operations; written standard practice instructions; and efficiency reward. The book contains a great many examples from practice indicating possibilities for improved efficiency and makes altogether interesting reading even if one should not everywhere agree with the conclusions of the author. On many important questions the author, although at odds with the trend of the times, undoubtedly strikes the true keynote of efficiency, as for example when he scores the great terminal stations of railroads as monuments of inefficiency, and shows that they are lacking in the application of true engineering principles.

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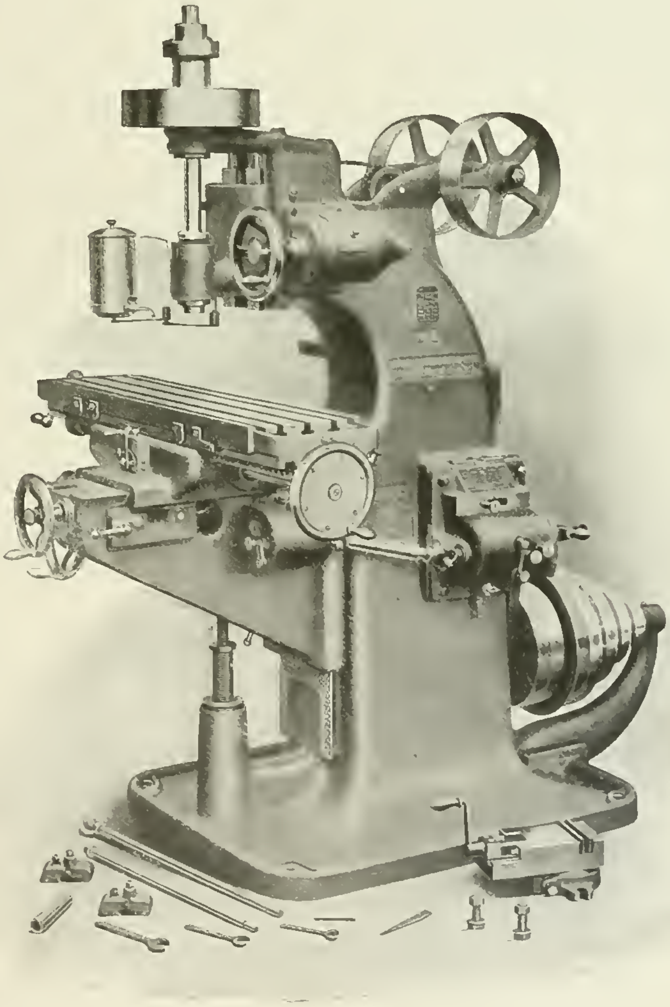

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PROVIDENCE, R. I., U. S. A.

Street Lighting. By J. M. Bryant and H. G. Hake. 61 pages, 6 by 9 inches. 28 illustrations. Published by the University of Illinois, Engineering Experiment Station, Urbana, Ill., as Bulletin No. 51.

Efficient and economical street lighting is a subject on which little information of a definite and tangible character has been published. Bulletin No. 51 is designed to supply such information concerning electric street lighting. The subject has been treated in a simple, direct manner, and while of especial interest and value to the technically trained illuminating engineer, will appeal particularly to city councils and central station managers. The general theory and construction of electric lamps, both incandescent and arc, are discussed together with the standard systems of electric distribution for lighting, and accepted methods for the measurement and study of illumination, with and without shades and reflectors. These principles are then applied to the study of street illumination, curves and calculations being given to show the candle-power distribution for the various lamps used, equipped with their proper glassware and reflectors, and others to show the illumination along the street for representative installations and conditions. Based upon these results a discussion is given of the proper lighting of business streets, cross streets, boulevards, residence streets and outlying districts. The subject of economy for the several systems and lamps is discussed—the initial cost, up-keep, interest, and depreciation of various lamps and equipment are considered in tables and curves showing their relative economy at standard costs of power. Attention is also called to the economical selection of different lamps for certain classes of illumination

NEW CATALOGUES AND CIRCULARS

Walter O. Amsler, Pittsburg, Pa. Descriptive pamphlet of the Amsler gas producers and accessories.

United Nut Lock Co., Springfield, Mass. Leaflet advertising the "Hugtite" nut lock manufactured by the company.

Emerson Electric Mfg. Co., St. Louis, Mo. Catalogue of Emerson fan motors for alternating and direct currents.

Robbins Conveying Belt Co., New York. Bulletin No. 48 on chains, sprockets and elevators; Bulletin No. 49 on conveyor belts.

Harvey Hubbell, Inc., Bridgeport, Conn. Folder advertising the Hubbell lamp guard, a wire guard for protecting the bulbs of electric lamps.

Calculagraph Co., 9 Maiden Lane, New York. Circular on the advantages of the calculagraph for registering actual working time in shops, mills, factories, etc.

National Tube Co., Pittsburg, Pa. Bulletin No. 8 treating of the necessity for protecting pipe with a coating material, and giving suggestions relating to the laying of pipe covered with "National" coating.

Sprague Electric Works of the General Electric Co., 527 W. 34th St., New York. Catalogue No. 325 of Sprague electric fans, illustrating and describing the various types of fans made by the company.

Fawcus Machine Co., Pittsburg, Pa. Booklet on worm gearing, containing a general outline of the requirements of worm-gearing installations, and tables of standard worm-gearing manufactured by the company.

Chicago Pneumatic Tool Co., Chicago, Ill. Bulletin No. E-19 on universal electric drills operating on direct or alternating current; bulletin No. E-20 on a new line of electric drills for heavy duty for direct current.

Pawling & Harnischfeger, Milwaukee, Wis. Folder illustrating "P. & H." apparatus for steel mills rolling mills, foundries, etc., comprising grab buckets, charging machines, mono-rail systems, mill type cranes, etc.

National Tube Co., Pittsburg, Pa. N. T. C. bulletin No. 4 on "Corrosion of Boiler Tubes," by Rear Admiral John D. Ford, U. S. N., being an abstract of a paper published in the journal of the American Society of Naval Engineers, May, 1904.

Electro-Dynamic Co., Bayonne, N. J. Circular No. 39, entitled "Ratings and Dimensions of Inter-Pole Constant and Adjustable Speed Type 'S' Motors." The circular, which covers 24 pages, is principally devoted to tables giving this information.

Electric Controller & Mfg. Co., Cleveland, Ohio. Bulletins No. 1917, on automatic controllers; No. 1918, motor field rheostats; No. 1019, protective panels for direct-current motors; No. 1020, automatic float switch; No. 1021, motor starting rheostats.

Uehling Instrument Co., Passaic, N. J. Bulletin No. 102 on recording instruments, describing a line of recorders for pressures up to 30 pounds per square inch. These instruments are calibrated either in ounces, pounds, inches of water or mercury.

Seager Engine Works, Lansing, Mich. 1912 catalogue of Olds gasoline and kerosene engines. Various types of engines from the smallest sizes up to 70 H. P., intended for miscellaneous uses—for small power plants as well as for agricultural work—are illustrated and described.

Link-Belt Co., Philadelphia, Pa. Circular illustrating application of the "Maximum" silent chain to automobile engines. The illustrations show the "Maximum" chain applied to driving the magneto, pump and camshaft, thus eliminating all toothed gearing in mesh and reducing the gear noise.

Western Tool & Mfg. Co., Springfield, Ohio. Catalogue of shop furniture comprising portable vise stands, tool stands, lathe stands, stands for blacksmith and machine shops, assembling stands, driving block stands, steel racks, power hacksaws, bench legs, drill holders, emery wheel dressers, etc.

Thomas E. Butterfield, consulting engineer and gas power specialist, 68 William St., New York. Circular indicating the work which Mr. Butterfield is prepared to undertake, such as testing gas and oil engines and producers, designing of gas engines and producers, building, equipping and organizing new shops, etc.

Lexington Instrument Works, Lexington, Ohio. Bulletin No. 1 on the Smith recording gas calorimeter, type A. This instrument is designed to supersede the ordinary type of calorimeter which requires the services of a skilled chemist in order to get satisfactory results. The Smith calorimeter will give reliable results in the hands of the ordinary plant operator.

General Electric Co., Schenectady, N. Y. Bulletins No. 4887, on small turbo-generator sets from 5 K.W. to 300 K.W.; No. 4900, on series incandescent lighting apparatus; No. 4918, on direct-current switchboards; No. 4919, on small plant direct-current switchboards; No. 4920, on GE-203A railway motor; and No. 4924, on Thomson prepayment watthour meters.

Smith-Booth-Usher Co., 228-238 Central Ave., Los Angeles, Cal. Catalogue A of machinery, supplies, pipe and fittings comprising equipment for pumping and irrigation plants, power plants, distillate engines, steam boilers, steam engines, air compressors, transmission machinery, machine tools, woodworking machinery, mining machines, concrete and brick machinery, etc.

George J. Henry, Jr., hydraulic and mechanical designing and constructing engineer, Rialto Bldg., San Francisco, Cal. Booklet entitled "Water Power," giving hints as to its economical and efficient development and use for hydro-electric transmission for mining and industrial plants, and containing miscellaneous information relating to hydraulic power plant developments.

B. F. Sturtevant Co., Hyde Park, Mass. Catalogue No. 190 on Sturtevant steam turbines illustrating and describing the new slow-speed type particularly adapted for direct connection with blowers, ventilating fans, gas exhausters, mechanical draft installations, electric generators, centrifugal pumps, and other apparatus for which efficient turbine speeds have generally been too high.

National Electric Welder Co., Warren, Ohio. Circular of the National spot welder, which in the 24-inch size will weld to the center of a 48-inch shape and unite two 3/8-inch pieces of boiler plate. The machine has a capacity of thirty spot welds per minute in 1/16-inch sheet steel and twenty per minute in 1/8-inch sheet steel. The company makes both spot and butt welding machines.

Langelier Mfg. Co., Providence, R. I. Bulletin No. 28-32 on Langelier multiple drilling machines with three interchangeable heads. These heads embody the well-known Langelier design of multiple spindles with cranks driven by a common crank plate on the main spindle. The design of drilling head enables the maker to place spindles in any desired relation and at a minimum distance apart.

Fitchburg Steam Engine Co., Fitchburg, Mass. Pamphlet on the Fitchburg plan of industrial education by Mr. W. B. Hunter, director of the industrial department of the Fitchburg high school. All who are interested in industrial education should procure copies of this pamphlet which describes the successful Fitchburg plan of educating boys in the high school and the shops simultaneously.

Cork Insert Co., 16 State St., Boston, Mass. Booklet entitled "Here's the Proof," containing a number of letters from customers of the company, giving the results obtained from cork-insert installations; also folder entitled "Relative Cost per H. P. transmitted by means of Plain and Cork-Insert Pulleys." This folder contains a diagram to illustrate the comparison, and tabulated cost estimates.

Sidney C. Carpenter, Box 191, Plainville, Conn. Binder with sheets of engineering data useful to draftsmen, designers, mechanical engineers, and others concerned with the design, construction and use of machinery. These data sheets comprise weights and measures, steam engines air brakes, pay-rolls, drafting room conventions, machine shop work, machine design, etc. Prices given upon application.

Hinckley Machine Works, Hinckley, Ill. Circular of the Davis milling attachment and compound table for drilling machines, consisting of a circular base carrying a saddle on cross-slides which are operated by screws having balanced handles. The circular illustrates the use of the attachment showing how any upright drill press from 14 inches to 42 inches swing can be converted into a vertical milling machine.

Wheeler Condenser & Engineering Co., Carteret, N. J. Booklet entitled "Steam Tables for Condenser Work." This is a hand-book of steam tables with pressures below atmosphere expressed in inches of mercury referred to a 30-inch barometer. It also includes a discussion of the use of the mercury column None of the tables given have ever been published before, but have been calculated especially for this book.

General Electric Co., Schenectady, N. Y. Bulletin No. 4893, describing automatic time switches; No. 4901, on alternating-current switchboard panels; No. 4904, on small plant alternating-current switchboard; No. 4905, on small plant alternating-current switchboards; No. 4906, on the lighting of textile mills with Edison Mazda lamps; No. 4907, on the lighting of offices, banks and public buildings; No. 4917, on direct current exciter panels.

Ferro Machine & Foundry Co., Hubbard Ave. and E. 66th St., Cleveland, Ohio. Catalogue of "Ferro" gasoline engines, including a practical treatise on the subject. This handsome publication will be found of general interest by all concerned with the use and operation of gasoline engines, being fully illustrated and showing details of construction throughout. The catalogue illustrates the company's line of marine engines for launches and power boats.

James Clark, Jr., Electric Co., Louisville, Ky. Catalogue of "Willey" electrically driven tools, dynamos and motors, comprising portable drills for alternating or direct current in a variety of styles; lathes, center grinders, suspended surface grinders, buffers and bench grinders, water tool grinders, wet and dry grinders, sensitive bench drills, upright floor drills, two and three spindle drills, radial drills, notching presses, winding machines, etc., all electrically driven.

Morton Mfg. Co., Muskegon Heights, Mich. Catalogue of draw-cut shapers and keyseating machinery, comprising bulletins Nos. 1, 2, 3, 4, 5, 6 and 7 on keyseating machines, portable planers and portable keyseaters, standard pillar draw-cut shapers, 26-inch stroke draw-cut shaper with rod brass and shell planing attachments, 30-inch stroke shaper with rod brass shell planing and parallel shoe and wedge attachments, special railroad draw-cut shaper and traveling head draw-cut cylinder planers with full equipment.

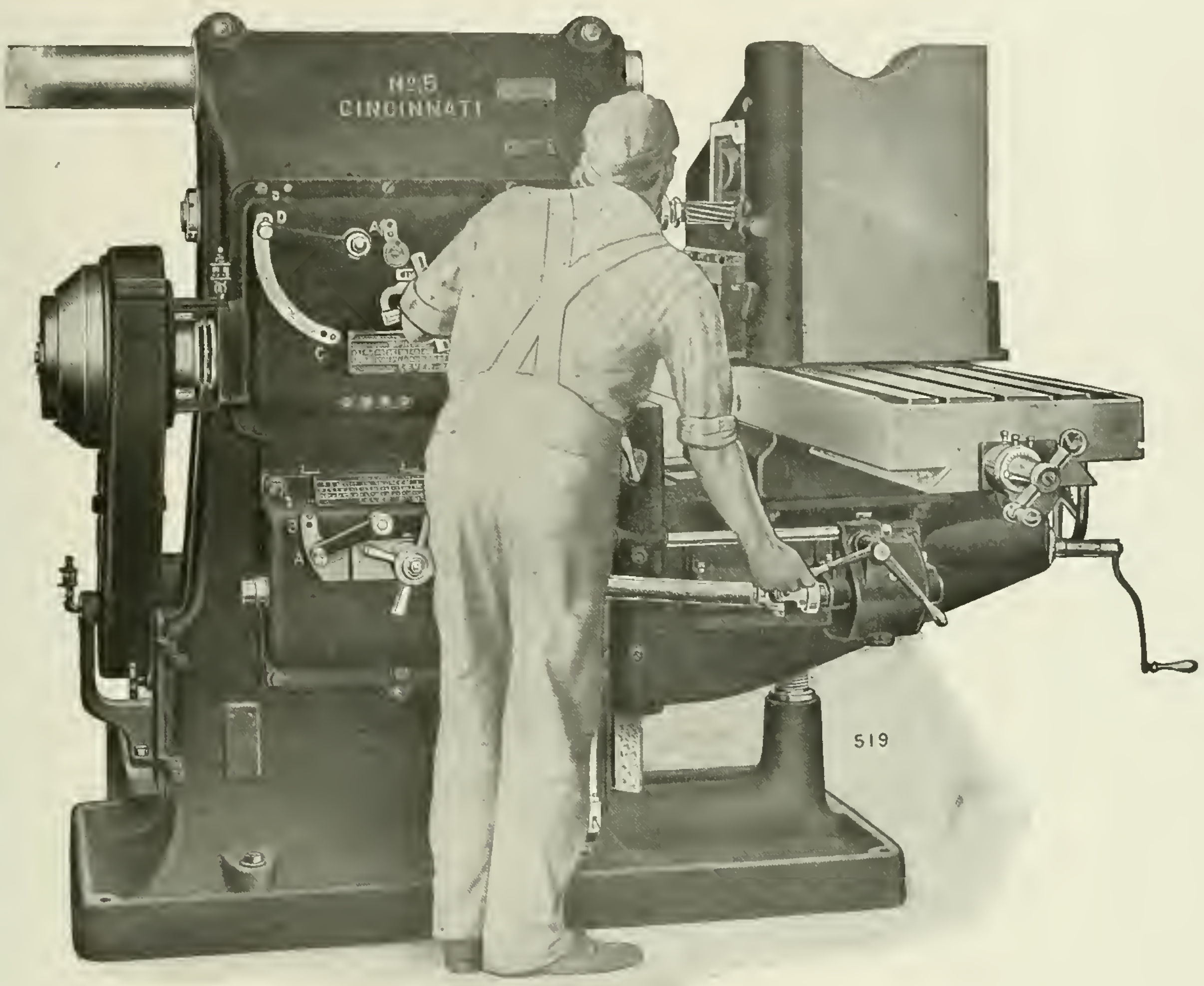
V & O Press Co., Glendale, Brooklyn, N. Y. Bulletin No. 6 illustrating and describing automatic attachments for power presses; bulletin No. 1A on inclinable presses; and bulletin No. 200 on sheet metal working machinery. The latter bulletin describes several types of sheet metal working machines which supplement the ordinary press and die equipment of manufacturers of sheet metal articles, such as small automatic screw machines, knurling machines, hand wire ring machines, beading and flanging machines, draw benches, and rolling machines.

Westinghouse Electric & Mfg. Co., East Pittsburg, Pa. Folder No. 4222, on economy coils for tungsten display lighting; descriptive leaflet No. 2299-A, on Westinghouse type HF slip ring induction motors; leaflet No. 2386, on alternating current heavy duty type MW slip ring induction motors; leaflet No. 2387, on type MS alternating current elevator motors; leaflet No. 2390, on type E alternating current generators for engine drive; leaflet No. 2389, on type G alternating current generators for belt drive; and folder 4213, on oil circuit breakers.

Armstrong Mfg. Co., 297 Knowlton St., Bridgeport, Conn. Catalogue showing the company's full line of pipe threading machines and parts. The catalogue comprises 45 pages, 6 by 9 inches. An interesting feature of this catalogue is that every detail that enters into the manufacture of this company's machines is illustrated and either lettered or numbered, so that a customer can order duplicate parts directly from the catalogue, and can thus replace broken or worn parts without delay, which is an extremely important feature in the case of a breakdown.

New Departure Mfg. Co., Bristol, Conn. Catalogue of ball bearings containing 76, 6 by 9 inch pages, giving information of a technical character relating to ball bearings, well illustrated with high-grade engravings. The book treats of the double row, the single row, and the "radax" type of ball bearings, and describes the accurate methods for testing used in the company's plant. The greater part of the catalogue is given over to concise descriptions of the application of ball bearings and suggestions for their proper use. A number of useful tables are included

Cincinnati Handiness



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Marvin & Casler Co., Canastota, N. Y. Catalogue of the Marvin & Casler offset boring tool for lathes, milling machines, drilling machines, boring machines, etc. The tool is graduated to 0.001 inch and provision is made for holding the adjustment so that the tool stays where it is set. The catalogue is illustrated with examples showing uses of the tool that will suggest other uses to interested persons. The tool is made in five sizes, the small size having offset capacity of 3/16 inch and drill chuck capacity of 1/2 inch, and the large size 5/8 inch and 1 1/2 inch respectively.

T. B. Wood's Sons Co., Chambersburg, Pa. Catalogue No. 55 entitled "Modern and Approved Appliances for the Transmission of Power." This catalogue comprises 242 pages, 6 by 9 inches, and is substantially bound. It lists a complete line of power transmission appliances with dimensions and price lists, and includes shafting, shaft collars, flange or plate couplings, double cone compression couplings, Collins compression couplings, clutch couplings, hangers and hanger bearings, pillow blocks, belt shifting appliances, countershafts, pulleys, belt tighteners, friction clutches, rope sheaves, etc.

Veeder Mfg. Co., 39 Sargeant St., Hartford, Conn. Catalogue of the Veeder products, including the Veeder hub odometer or mileage recorder for trucks, automobiles or taxicabs; the Veeder tachodometer, which is a combination of speed indicator and mileage recorder; cyclometers for bicycles and motor cycles; the Veeder counters for different purposes; revolution counters for finding the revolutions per minute made by a shaft or any other revolving part; and printing press counters and tachometers. The catalogue gives complete descriptions of the various instruments and their use and care. It also includes illustrations and descriptions of die castings, which this firm makes for the trade.

Norton Co., Worcester, Mass. 1912 edition of catalogue of grinding wheels and machinery, listing the Norton products, including alundum grinding wheels, crystolon grinding wheels, alundum grain for polishing, crystolon grain for polishing, India oilstones crystolon sharpening stones, glass cutting wheels, razor hones, scythe stones, Norton alundum refractories, Norton valve grinding compound, rubbing bricks and stones, grinding wheel dressers, and grinding machinery. The catalogue comprises 142 pages, 6 by 9 inches, and shows excellent illustrations of all the products of the company. It also contains considerable information of a general nature, useful in the grinding department of a machine shop.

Morse Twist Drill & Machine Co., New Bedford, Mass. Catalogue of increase and constant angle twist drills, reamers, chucks, milling cutters, taps, dies, machinery and machinists' tools. This catalogue for 1912 is the largest and most comprehensive catalogue issued by the company. The alphabetical index of contents covers nearly seven and one-half pages, and the index by numbers nearly six and one-half pages. The two indexes make the finding of any desired article an easy matter. Tables and data which conclude the catalogue are of general value to users of machine tools, and the catalogue will be of general interest and value to superintendents, foremen, machinists, toolmakers, apprentices, etc.

Carlyle Johnson Machine Co., Manchester, Conn. Booklet entitled "The Johnson Friction Clutch as Applied in Machine Building," showing illustrations of well-known machine tools in which the Johnson clutch is being successfully used. The illustrations comprise the Newton horizontal milling machine, Betts vertical boring mill, Gridley multiple spindle automatic screw machine, Beaman & Smith quick operating vertical spindle milling machine, J. E. Snyder & Son's upright drill, Merrell Mfg. Co's pipe threading machine, Fay Machine Tool Co's automatic turning lathe, National-Acme Mfg Co's automatic screw machine, etc. The booklet illustrates the construction of the clutch, showing its compactness and simplicity.

Crescent Machine Co., 56 Main St., Leetonia, Ohio. Catalogue No. 51 of the Crescent universal wood-worker which comprises a band saw, jointer, shaper, saw table and borer in one machine. It is not, however, a combination in the sense of a single machine that can be adapted for different uses, but is a combination of machines each independent of the other, arranged compactly and self-contained so that all can be driven by one main belt from the lineshaft. It is not necessary to run more than one machine when only one is in use, but four persons may use different machines at the same time without hindrance. The value of a machine of this compact arrangement for pattern shops and other places where space is limited, is obvious.

Charles H. Besly & Co., 118 N. Clinton St., Chicago, Ill. Catalogue of Besly spiral disk grinders, band polishing machines, "Helmet" spiral circles, etc. The growth of the disk grinder business is strikingly shown by this catalogue of 112 pages. It has been necessary to index the different types of grinders, covering their general purposes, the divisions being single spindle, belt-driven machines; single spindle, motor-driven machines; double spindle, belt-driven machines; vertical spindle and special grinders, and patternmakers' disk grinders. It has been the aim to make the catalogue answer any reasonable question, and not only is full information given in connection with each machine, but also detailed dimensions, weights, etc., of disk wheels, ring wheel chucks, various types of floor presses, work tables, countershafts, fixtures, accessories, etc.

Heald Machine Co., 20 New Bond St., Worcester, Mass. Booklet "Oversize Standards for Pistons and Rings," by Mr. James N. Heald, being a reprint of a paper presented at the summer meeting of the Society of Automobile Engineers, June, 1911. The author advocates establishing certain oversize standards for automobile pistons and rings, the object being to enable automobile engines to be refitted with new pistons at low cost. If worn automobile cylinders are bored or ground under present conditions it is necessary to make patterns for new pistons, and to fit the pistons up from the rough castings. The automobile manufacturers should provide oversize pistons as they have the jigs, fixtures and patterns that can be easily adapted to the oversize requirements. The oversizes suggested are 0.010, 0.020 or 0.050 inch more than the standard sizes. With these sizes in stock a repair man could regrind an auto cylinder and fit it with a new piston and rings in short time and at small expense.

TRADE NOTES

Mumford Molding Machine Co., Plainfield, N. J., reports the sale of a large 24-inch jolt reamer, having a capacity of 24,000 pounds, to the Canadian Rand Co., Sherbrooke, Quebec, Canada.

Stark Rolling Mill Co., Canton, Ohio, has furnished a large amount of formed sheet metal of anti-corrosive "Toncan" metal for the United States coaling station at Pearl Harbor, Hawaii.

Westinghouse Air Brake & Traction Brake Co., has removed the office of its southeastern manager, Mr. R. A. Craig, from the general office Wilmerding, Pa., to 308 Westinghouse Bldg., Pittsburg, Pa.

Adams-Bagnall Electric Co., Cleveland, Ohio, manufacturer of electric light apparatus specializing on electric lighting systems for industrial plants, is now located in its new factory at 7125 Platt Ave., S. E., Cleveland.

Ruggles-Coles Engineering Co., 50 Church St., New York, reports that the Bayonne Casting Co. has just cast the second propeller for one of the Japanese battleships. These propellers, each of which weighs approximately 12,000 pounds, are to go to the Fore River Ship-Building Co. for finishing and will then be sent to Japan.

H. W. Johns-Manville Co., has moved its Pittsburg office from Liberty Ave. above Ninth St. to the eight-story stone, reinforced concrete and steel building at the northeast corner of Wood St. and First Ave. The company has leased the entire building for a term of years and will occupy the whole of it. The building is 31 by 96 feet and contains a gross floor space of approximately 23,800 square feet.

H. W. Johns-Manville Co., 100 William St., New York, has acquired the sole selling agency for the Frink reflectors and illuminating specialties. The company is already known in the illuminating field by reason of its J-M linolite system of illumination and will now be in position to design and sell lighting systems for every known form of artificial illumination. An extensive engineering department will be maintained.

Standard Electric Time Co., a Connecticut corporation formerly located at Waterbury, Conn., and now temporarily located at Foxboro, Mass., will move to its new factory building on Logan St., Springfield, Mass., in April. The general office of the company, which has been in Boston, Mass., will also be transferred to Springfield. Mr. George L. Riggs is president and general manager, and Mr. G. F. Harter, works manager.

Best Mfg. Co., Pittsburg, Pa., has equipped its new plant to expeditiously fill all orders for piping of every description. It is prepared to lay out entire piping systems, furnish material cut and fitted ready for erection, or to take contracts and install complete, ready for operation. Mr. H. W. Evans, formerly with the Crane Co., Chicago, is general manager of sales in charge of the sales, order and engineering departments.

Boye & Emmes Machine Tool Co., Cincinnati, Ohio, is the successor of Schumacher & Boye and Schumacher, Boye & Emmes. Mr. F. W. Boye, Jr., and W. T. Emmes have purchased the interest of Mr. W. A. Schumacher in both firms. Mr. Emmes has been connected with the firm for a number of years and has a wide reputation in the mechanical line. The firm of Schumacher & Boye has been in existence for about fourteen years.

H. B. Brown Co., East Hampton, Conn., recently had an important change in personnel of its officers. Prof. Charles S. Brown has acquired a controlling interest, and has been made president; Abner W. Barton is secretary and treasurer; and Henry B. Brown, the late president, after forty-six years of continuous and successful labor, retires from active duty. The company manufactures bolt and nut machinery, and its product is well known throughout the world.

Vermont Machine Tool Co., Windsor, Vt., has been incorporated to manufacture a multiple-spindle automatic turret drilling machine, designed by Mr. G. O. Gridley of the Windsor Machine Co. In addition to the advantages of the usual type of multiple-spindle drill, this machine is fully automatic in its action, so that its output is not dependent upon the personal element of the operator, and it has in addition certain features in common with the turret machines.

Neil Machinery Co., successors to Geo. E. Neil, machine tool dealer, has opened large display rooms at 711-713 St. Clair Ave., N. E., Cleveland, Ohio, and will handle a line of machine tools. The company will represent, among other concerns, the Springfield Machine Tool Co., Springfield Ohio; Oliver Machinery Co., Grand Rapids, Mich., and the Waterbury, Farrel Foundry & Machine Co., Waterbury, Conn. Mr. Neil was for a long time connected with the W. M. Pattison Supply Co., but has been doing business for himself for the past three years. The company is open for arrangements for agencies in non competing lines.

Lea Equipment Co., manufacturer of high-duty centrifugal pumping equipment and the "Lea-Simplex" cold saws, which has heretofore had general offices at 97 West St., New York, has found it necessary to enlarge its manufacturing facilities to accommodate its extensive and growing trade by removal to the works at the corner of Stenton and Wyoming Aves., Philadelphia. The general sales offices will be located at the works under the supervision of Mr. H. R. Williams, the general sales manager. The company will retain quarters in the West St. building, New York, from which point the export and Eastern trade will be served by the president, Mr. Albert G. Lea

Bausch Machine Tool Co., 200 Wason Ave., Springfield, Mass., has increased its capital stock to $500,000, 6 per cent accumulative preferred stock and $1,000,000 common stock following the transfer of a controlling interest from Mr. Frank H. Page, president of the National Equipment Co., to Mr. C. K. Lassiter, mechanical superintendent of the American Locomotive Co. The company will take over the manufacture of multiple-spindle and hydro-pneumatic drills, bolt turning machines and stay-bolt threading machines, designed and patented by Mr. Lassiter. The officers of the new company are: C. K. Lassiter, president; Frank E. Bocorselski, vice-president; Walter H. Foster, treasurer; J. A. Eden, general manager; and Charles A. Smith, superintendent.

Van Dorn & Dutton Co., Cleveland, Ohio, reports that it is receiving many orders from concerns that appreciate the high electrical and mechanical efficiency of its electrical portable tools. The McClintic-Marshall Construction Co., Pittsburg, Pa., several months ago purchased for its Panama Canal work twelve of the Van Dorn & Dutton hard service electric reamers, and later duplicated the order. The same company has recently given another order for twenty-four of the type DC-3 hard service electric reamers. The Hupp Motor Co., Detroit, Mich., recently ordered twenty-five Van Dorn & Dutton electric drills, having found them peculiarly adapted to motor car construction work. The C. R. Wilson Body Co., Detroit, Mich., has twenty-four electric drills in service, and the Haskell & Barker Car Co., Michigan City, Ind., has twenty in its new steel freight car shop.

Eagan-Rogers Steel & Iron Co., has been incorporated under the laws of the state of Pennsylvania with a capitalization of $100,000. The company has acquired a five-acre tract on the Pennsylvania Railroad in the Chester district between Crum Lynne and Eddystone, Pa., and has started the erection of modern steel buildings, the contract for which was let to the McClintic-Marshall Construction Co. The men most actively interested in the company are Messrs. Daniel C. Eagan and John I. Rogers. Mr. Eagan is the son of the late Daniel Eagan and has had wide experience in this line of work, and Mr. Rogers is an engineer who was formerly with the Midvale Steel Co., and has been in consulting practice for the last few years in New York and Philadelphia. The company will specialize on forging plants; hammer, hydraulic press, and drop forging; tire and wheel rolling, etc. The plant is expected to be in active operation about March 1.

Permanent Manufacturers Exhibit Railway Supplies and Equipment, Karpen Bldg., 900 S. Michigan Blvd., Chicago, Ill., has been established on the twelfth floor, having an area of 26,000 square feet. Provisions have been made for additional floors should they be required. The purpose of the exhibition is to display all kinds of railway supplies. In connection with the exhibition there are large assembly and committee rooms for the use of railway associations, free of charge, and also a large club room, which, in furnishings and service, is of the highest class. The booths or display spaces are furnished by the management with all the necessary equipment for doing business, such as rugs, furniture, heat, light, janitor service,

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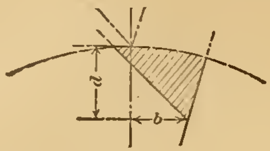
SETTING DOUBLE-ANGLE FLUTING CUTTERS—I



Elevation Formula:

$d = R_1 - x R$

R_1 = radius of blank,

R = radius of finished cutter,

d, see illustration; x, see table.

Cross-movement Formula:

$b = y R$

R = radius of finished cutter,

b, see illustration; y, see table.

In table, W = width of land.

Number of Teeth in Cutter	$\frac{W}{R} = \frac{\text{Land}}{\text{Rad.}}$	Value of x for "Elevation" Formula						Valne of y for "Cross-movement" Formula					
		$\alpha = 12°$ $\beta = 52°$	12° 55°	12° 60°	12° 65°	12° 72°	15° 80°	12° 52°	12° 55°	12° 60°	12° 65°	12° 72°	15° 80°
6	0.020	......	......	0.0235	0.1125	0.2328	0.3536	......	......	0.0050	0.0238	0.0497	0.0948
	0.040	......	......	0.0489	0.1344	0.2540	0.3719	......	......	0.0098	0.0285	0.0540	0.0997
	0 060	......	......	0.0685	0.1563	0.2736	0.3902	......	......	0.0146	0.0332	0.0582	0.1046
	0.080	......	......	0.0910	0.1782	0.2934	0.4085	.....	......	0.0190	0.0379	0.0624	0.1095
	0.100	......	......	0.1133	0.2001	0.3130	0.4269	......	......	0.0230	0.0425	0.0666	0.1144
	0.120	......	......	0.1359	0.2220	0.3326	0.4453	......	......	0.0288	0.0471	0.0708	0.1193
8	0.020	0.1770	0.2300	0.3159	0.3912	0.4861	0.5795	0.0375	0.0488	0.0671	0.0831	0.1034	0.1553
	0.040	0.2010	0.2529	0.3368	0.4118	0.5041	0.5934	0.0426	0.0542	0.0715	0.0873	0.1071	0.1590
	0.060	0.2251	0.2758	0.3580	0.4308	0.5212	0.6073	0.0479	0.0595	0.0779	0.0915	0.1108	0.1627
	0.080	0.2491	0.2987	0.3791	0.4500	0.5383	0.6210	0.0531	0.0644	0.0803	0.0957	0.1145	0.1664
	0.100	0.2732	0.3216	0.4000	0.4698	0.5555	0.6352	0.0582	0.0689	0.0847	0.0999	0.1182	0.1701
	0.120	0.2973	0.3445	0.4196	0.4890	0.5726	0.6495	0.0632	0.0730	0.0891	0.1040	0.1219	0.1738
10	0.020	0.3648	0.4108	0.4793	0.5421	0.6192	0.6950	0.0767	0.0872	0.1019	0.1152	0.1318	0.1861
	0.040	0.3880	0.4328	0.5000	0.5602	0.6350	0.7081	0.0821	0.0920	0.1062	0.1190	0.1352	0.1896
	0.060	0.4121	0.4548	0.5202	0.5783	0.6511	0.7212	0.0874	0.0969	0.1105	0.1228	0.1386	0.1931
	0.080	0.4351	0.4768	0.5401	0.5964	0.6673	0.7343	0.0926	0.1015	0.1148	0.1266	0.1420	0.1966
	0.100	0.4582	0.4988	0.5598	0.6145	0.6831	0.7474	0.0977	0.1062	0.1191	0.1304	0.1454	0.2001
	0.120	0.4822	0.5213	0.5790	0.6326	0.6992	0.7605	0.1027	0.1110	0.1234	0.1342	0.1488	0.2036
12	0.020	0.4871	0.5243	0.5839	0.6340	0.7011	0.7621	0.1035	0.1116	0.1240	0.1350	0.1493	0.2045
	0.040	0.5089	0.5462	0.6031	0.6521	0.7160	0.7741	0.1081	0.1160	0.1280	0.1386	0.1525	0.2076
	0.060	0.5317	0.5681	0.6220	0.6692	0.7312	0.7862	0.1127	0.1205	0.1320	0.1422	0.1557	0.2107
	0.080	0.5540	0.5900	0.6412	0.6863	0.7463	0.7980	0.1173	0.1251	0.1360	0.1458	0.1589	0.2138
	0.100	0.5768	0.6120	0.6601	0.7032	0.7612	0.8100	0.1220	0.1297	0.1400	0.1494	0.1621	0.2160
	0.120	0.5986	0.6309	0.6778	0.7200	0.7761	0.8221	0.1265	0.1340	0.1440	0.1529	0.1653	0.2200
14	0.020	0.5732	0.6045	0.6540	0.6993	0.7581	0.8084	0.1220	0 1288	0.1391	0.1486	0.1610	0.2162
	0.040	0.5949	0.6251	0.6731	0.7150	0.7712	0.8195	0.1265	0.1325	0.1430	0.1520	0.1639	0.2191
	0.060	0.6167	0.6450	0.6912	0.7311	0.7841	0 8302	0.1310	0.1375	0.1469	0.1554	0.1668	0.2220
	0.080	0.6385	0.6660	0.7089	0.7472	0.7973	0.8400	0.1355	0.1418	0.1508	0.1588	0.1697	0.2249
	0.100	0.6590	0.6861	0.7267	0.7636	0.8160	0.8506	0.1400	0.1464	0.1546	0.1622	0.1726	0.2278
	0.120	0.6788	0.7062	0.7443	0.7798	0.8232	0.8609	0.1445	0.1500	0.1584	0.1656	0.1756	0.2307

Contributed by George W. Burley

No. 153, Data Sheet, MACHINERY, April, 1912

SETTING DOUBLE-ANGLE FLUTING CUTTERS—II

Number of Teeth in Cutter	$\frac{W}{R} = \frac{\text{Land}}{\text{Rad.}}$	Value of x for "Elevation" Formula						Value of y for "Cross-movement" Formula					
		$\alpha = 12°$ $\beta = 52°$	12° 55°	12° 60°	12° 65°	12° 72°	15° 80°	12° 52°	12° 55°	12° 60°	12° 65°	12° 72°	15° 80°
16	0.020	0.6328	0.6624	0.7062	0.7465	0.7972	0.8360	0.1345	0.1410	0.1501	0.1581	0.1691	0.2234
	0.040	0.6536	0.6812	0.7229	0.7600	0.8091	0.8461	0.1395	0.1450	0.1537	0.1611	0.1717	0.2260
	0.060	0.6745	0.7000	0.7394	0.7742	0.8210	0.8562	0.1435	0.1490	0.1573	0.1641	0.1743	0.2286
	0.080	0.6954	0.7191	0.7561	0.7884	0.8329	0.8663	0.1480	0 1530	0.1609	0.1671	0.1769	0.2312
	0.100	0.7164	0.7382	0.7730	0.8033	0.8448	0.8754	0.1525	0.1570	0.1645	0.1701	0.1795	0.2338
	0.120	0.7360	0.7571	0.7893	0.8185	0.8567	0.8845	0.1565	0.1609	0.1680	0.1730	0.1820	0.2364
18	0.020	0.6791	0.7052	0.7451	0.7781	0.8230	0.8601	0.1440	0.1499	0.1582	0.1652	0.1751	0.2307
	0.040	0.6992	0.7234	0.7610	0.7919	0.8351	0.8691	0.1485	0.1539	0.1617	0.1683	0.1775	0.2330
	0.060	0.7191	0.7416	0.7773	0.8058	0.8471	0.8780	0.1530	0.1578	0.1652	0.1714	0.1799	0.2353
	0.080	0.7393	0.7598	0.7932	0.8200	0.8582	0.8860	0.1570	0.1617	0.1687	0.1745	0.1823	0.2376
	0.100	0.7594	0.7780	0.8090	0.8351	0.8692	0.8942	0.1610	0.1654	0.1721	0.1776	0.1847	0.2399
	0.120	0.7791	0.7972	0.8251	0.8501	0.8802	0.9021	0.1650	0.1697	0.1755	0.1806	0.1871	0.2422
20	0.020	0.7142	0.7391	0.7750	0.8052	0.8441	0.8791	0.1520	0.1570	0.1643	0.1709	0.1796	0.2357
	0.040	0.7336	0.7571	0.7908	0.8181	0.8552	0.8872	0.1560	0.1609	0.1677	0.1738	0.1819	0.2378
	0.060	0.7530	0.7750	0.8076	0.8310	0.8661	0.8953	0.1600	0.1648	0.1711	0.1767	0.1842	0.2399
	0.080	0.7731	0.7931	0.8224	0.8441	0.8770	0.9035	0.1640	0.1686	0.1745	0.1796	0.1865	0.2420
	0.100	0.7926	0.8112	0.8372	0.8571	0.8881	0.9113	0.1680	0.1724	0.1778	0.1825	0.1888	0.2441
	0.120	0.8122	0.8281	0.8509	0.8702	0.8981	0.9181	0.1730	0.1761	0.1811	0.1852	0.1910	0.2462
22	0.020	0.7421	0.7652	0.7963	0.8250	0.8592	0.8880	0.1580	0.1623	0.1695	0.1758	0.1829	0.2380
	0.040	0.7623	0.7831	0.8112	0.8380	0.8700	0.8961	0.1620	0.1662	0.1728	0.1783	0.1852	0.2400
	0.060	0.7825	0.8010	0.8260	0.8509	0.8809	0.9039	0.1660	0.1701	0.1761	0.1808	0.1875	0.2420
	0.080	0.8026	0.8179	0.8409	0.8642	0.8921	0.9121	0.1700	0.1740	0.1793	0.1833	0.1897	0.2440
	0.100	0.8217	0.8350	0.8561	0.8768	0.9021	0.9188	0.1740	0.1777	0.1825	0.1858	0.1919	0.2460
	0.120	0.8409	0.8527	0.8713	0.8891	0.9122	0.9260	0.1779	0.1813	0.1857	0.1883	0.1941	0.2480
24	0.020	0.7682	0.7871	0.8172	0.8423	0.8754	0.8973	0.1630	0.1674	0.1738	0.1788	0.1860	0 2402
	0.040	0.7851	0.8040	0.8311	0.8551	0.8853	0.9042	0.1670	0.1711	0.1769	0.1815	0.1880	0.2421
	0.060	0.8030	0.8210	0.8450	0.8680	0.8952	0.9111	0.1710	0.1746	0.1800	0.1842	0.1900	0.2440
	0.080	0.8221	0.8381	0.8600	0.8821	0.9050	0.9180	0.1750	0.1781	0.1830	0.1869	0.1920	0.2459
	0.100	0.8413	0.8550	0.8751	0 8942	0.9141	0.9251	0.1790	0.1817	0.1860	0.1896	0.1940	0.2478
	0.120	0.8605	0.8711	0.8891	0.9063	0.9234	0.9323	0.1829	0.1854	0.1890	0.1924	0.1960	0.2497
26	0.020	0.7850	0.8050	0.8283	0.8552	0.8842	0.9051	0.1675	0.1710	0.1759	0.1816	0.1881	0.2424
	0.040	0.8031	0.8218	0.8429	0.8684	0.8938	0.9121	0.1715	0.1746	0.1791	0.1844	0.1901	0.2443
	0.060	0.8222	0.8386	0.8576	0.8816	0.9034	0.9191	0.1755	0.1782	0.1823	0.1872	0.1921	0.2462
	0.080	0.8413	0.8554	0.8723	0.8948	0.9130	0.9261	0.1795	0.1818	0.1855	0.1900	0.1941	0.2481
	0.100	0.8604	0.8722	0.8870	0.9080	0.9226	0.9330	0.1835	0.1854	0.1887	0.1928	0.1961	0.2500
	0.120	0.8795	0.8890	0.9018	0.9212	0.9322	0.9401	0.1874	0.1890	0.1920	0.1956	0.1981	0.2519

Contributed by George W. Burley

No. 153, Data Sheet, MACHINERY, April, 1912

SETTING DOUBLE-ANGLE FLUTING CUTTERS—III

Number of Teeth in Cutter	$\frac{W}{R} = \frac{\text{Land}}{\text{Rad.}}$	Value of x for "Elevation" Formula						Value of y for "Cross-movement" Formula					
		α = 12° β = 52°	12° 55°	12° 60°	12° 65°	12° 72°	15° 80°	12° 52°	12° 55°	12° 60°	12° 65°	12° 72°	15° 80°
28	0.020	0.7921	0.8182	0.8443	0.8654	0.8930	0.9111	0.1705	0.1739	0.1791	0.1838	0.1900	0.2445
	0.040	0.8121	0.8351	0.8581	0.8778	0.9025	0.9180	0.1745	0.1777	0.1821	0.1863	0.1919	0.2463
	0.060	0.8321	0.8520	0.8720	0.8891	0.9120	0.9250	0.1785	0.1815	0.1851	0.1888	0.1938	0.2481
	0.080	0.8521	0.8692	0.8860	0.9012	0.9213	0.9311	0.1820	0.1843	0.1881	0.1913	0.1957	0.2499
	0.100	0.8721	0.8851	0.9000	0.9133	0.9306	0.9371	0.1860	0.1881	0.1911	0.1938	0.1976	0.2517
	0.120	0.8921	0.9012	0.9133	0.9253	0.9390	0.9431	0.1900	0.1919	0.1941	0.1963	0.1995	0.2535
30	0.020	0.8172	0.8321	0.8560	0.8761	0.9011	0.9170	0.1740	0.1768	0.1820	0.1860	0.1918	0.2458
	0.040	0.8351	0.8491	0.8701	0.8881	0.9100	0.9241	0.1780	0.1801	0.1849	0.1885	0.1936	0.2475
	0.060	0.8530	0.8660	0.8842	0.9000	0.9190	0.9302	0.1820	0.1835	0.1878	0.1910	0.1954	0.2492
	0.080	0.8706	0.8822	0.8976	0.9120	0.9281	0.9362	0.1860	0.1870	0.1907	0.1935	0.1972	0.2509
	0.100	0.8882	0.8982	0.9110	0.9241	0.9372	0.9421	0.1895	0.1905	0.1936	0.1960	0.1990	0.2526
	0.120	0.9052	0.9142	0.9241	0.9362	0.9451	0.9480	0.1929	0.1940	0.1965	0.1985	0.2008	0.2543
32	0.020	0.8293	0.8441	0.8661	0.8841	0.9080	0.9221	0.1765	0.1797	0.1838	0.1877	0.1930	0.2470
	0.040	0.8476	0.8600	0.8792	0.8960	0.9171	0.9282	0.1800	0.1830	0.1867	0.1902	0.1949	0.2486
	0.060	0.8660	0.8759	0.8921	0.9072	0.9260	0.9343	0.1840	0.1863	0.1896	0.1927	0.1968	0.2502
	0.080	0.8831	0.8918	0.9053	0.9183	0.9342	0.9404	0.1880	0.1896	0.1924	0.1952	0.1987	0.2518
	0.100	0.9000	0.9081	0.9184	0.9291	0.9420	0.9463	0.1920	0.1929	0.1953	0.1977	0.2006	0.2534
	0.120	0.9163	0.9241	0.9313	0.9400	0.9500	0.9521	0.1955	0.1962	0.1982	0.2002	0.2025	0.2550
34	0.020	0.8400	0.8530	0.8743	0.8911	0.9141	0.9261	0.1785	0.1816	0.1859	0.1891	0.1941	0.2480
	0.040	0.8575	0.8691	0.8874	0.9020	0.9232	0.9323	0.1820	0.1849	0.1888	0.1916	0.1959	0.2495
	0.060	0.8750	0.8851	0.9003	0.9132	0.9310	0.9382	0.1860	0.1882	0.1916	0.1941	0.1977	0.2510
	0.080	0.8925	0.9010	0.9132	0.9243	0.9393	0.9444	0.1900	0.1915	0.1944	0.1966	0.1995	0.2525
	0.100	0.9100	0.9162	0.9263	0.9352	0.9472	0.9500	0.1935	0.1948	0.1971	0.1991	0.2013	0.2540
	0.120	0.9270	0.9328	0.9394	0.9462	0.9551	0.9551	0.1973	0.1981	0.1998	0.2017	0.2031	0.2555
36	0.020	0.8500	0.8621	0.8800	0.8981	0.9190	0.9292	0.1804	0.1836	0.1874	0.1902	0.1950	0.2489
	0.040	0.8695	0.8782	0.8931	0.9092	0.9271	0.9348	0.1850	0.1869	0.1901	0.1927	0.1968	0.2503
	0.060	0.8890	0.8943	0.9060	0.9200	0.9352	0.9404	0.1890	0.1902	0.1928	0.1952	0.1986	0.2517
	0.080	0.9045	0.9100	0.9191	0.9312	0.9433	0.9460	0.1925	0.1935	0.1955	0.1977	0.2004	0.2531
	0.100	0.9200	0.9251	0.9320	0.9411	0.9512	0.9516	0.1960	0.1968	0.1982	0.2002	0.2022	0.2545
	0.120	0.9381	0.9401	0.9450	0.9510	0.9590	0.9572	0.1994	0.2001	0.2010	0.2027	0.2040	0.2559
38	0.020	0.8561	0.8691	0.8862	0.9043	0.9230	0.9320	0.1819	0.1850	0.1885	0.1921	0.1961	0.2497
	0.040	0.8760	0.8850	0.8990	0.9152	0.9312	0.9374	0.1860	0.1883	0.1913	0.1943	0.1978	0.2511
	0.060	0.8941	0.9011	0.9121	0.9261	0.9393	0.9428	0.1900	0.1916	0.1941	0.1965	0.1995	0.2524
	0.080	0.9122	0.9162	0.9250	0.9368	0.9474	0.9482	0.1936	0.1949	0.1969	0.1987	0.2012	0.2537
	0·100	0.9282	0.9311	0.9381	0.9480	0.9555	0.9536	0.1970	0.1982	0.1997	0.2009	0.2029	0.2550
	0.120	0.9441	0.9461	0.9512	0.9633	0.9636	0.9590	0.2004	0.2015	0.2025	0.2031	0.2046	0.2563

Contributed by George W. Burley

No. 153, Data Sheet, MACHINERY, April, 1912

SETTING DOUBLE-ANGLE FLUTING CUTTERS—IV

Number of Teeth in Cutter	$\frac{W}{R} = \frac{\text{Land}}{\text{Rad.}}$	Value of x for "Elevation" Formula						Value of y for "Cross-movement" Formula					
		α = 12° β = 52°	12° 55°	12° 60°	12° 65°	12° 72°	15° 80°	12° 52°	12° 55°	12° 60°	12° 65°	12° 72°	15° 80°
40	0.020	0.8660	0.8760	0.8900	0.9081	0.9271	0.9352	0.1840	0.1863	0.1900	0.1927	0.1968	0.2504
	0.040	0.8828	0.8912	0.9031	0.9190	0.9352	0.9411	0.1875	0.1896	0.1926	0.1950	0.1985	0.2517
	0.060	0.8996	0.9064	0.9162	0.9300	0.9433	0.9459	0.1910	0.1929	0.1952	0.1973	0.2002	0.2530
	0.080	0.9164	0.9216	0.9293	0.9401	0.9510	0.9515	0.1950	0.1962	0.1978	0.1996	0.2018	0.2543
	0.100	0.9332	0.9368	0.9424	0.9500	0.9592	0.9562	0.1990	0.1995	0.2004	0.2019	0.2034	0.2556
	0.120	0.9500	0.9520	0.9550	0.9598	0.9659	0.9608	0.2025	0.2028	0.2030	0.2042	0.2050	0.2569
42	0.020	0.8720	0.8820	0.8951	0.9122	0.9292	0.9372	0.1855	0.1880	0.1909	0.1948	0.1975	0.2510
	0.040	0.8886	0.8972	0.9080	0.9231	0.9371	0.9431	0.1891	0.1913	0.1936	0.1969	0.1992	0.2522
	0.060	0.9052	0.9124	0.9210	0.9343	0.9449	0.9479	0.1925	0.1946	0.1963	0.1990	0.2009	0.2534
	0.080	0.9218	0.9276	0.9339	0.9444	0.9532	0.9531	0.1965	0.1979	0.1990	0.2011	0.2026	0.2546
	0.100	0.9384	0.9428	0.9471	0.9546	0.9610	0.9581	0.2000	0.2012	0.2017	0.2032	0.2042	0.2558
	0.120	0.9550	0.9580	0.9600	0.9645	0.9681	0.9628	0.2035	0.2045	0.2044	0·2053	0.2058	0.2570
44	0.020	0.8770	0.8870	0.9000	0.9151	0.9310	0.9391	0.1860	0.1887	0.1918	0.1944	0.1981	0.2515
	0.040	0.8936	0.9021	0.9131	0.9260	0.9391	0.9440	0.1900	0.1920	0.1945	0.1966	0.1998	0.2527
	0.060	0.9102	0.9172	0.9261	0.9371	0.9472	0.9492	0.1935	0.1953	0.1972	0.1988	0.2015	0.2539
	0.080	0.9268	0.9321	0.9389	0.9472	0.9551	0.9539	0.1970	0.1986	0.1999	0.2010	0.2032	0.2550
	0.100	0.9434	0.9472	0.9520	0.9569	0.9632	0.9591	0.2010	0.2019	0.2026	0.2032	0.2049	0.2561
	0.120	0.9600	0.9620	0.9649	0.9670	0.9700	0.9640	0.2045	0.2052	0.2053	0.2054	0.2065	0.2572
46	0.020	0.8820	0.8920	0.9040	0.9181	0.9333	0.9411	0.1875	0.1898	0.1926	0.1951	0.1987	0.2520
	0.040	0.8986	0.9070	0.9171	0.9293	0.9410	0.9459	0.1911	0.1930	0.1953	0.1974	0.2004	0.2531
	0.060	0.9152	0.9226	0.9300	0.9400	0.9491	0.9507	0.1947	0.1962	0.1980	0.1997	0.2021	0.2542
	0.080	0.9318	0.9371	0.9429	0.9502	0.9572	0.9555	0.1985	0.1994	0.2007	0.2020	0.2038	0.2553
	0.100	0.9484	0.9523	0.9558	0.9603	0.9651	0.9600	0.2019	0.2026	0.2034	0.2042	0.2054	0.2564
	0.120	0.9650	0.9670	0.9682	0.9705	0.9720	0.9634	0.2055	0.2058	0.2061	0.2064	0.2070	0.2575
48	0.020	0.8850	0.8960	0.9081	0.9210	0.9358	0.9426	0.1885	0.1907	0.1935	0.1958	0.1993	0.2525
	0.040	0.9020	0.9112	0.9212	0.9321	0.9430	0.9470	0.1920	0.1939	0.1962	0.1981	0.2010	0.2536
	0.060	0.9190	0.9261	0.9343	0.9432	0.9519	0.9521	0.1955	0.1971	0.1999	0.2004	0.2026	0.2547
	0.080	0.9360	0.9413	0.9471	0.9534	0.9593	0.9572	0.1990	0.2003	0.2016	0.2027	0.2042	0.2557
	0.100	0.9530	0.9562	0.9600	0.9632	0.9671	0.9610	0.2026	0.2035	0.2043	0.2050	0.2058	0.2567
	0.120	0.9700	0.9710	0.9720	0.9730	0.9740	0.9645	0.2062	0.2066	0.2070	0.2072	0.2074	0.2577
50	0.020	0.8880	0.9000	0.9130	0.9250	0.9389	0.9431	0.1892	0.1917	0.1940	0.1962	0.1998	0.2529
	0.040	0.9061	0.9149	0.9259	0.9351	0.9468	0.9482	0.1931	0.1949	0.1967	0.1985	0.2014	0.2539
	0.060	0.9239	0.9298	0.9389	0.9452	0.9536	0.9533	0.1970	0.1980	0.1994	0.2008	0.2030	0.2549
	0.080	0.9417	0.9447	0.9518	0.9553	0.9610	0.9571	0.2007	0.2011	0.2021	0.2031	0.2046	0.2559
	0.100	0.9585	0.9595	0.9637	0.9652	0.9677	0.9632	0.2039	0.2042	0.2048	0.2053	0.2061	0.2569
	0.120	0.9742	0.9744	0.9747	0.9751	0.9761	0.9650	0.2070	0.2072	0.2074	0.2075	0.2076	0.2579

Contributed by George W. Burley

No. 153, Data Sheet, MACHINERY, April, 1912

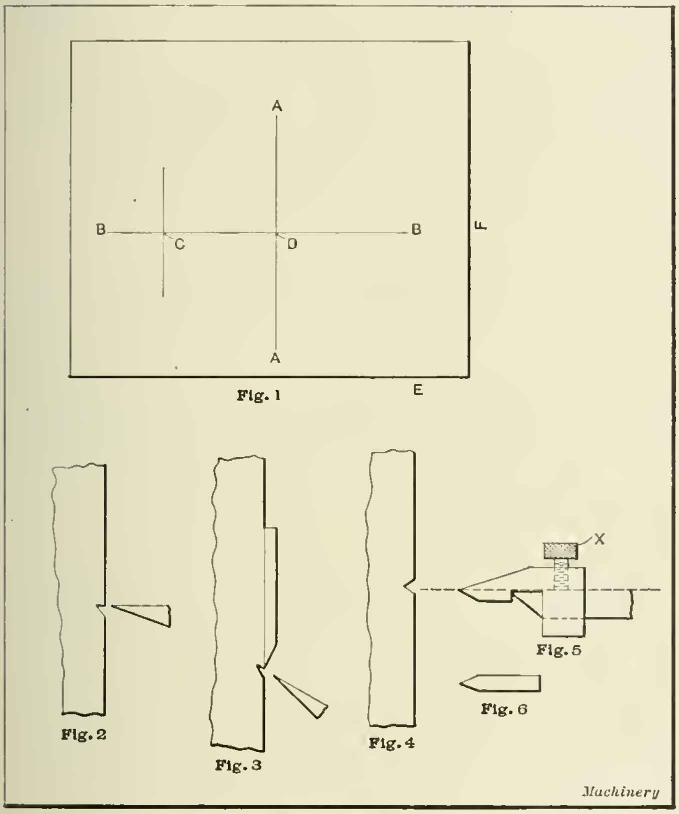
MACHINERY

April, 1912

A NEW SYSTEM FOR LOCATING HOLES TO BE BORED ON THE MILLING MACHINE

By GEORGE J. MURDOCK*

THE problem of accurately locating holes to be bored on the milling machine has received much attention, as this machine is the only one on which a large class of work can be done correctly and rapidly. The method generally used where accuracy has been required is known as the "button system." This consists in locating the holes by a device known to toolmakers as a button, which is located for the first hole from a base line, while for subsequent holes the buttons are located by micrometer measurements between the buttons. The work, with the buttons on it, is then placed upon the milling machine table, and indicated from the axis of the spindle until the axis of the button coincides with it, when the hole is bored. The cost of doing the work by this method is so great, however, that numerous efforts have been made to achieve equally good results in other ways, many of which have been tried, but most of which have developed such objectionable features in practice that their use has been limited.



Figs. 1 to 6. Method of Locating Holes to be bored

The increasing demand for rapidity coupled with accuracy, with a minimum liability of error, led the writer to develop the system described in this article, a center-punch mark taking the place of the button from which to indicate the work into the proper position for boring. The fundamental principle involved is to lay out, accurately, two lines at right angles to each other, and correctly centerpunch the point where they intersect. With proper care lines may be drawn with a vernier height gage at right angles, with extreme accuracy, the chief difficulty being to accurately center the lines where they cross. Casual consideration may make this appear easy with the common center-punch, and with semi-accurate work this may be done; but where extreme accuracy is required this method is not applicable, as the hand and the eye of the average man, at best, is incapable of marking the correct location closer than 0.001 inch.

Fig. 1 illustrates in a simple way the procedure adopted in laying out work by the new system. The base *E* is in contact with the surface plate while the line *B–B* is drawn with a height gage. Side *F* is used on the plate while drawing the line *A–A*. It will be seen that these lines will be at right angles to each other if the bases *E* and *F* are correct. Work done by this method must have two working surfaces or base lines, and these must be at right angles to each other. There is no particular difficulty in drawing the locating lines *A–A* and *B–B* correctly, either with a vernier height gage or with a special micrometer gage reading to tenths of thousandths (0.0001) inch, the only difficult element being to accurately centerpunch the lines where they intersect as at *D*. It is assumed that two holes are to be bored, so that the intersection at *C* would also be centerpunched.

An analytical consideration of the conditions will illustrate the importance of beginning the work correctly. Fig. 2 shows on an enlarged scale the line made by an ordinary vernier height gage. Resembling, as it does, a saw tooth, it is clear that if two such lines are drawn at right angles as shown in Fig. 1, it would be impossible to so centerpunch them where they cross at *D* that the mark would be exactly at the center of the intersection of the lines. It would be quite incorrect, and no matter how carefully indicated, the resulting hole would be also inaccurate. Fig. 3 shows this type of line as drawn with a scriber along a straightedge, and two lines of this character drawn at right angles would produce a condition at *D* (Fig. 1), still worse than that caused by those drawn by the vernier height gage. In Fig. 4 is shown the correct contour of line to use with this system, while Fig. 5 illustrates the scriber attachment for the ordinary vernier height gage to which the scriber, Fig. 6, is secured by the set-screw *X*.

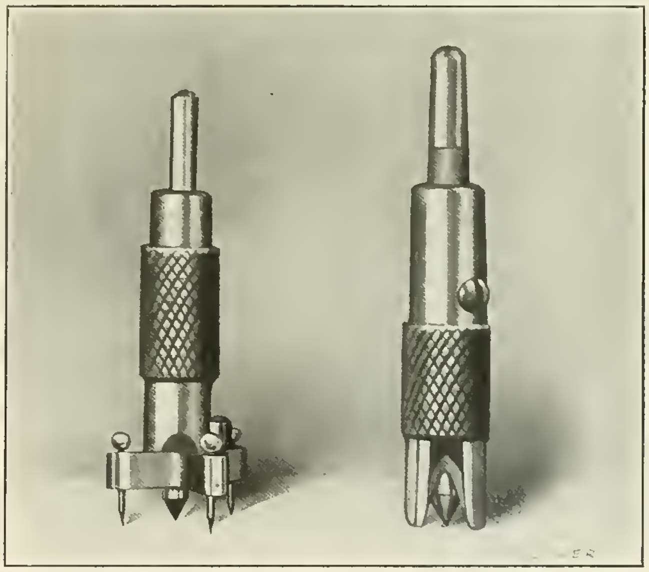


Fig. 7. Center Locating Punch Fig. 8 Center Enlarging Punch

As it is quite or almost impossible to accurately centerpunch the intersection of even two correctly drawn lines by any means heretofore known, the punch shown in Figs. 7 and 9 has been evolved, and an extended experience with it on a very high grade of work has demonstrated its value for the purpose. It consists essentially of a small centerpunch *O* held in an exactly vertical position by a holder *P* which is knurled to facilitate handling. Great care should be exercised in making this tool to have the body of the punch straight, and to have it stand correctly in the holder, at right angles to the surface to be operated upon, for the slightest inclination will cause the finished hole to be incorrect, no matter how carefully the lines are drawn. The 60-degree point must be ground correctly with the axis. The holder for the punch stands on three legs, located as indicated, and ground accurately to a taper that fits in the holder, where they are secured by watch screws bearing on their tops. The lower ends are hardened, and terminate in an angular point of 55 degrees (the point of the vernier scriber being 60 degrees). The edges are sharp, and slightly rounded at the ends, so that the legs will slide along a line smoothly. The points *V* and *U* (Fig. 9) have edges that are in line with each other, while the point *T* has an edge at right angles to the other two. The center of the punch is located at equal distances from all the legs, and is held off the work normally by a leather friction acted upon by a set-screw in the side of holder *P*.

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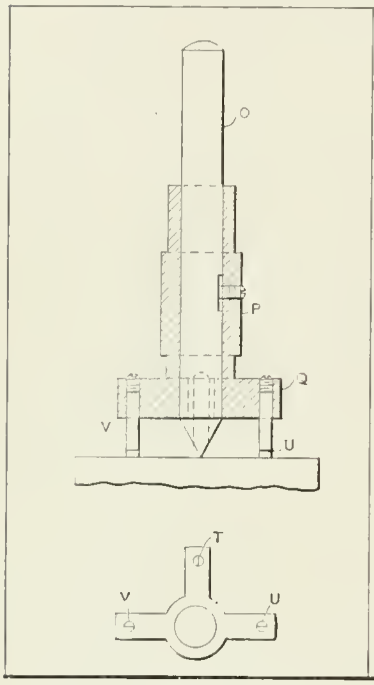

Fig. 9. Section of Center Locating Punch

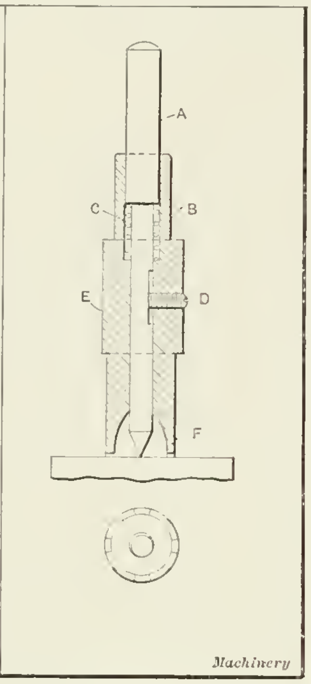

Fig. 10. Section of Center Enlarging Punch

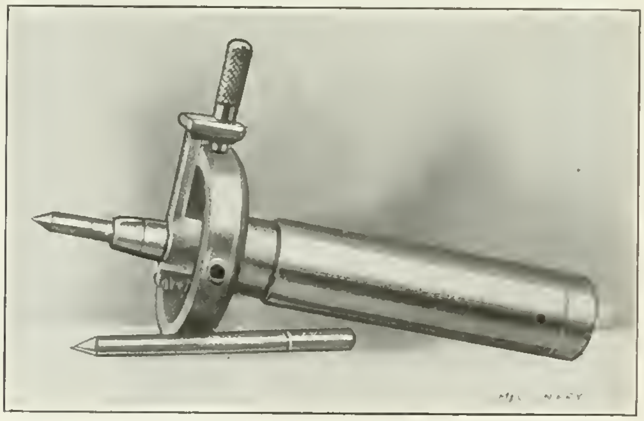
Fig. 11. Indicator Assembled; Long Centering Rod in the Foreground

If this tool is placed upon lines of the character shown in Fig. 4 (which for the purpose of this description will be assumed to be drawn on a block of metal, Fig. 1, in which holes are to be bored), the legs *V* and *U* may be slid along line *B–B* until the sharp edge of leg *T* drops into line *A–A*. When this occurs the punch *O* is lightly tapped with a hammer, and the resulting mark will be accurately located in the center of the intersection of the lines. It is the practice of the writer to make the work very smooth before drawing the lines, and after laying them out, to stone them so as to remove the slight burr raised in drawing them. A drop of oil is then rubbed into the lines, and the surplus wiped off. This procedure permits points *V* and *U* to run very smoothly along the line, and the burr having been removed, the edge of leg *T* drops into the line very readily with a slight click. As it is not advisable to strike punch *O* more than a very light blow, it marks the work but slightly, and a more distinct indentation is made with the follower punch shown in Figs. 8 and 10. This is made like the previous one so that it will stand perfectly at right angles to the work. The sectional view (Fig. 10) shows the punch *A* supported by the holder *E* which has four legs *F* cut away on the sides so that the point of the punch may be seen. When this punch is in position, it is struck a sufficiently heavy blow to make a distinctly visible mark. The work is now ready to be placed upon the work table of the milling machine, and indicated for boring the holes, an indicator being used in the milling machine spindle.

An indicator which has been found especially valuable for this purpose is shown in Figs. 11 and 12. The only requirements are that the milling machine spindle be in good condition, and that the indicator be accurately made. It is of the concentric centering type, and with it the work is brought concentric with the axis of the spindle. The arbor *I* is provided with a threaded nose on which disk *D* is screwed. This disk has four holes in its rim, equally spaced from each other. Hardened, ground, and lapped bushings *b* are put into these holes to receive plug *A* which is made a gage-fit both in these holes and in hole *B* in the outer end of sector *C*. This sector is held by a split sleeve to the barrel *L* which carries the 60-degree centering-rod *K* that comes into contact with the work to be bored. The latter, of course, is secured to the work table. The spherical base of barrel *L* fits into a corresponding concave seat in the nose of the arbor at *H*, and is held in place by a spring *E* which connects at one end to the cylindrical stud in the base of the barrel, and at the other to the axial rod *M* by which it and the other connecting parts may be drawn into place, and held by the headless set-screw *J*, bearing on a flat spot on the tang end of the rod.

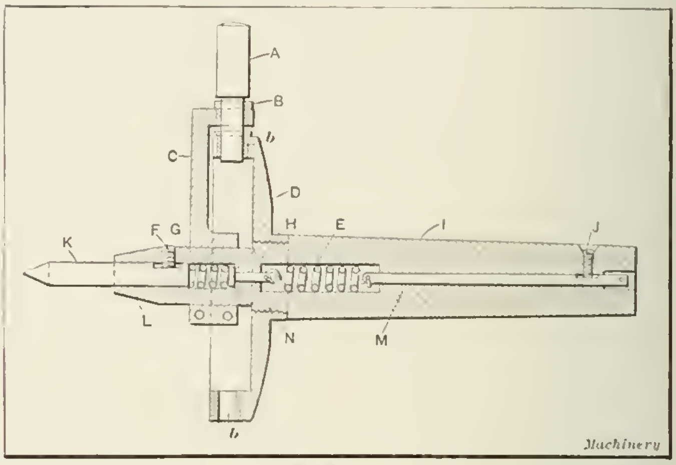

Fig. 12. Sectional View of Indicator

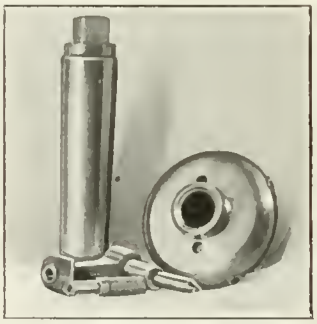
Fig. 13. Parts of the Indicator

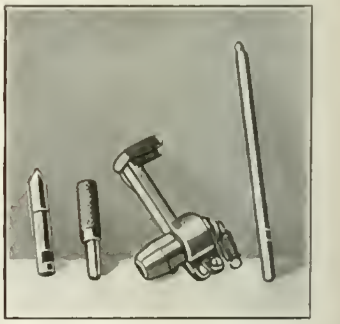
Fig. 14. Sector, Plug and Centering Punch

Now, if plug *A* is removed from bushing *b* the point of the centering-rod *K* may be made to describe a circle. At some point within this circle is located the center-punch mark on the work to be bored. The holes in the rim of the faceplate all being exactly the same distance from an axial line through both the arbor *I* and centering-rod *K*, it follows that the center mark on the work must be so located by horizontal and vertical movements of the work table that pin *A* may be freely entered in all the four holes in the rim of disk *D*. When that occurs, the center coincides with the axis of the spindle.

The point of the center-punch *A* (Fig. 10) should have an angle slightly greater than the angle on the centering-rod *K*, as it is impossible to locate the work in the preliminary trials so that the center of the work will be coincident with the axis of the spindle, and unless the precaution mentioned is taken, the true center on the work is liable to be drawn from its proper location when trying to bring the work into such a position that the plug will enter all the holes in the disk. As the work being operated on is brought nearer to the proper location by the movements of the milling machine table, spring *G* will be compressed, the center rod sliding back into barrel *L*. This spring is made so that it will hold the center against the work firmly, but without interfering with the free rotation of the sector *C* around disk *D*. When the work is located so that the plug enters the holes, the gibs of the machine should be tightened up and the plug tried once more, to make sure that the knee of the machine has not moved sufficiently to cause the work on the table to be out of line. The work table is now clamped to prevent accidental horizontal shifting, and the work is drilled and bored as in common practice.

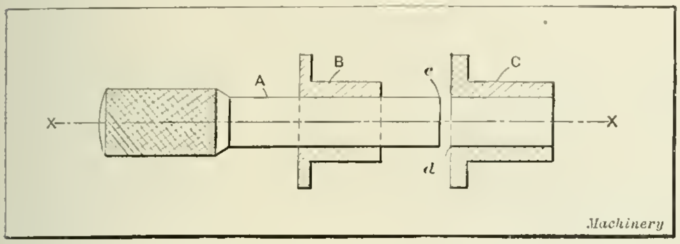

Fig. 15. Detail View of Plug and Bushings

In using this indicator the milling machine spindle is not rotated together with arbor *I*, only the sector being turned around the disk. The tool is so set, however, in the beginning, that the axes of two of the bushings *b* would be at right angles to the horizontal plane of the machine table, while the axes of the other holes in the disk would be parallel with the top of the work table. The plug *A* projects outwardly at right angles to the spindle, and is therefore out of the way of the work on the table of the machine. The centering-rods are made interchangeable and of various lengths, to reach more or less easily accessible centers. Fig. 11 shows the indicator with one of the long center-rods in the foreground.

One of the desirable features in a tool of this class is compactness and capability of being easily packed in the tool-chest. Fig. 13 shows it taken apart, and it is so designed that the calibration is correct when it is again assembled.

It is plain that the question of "feel" would enter largely into the use of the indicator described, if the tool were incorrectly constructed, as, for example, if the hole in bushing *C*, Fig. 15, were slightly bell-mouthed, or if plug *A* were tapered. In making these, however, care is taken to have the plug, as well as the holes in the bushings, precisely the same diameters at both ends. The edge *c* of plug *A*, as well as bushing *C* at *d* are square and sharp. If plug *A* were either tapered or slightly rounded at *c* it might be forced into the bushing, in which case the "feel" would be an important factor. The plug, however, cannot enter the bushing *C* until both bushings and plug coincide axially with the line *X–X;* and when the milling machine table is so moved that this can occur, it is not possible to distinguish any difference between the fit of the plug whether the centering-rod is in contact with the work or away from it.

While this indicator has been specifically described for use with the milling machine, it may be used also to set the tailstocks of lathes central with the headstocks. A female center is put in the headstock, and only the horizontal holes in disk *D* are used. Work may also be located for boring on the lathe faceplate (after the lathe has been "centralized"), and accurate results obtained by following the system described in this article.

On some classes of work buttons may be preferred, and micrometer measurements made. In such cases a sleeve provided with a center is slipped over the button after it is located. This indicator may then be used to bring the work into the proper position to be bored with comparative ease and rapidity. The only part of the milling machine on which dependence must be placed for accuracy is the hole in the spindle, and this is less liable to get out of truth, from wear such as would impair the accuracy, than are the knee, table, or micrometer screws. The only moving part is the sector, and this, being light, is very sensitive.

A series of 24 holes was recently laid out and bored in one and one-half day. Measurements with lapped accurate plugs in the holes showed the greatest deviation from truth to be 0.0002 inch, and running from that to accuracy so great that no error was measurable. This same work with buttons would have required at least one week, and with results no better, if as good.

* * *

ADHESION OF SWEDISH GAGES

A remarkable property of the so-called Swedish gages is their adhesiveness to one another. When wrung together they will resist separation in a direction at right angles to the faces in contact, with a force considerably greater than the atmospheric pressure on the area of contact. This phenomenon has caused some to believe that actual molecular adhesion takes place when surfaces that are nearly perfect planes are brought into intimate contact. Tyndall, the eminent English physicist, reached the conclusion thirty-five years ago that molecular attraction was partly the cause of the phenomenon.

The error of this theory has been shown by some recent investigations of H. M. Budgett, reported to the London Royal Society, showing that the adhesion results from the presence of a very thin liquid film. Some blocks of hardened steel were prepared, each weighing an ounce and a half and having surfaces of 0.7 square inch polished flat to within a millionth of an inch of accuracy, and these were used to test the adhesive properties of many liquids. The contact faces were carefully freed from moisture and grease with alcohol before being smeared with a very thin film of the liquid under test. On wringing together perfectly clean they fell apart under their own weight; but blocks held together by films required to separate them, a force ranging from seventeen pounds for Rangoon oil, to twenty-two for lubricating oil, twenty-nine for turpentine, and thirty-five for condensed water vapor. After washing the hands with soap, blocks rubbed on them showed adhesion as high as ninety pounds. There was no adhesion from volatile liquids, like alcohol and benzine; and very little from viscous liquids, such as glycerine and glucose.

The microscope showed that the films, drawn out in thin lines, covered only a tenth or less of the metal faces. From varied experiments it appeared that in the case of paraffine film, for instance, the twenty-seven pounds required to part the plates included about one pound due to atmospheric pressure, one to surface tension and twenty-five pounds to the actual tensile strength of the liquid. The tensile strength of water seemed to be as high as 443 pounds per square inch!

* * *

THE ENGINEER'S PLACE IN MUNICIPAL AFFAIRS

The government of cities and municipalities presents some of the most difficult problems that confront American citizens. The lack of central authority and responsibility as well as the common lack of efficient supervision and coordination of the work of departments inevitably lead to deplorable waste and confusion. Gen. Bingham, former police commissioner of New York City and now an official in its department of bridges, in a recent talk to the Swedish Engineers' Club of Brooklyn, attributed much of the trouble to the common misconception that business men are best qualified to administer the affairs of a city. He asserted that spending the money raised by taxes to the best advantage was essentially an engineering problem and that city officials should be trained engineers. With an engineering organization the working at cross purposes and the waste of materials and labor now so common would be largely eliminated. For example, the laying of pavements would be done scientifically and provision would be made for pipe galleries, or if that were not feasible, care would be taken to have the pipe and sewer systems in good condition before pavements were laid.

AN INTERESTING JOB ON THE GRIDLEY AUTOMATIC TURRET LATHE

By CHESTER L. LUCAS*

The accompanying halftone and line illustrations show an interesting job done on the Gridley single-spindle automatic turret lathe. The work is a three-inch shrapnel shell which is made on the 3¼-inch machine. The steel from which the shell is made is extremely tough. The specifications are from 125,000 to 135,000 pounds tensile strength, 110,000 pounds elastic limit, a twenty-five per cent reduction of area, and a twelve per cent elongation. It will be seen from the above specifications that the steel is, of necessity, very tough and difficult to work; in addition, a large taper reamer must be used, and the outside of the shell must be relieved throughout the central portion. It is also necessary to machine the piece to extremely accurate dimensions, all of which tends to make the work still more difficult, and, therefore, more interesting.

Fig. 1 shows a view of the shrapnel shell. It is approximately three inches diameter and eight inches long and the limits allowed for the sizes are extremely close throughout, both inside and outside. Fig. 4 shows the successive steps employed in machining the piece complete, the four views presented representing the appearance of the work and the operations performed at each indexing of the turret. Fig. 2 shows the machine complete, and Fig. 3 will enable the operation of the different parts to be more clearly understood.

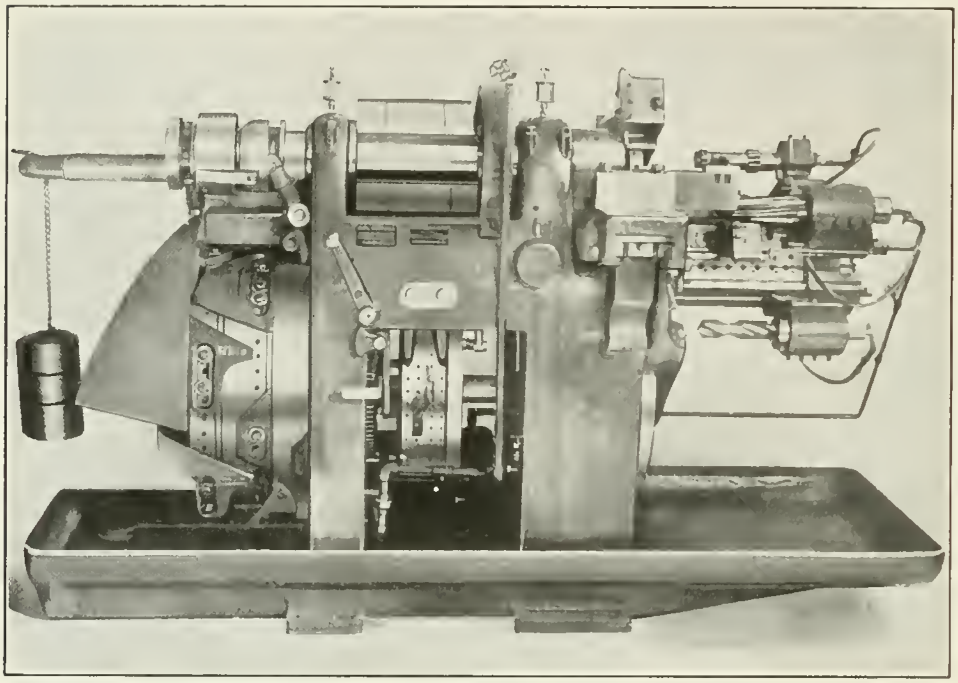

Fig. 2. Gridley 3 1/4 inch Automatic Turret Lathe (Single Spindle)

While the operation of the Gridley automatic turret lathe is generally understood by mechanics, it may be well to state briefly the general principles upon which work is done in the single-spindle machine. In this type of machine, the position of the work does not change as it does in the multiple-spindle machine, but the turning is accomplished by the operation of tools mounted on tool-slides which, in turn, work on a turret that revolves about a horizontal axis, successively presenting the tools for operation upon the work. This will be readily understood by glancing at the illustration Fig. 3. It will also be noticed from this illustration that the forming tools and cutting-off tools are operated from a face-cam at the lower part of the machine. The forming slide is actuated by a cam-groove cut in one side of the cam-plate while the cutting-off slide receives its movement from a cam-groove on the reverse side of this plate.

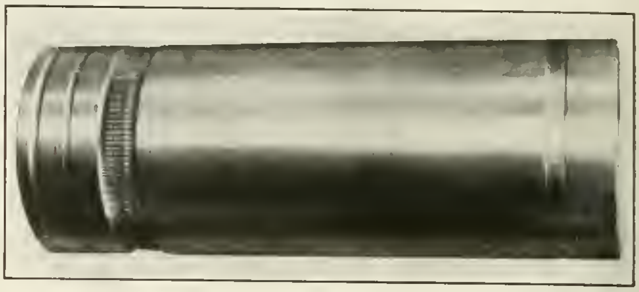

Fig. 1. Three-inch Shrapnel Shell made on a Gridley Automatic Turret Lathe

At the first position of the turret, a large 2 11/32-inch high-speed oil drill is run into the bar to a depth of 6 1/32 inches, and, at the same time, a knee-turner located on the tool-slide turns the outside of the stock, thereby removing the scale from the bar. Referring to Fig. 3, which shows the turret in the third position, the end of this large drill is shown at *A*, and, of course, when at work, it would be in the position of the reamer which is shown at *F*. The time elapsed at the completion of this part of the work is eleven minutes, five seconds.

At the second position of the turret, a smaller drill, 2 1/16 inches diameter, which is shown at *B*, is run in at the bottom of the hole previously drilled, to a depth of 29/32 inch. At the same time a counterboring tool, which is located at *C* and which is attached to the drill with a set-screw, is at work counterboring the end of the hole in the shell. During the time that this drilling and counterboring operation is being performed, the forming tool shown at *D* is being fed into the outside of the head of the shell, finishing the three grooves as shown; in addition a

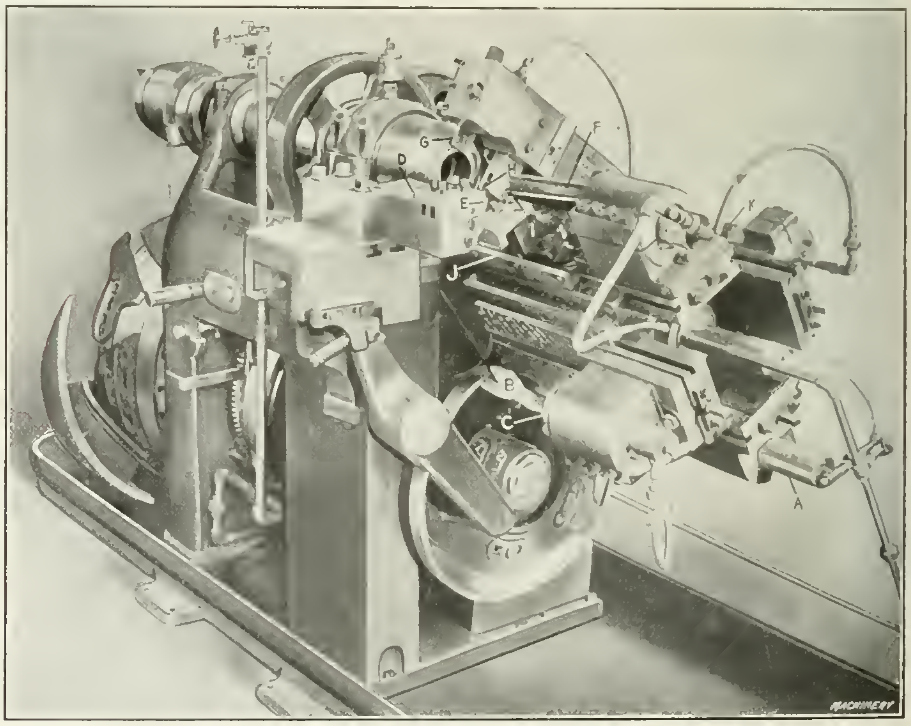

Fig. 3. Tool set up for Producing the Shell shown in Fig 1

sizing tool *E* which is at a fixed distance from the forming tool, comes in and sizes the work to exactly the right length. The time elapsed up to the finishing of this part of the work is thirteen minutes, thirty-five seconds.

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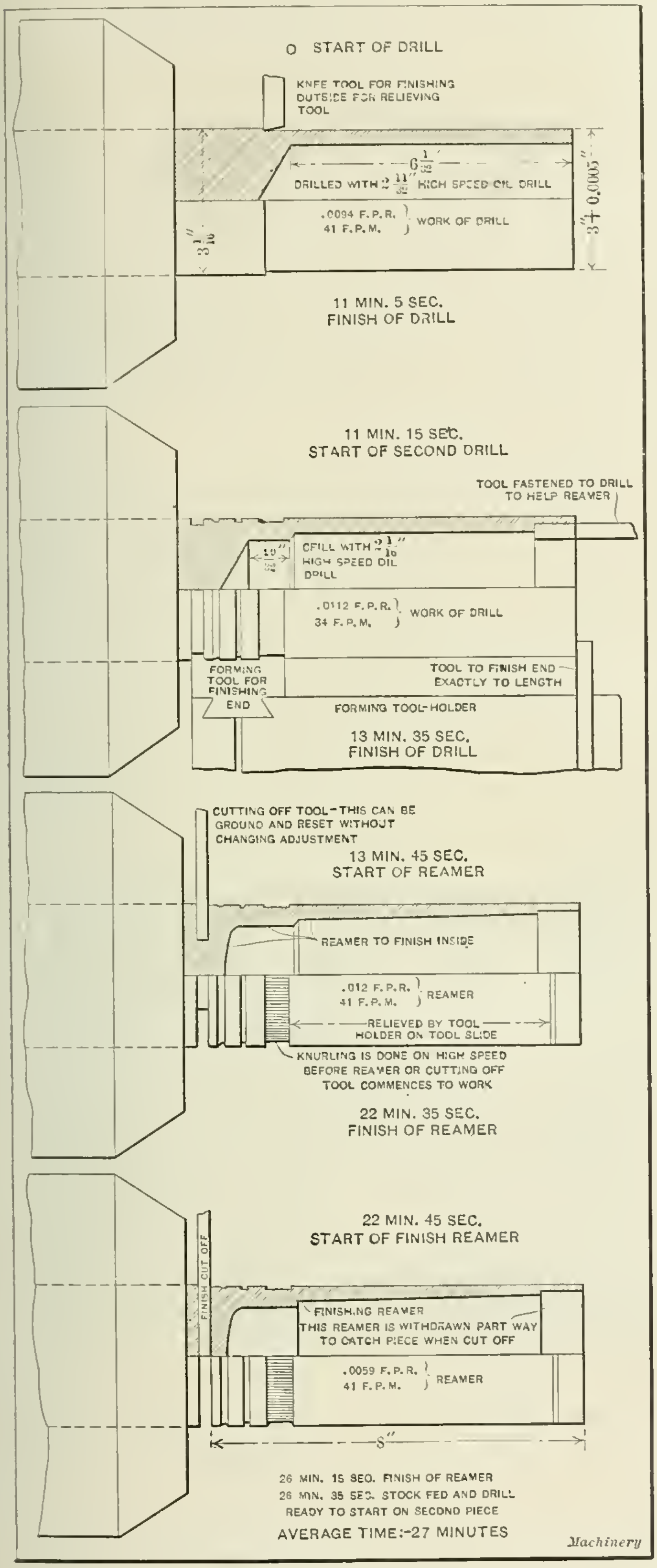
* Associate Editor of MACHINERY.

At the third position of the turret, which by the way, is the one shown in Fig. 3, the large taper reamer *F* is run in, which operation removes the bulk of the stock for the taper, and a second step at the end of this reamer finishes the extreme end of the hole at the bottom of the shell. The blades of this reamer are nicked to break the chips as they are being formed. Before the reamer begins to cut, the knurling tool *H* is brought against the work (while it is on the high speed) by the cutting-off slide, which, of course, results in a better knurled section than would result if the knurling of the piece was done at a slower speed. During the reaming operation, the cutting-off tool *G* is run in part way to facilitate the final severing of the piece. In addition, the relieved part of the work is turned by a tool mounted in a tool-holder on the slide of the turret. This tool is shown at *I* and it is operated by a templet *J* which has a raised projection that throws the tool into the work after it has reached the right position with relation to the length of the shell. The total time elapsed up to the finishing of this part of the work, is twenty-two minutes, thirty-five seconds.



O START OF DRILL
KNIFE TOOL FOR FINISHING OUTSIDE FOR RELIEVING TOOL
$6\frac{1}{32}$"
DRILLED WITH $2\frac{11}{32}$" HIGH SPEED OIL DRILL
.0094 F.P.R.
41 F.P.M.
WORK OF DRILL
$3\frac{1}{16}$"
3" + 0.0005"
11 MIN. 5 SEC.
FINISH OF DRILL
11 MIN. 15 SEC.
START OF SECOND DRILL
TOOL FASTENED TO DRILL TO HELP REAMER
$\frac{19}{32}$"
DRILL WITH $2\frac{1}{16}$" HIGH SPEED OIL DRILL
.0112 F.P.R.
34 F.P.M.
WORK OF DRILL
FORMING TOOL FOR FINISHING END
TOOL TO FINISH END EXACTLY TO LENGTH
FORMING TOOL-HOLDER
13 MIN. 35 SEC.
FINISH OF DRILL
CUTTING OFF TOOL-THIS CAN BE GROUND AND RESET WITHOUT CHANGING ADJUSTMENT
13 MIN. 45 SEC.
START OF REAMER
REAMER TO FINISH INSIDE
.012 F.P.R.
41 F.P.M.
REAMER
RELIEVED BY TOOL HOLDER ON TOOL SLIDE
KNURLING IS DONE ON HIGH SPEED BEFORE REAMER OR CUTTING OFF TOOL COMMENCES TO WORK
22 MIN. 35 SEC.
FINISH OF REAMER
22 MIN. 45 SEC.
START OF FINISH REAMER
FINISH CUT OFF
FINISHING REAMER
THIS REAMER IS WITHDRAWN PART WAY TO CATCH PIECE WHEN CUT OFF
.0059 F.P.R.
41 F.P.M.
REAMER
8"
26 MIN. 15 SEC. FINISH OF REAMER
26 MIN. 35 SEC. STOCK FED AND DRILL READY TO START ON SECOND PIECE
AVERAGE TIME:-27 MINUTES
Machinery

Fig. 4. Successive Steps and Operations employed in Making the Shell shown in Fig. 1

At the fourth and last position of the turret, a finishing reamer sizes the outer end of the interior of the shell and is withdrawn but part way, so that when the cutting-off slide comes in and finishes severing the piece, the shell is caught on the reamer and not allowed to drop and possibly be injured by so doing.

The average total time for making this piece complete is twenty-seven minutes. On account of the rigidity of the tool support, the tools do not require sharpening oftener than once for fifty pieces, with the possible exception of the cutting-off tool, which must be sharpened after about half that number of pieces have been done. Considering the toughness of the material, the time in which the piece is made, the accuracy required, and the number of operations performed, this job is an excellent example of lathe work and especially does it represent the possibilities of modern automatic turret lathe practice.

* * *

POWER FROM THE TIDES

In a recent issue of the *Engineering Record*, Mr. J. Royden Peirce discusses the possibilities of obtaining power from the tides. Along the New England coast there still exist a few of the tide mills of early days. They were erected at a time when the cost of power was high, and they continue to operate, defying the most economical modern power plants by their ability to produce power, as one might say, for nothing. Among the most prominent of these tide mills is that at Mamaroneck. It was erected shortly after the Revolution, and although rebuilt a number of times, it has been in almost continuous operation since that time. At present this mill is equipped with two modern mixed-flow turbines and with machinery designed to grind pumice stone. The necessary dam or basin has been formed by joining several islands to each other and to the mainland, thereby enclosing an area of 1,200,000 square feet. Three flood gates automatically allow the water to enter when the sea level is above that of the basin, and they automatically close when the tide begins to recede. The rise and fall of the tide at a certain test was 7 feet, but the basin level dropped only 1.4 feet during the test. Although the area of the basin is nearly 1,200,000 square feet, the average horsepower was found to be only 37. This furthermore was the water horsepower; the actual power delivered by the turbines must have been considerably less.

Along the Atlantic coast in New York and Connecticut there are a number of tide mill ponds. The largest of these is the Holly pond at Stamford, which has an area of approximately 10,000,000 square feet. There is a second at East Bridgeport about one-half as large, and a number of others scattered between Larchmont and South Norwalk. Their combined area is in the neighborhood of 20,000,000 square feet. If these mills averaged 50 horsepower-hours for every million square feet the aggregate output would be about 1000 horsepower. While the best locations have been utilized, there are many bays and indentations along the coast still available, but a study of the hydrographic charts show that the greatest possible power which the North shore of Long Island Sound is ever capable of producing is not more than 5000 horsepower. This is not a very encouraging figure for 100 miles of coast line. It is equal to only one-fifth of the new turbine units in the New York Edison Co.'s Waterside station.

* * *

The man who trades on the ignorance of his fellow-men, or goes on the theory that he knows more than anybody else, and is not going to let anyone into his institution or see what he is doing, generally wakes up some day to find that the world has moved on, and he is only clinging to it by a very precarious tailhold.—*Exchange.*

POWER-DRIVEN AIR COMPRESSORS FOR AUTOMOBILES

The Hartford Machine Screw Co., Hartford, Conn., is manufacturing a very ingenious and compact design of air pump for use on automobiles. This pump is intended for the inflation of tires and can be used in connection with automatic engine starters requiring compressed air. It is built with a single air-compressing cylinder, as illustrated in Fig. 1, or as a combination water pump and air compressor. The interesting feature of this pump, from a mechanical point of view, is the crank mechanism which doubles the stroke of the piston for a given throw of the crank, so that a large capacity is obtained from a comparatively small pump.

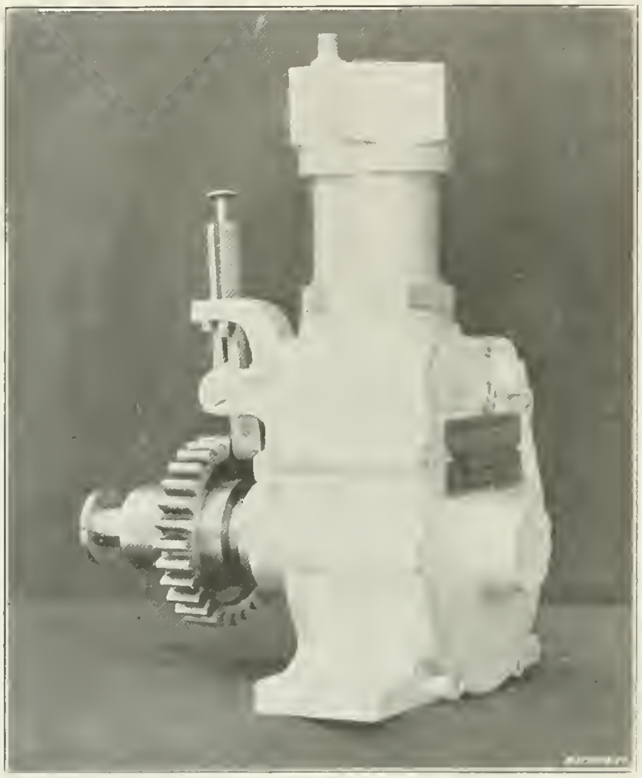


Fig. 1. Compressor for Inflating Tires and supplying Air to Engine Starters

The arrangement of the crank is illustrated by the sectional views, Fig. 2. The crank proper is of the center type and has a bearing on each side. The connecting-rod is attached to the yoke *A*, which is mounted on the main crankpin. The opposite end of this yoke is pivoted to link *B*, suspended from the compressor casing. As the crankshaft rotates, this link oscillates to and fro and so controls the movement of yoke *A* that the stroke of the piston is practically doubled. The relative movements of the yoke and crank are clearly shown by the different views which indicate the rotary motion of the crankshaft.

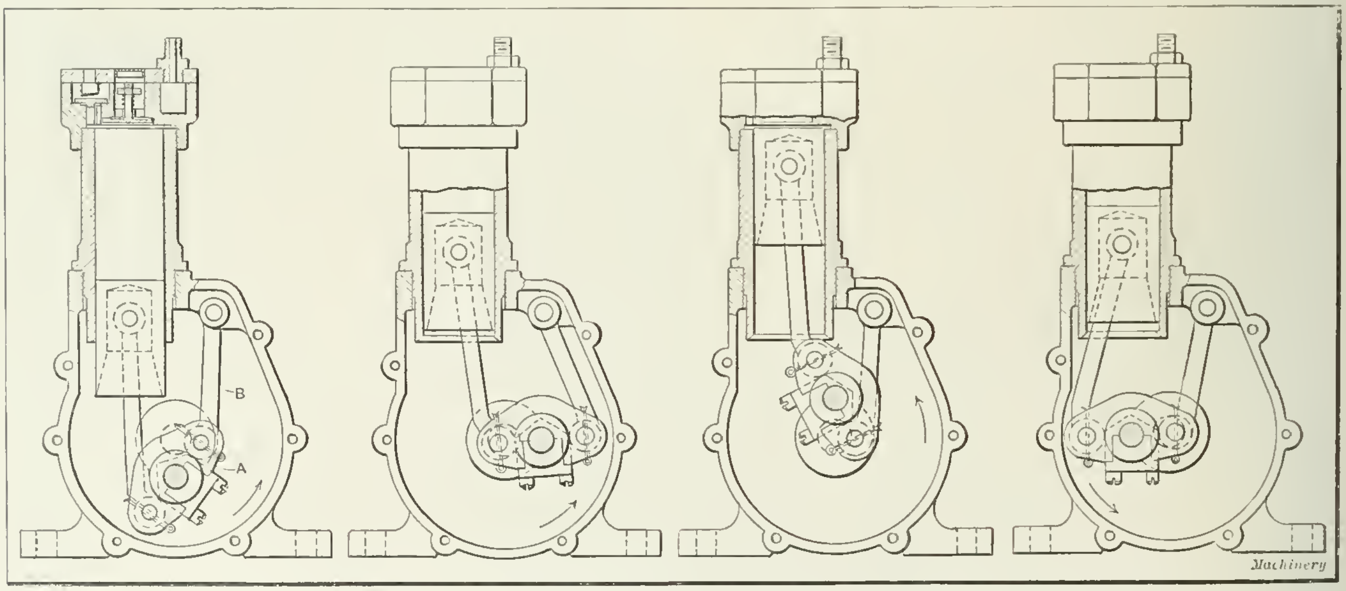


Fig. 2. Sectional Views of Air Compressor, showing Arrangement for Doubling Stroke of Crank

This pump is driven through gearing from the engine and the normal speed is 550 revolutions per minute. At this speed, the pump is said to inflate a 36- by 5-inch tire to a pressure of 85 pounds in less than three minutes without overheating. The piston is made of crucible steel and is hardened and ground. There are no packing rings or packing to cause trouble. Both the intake and exhaust valves are located in the head as shown in the view to the left, Fig. 2. These valves are formed of simple flat disks which close onto raised seats. All bearings are bushed with high-grade bearing metal. The water pump of the combination compressor and pump, is of the rotary type and is intended for circulating water around the cylinder jackets. The air compressor can be engaged or disengaged by operating the small lever seen to the left, Fig. 1, which is provided with an automatic lock to prevent accidental engagement. When the combination pump is used to compress air in a tank for starting the engine, it is equipped with a clutch. Engagement and disengagement of the compressor is then controlled by a pedal under the driver's foot. The casings of these compressors are of aluminum alloy. The single type weighs only 6½ pounds and the combination pump, 16½ pounds.

* * *

INTERNATIONAL SAFETY CONGRESS

The new American idea of the safety engineer, an accident prevention specialist, will be brought to the notice of world industrialists at an International Safety Congress to be held in Milan, Italy, for five days, beginning May 27, 1912. This congress, the first of its kind of international scope ever held, will be for the purpose of setting in motion a world-wide movement for the conservation of human life in industry.

The American Museum of Safety, 29 West 39th St., is making preparations so that the United States will be well represented. An American national committee has been selected by the American Museum to cooperate with the international body and to promote the American ideas and views at the congress. Dr. W. H. Tolman, director of the American Museum of Safety, and other members of the committee will attend the congress.

The following are some of the papers which will be read at the Milan congress:

"The Safety Engineer on a Large Transportation System," by Dr. W. H. Tolman, chairman, American national committee.

"How the New York Edison Safeguards the Lives and Limbs of Its Employes," by Arthur Williams.

"The Work of the Safety Committee of the United States Steel Corporation."

"Safeguarding the Traveling Public and Protecting the Employes of the Electric Street Railway Association."

"Proper Illumination and Accident Prevention," by J. V. Lansingh, president of the Illuminating Engineering Society.

REPAIRING PLANERS AND SHAPERS[*]

By EDWARD K. HAMMOND[†]

The wearing of parts of a machine, through use or misuse, necessarily disturbs its alignment and makes accurate work impossible. In such cases, the wear in each individual member need not be great, because the errors produced are cumulative in their effect, and negligible amounts of error in the different members combine to result in a serious inaccuracy in the work produced by the machine. The average mechanic, experienced in the operation of machinery, is familiar with these facts, but when he attempts to adjust a machine to compensate for wear, he is more than likely to fail. This failure is generally due to the use of improper methods of doing the work.

The firm of A. O. Walworth & Co., 30 S. Clinton St., Chicago, Ill., makes a specialty of rebuilding machinery, and, as the result of a wide experience in this work, special methods have been developed to compensate for the wear in used machine tools. These methods enable a badly worn machine to be adjusted to practically the same degree of accuracy that it possessed when new, and in this article, the practice of this company in the adjustment of planers and shapers will be described. While these methods are all of a special character, they will be readily understood by any mechanic, and their use will make it possible to put machines back into such a condition as to fit them for the production of accurate work.

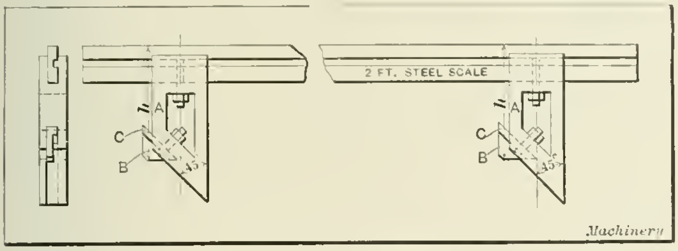


Fig. 1. Special Gage used for Testing Planer Beds and Tables

Method of Adjusting a Worn Planer

In starting upon the adjustment of a planer, the first step is to completely dismantle the machine, in order that the condition of each part may be determined by tests and inspection. The class of service for which the planer has been used necessarily determines the amount of wear and the points where it will have been produced. In general, however, it may be stated that the table and its bearings in the bed, the crossrail, the saddle bearing on the crossrail, and the shaft bearings, are the points where the most serious inaccuracy is likely to be found.

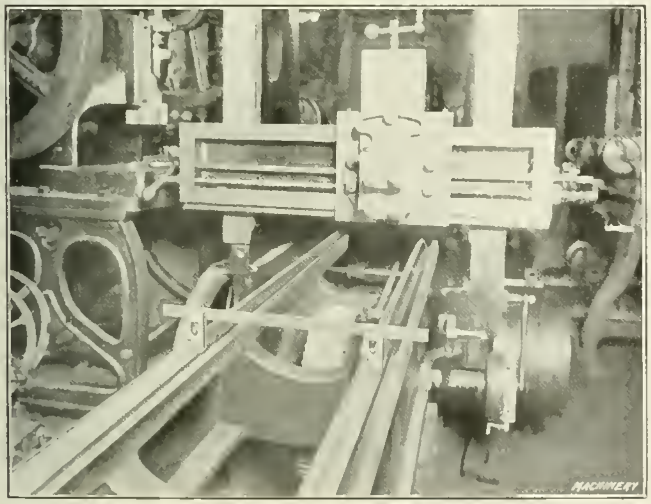


Fig. 2. Testing the Distance between Corresponding Surfaces of the Vees

Planer tables are frequently sprung out of shape as the result of poor judgment on the part of the operators in clamping down the work. When the clamping bolts are tightened to such an extent that the table is drawn out of shape, and the work and table are then allowed to stand in this way for a number of hours, a permanent set is more than likely to be produced. This is especially true if tools or other heavy objects are dropped on the table while it is in this strained condition. In such a case a vibration is set up which causes the metal to readjust itself to the new shape. Where inaccuracy of this kind occurs, it will usually be found that the middle of the table has become high, the amount of the deformation being easily determined with a straightedge. The error in planer tables from this cause is often a very serious matter, an instance having been brought to the writer's attention where an 8-foot planer table was ½ inch higher at the middle than at either end.

In adjusting a table that has been sprung out of shape in this way, it must be remembered that the thickness has originally been properly proportioned to the length and width. Consequently, if any considerable amount of metal is removed by planing, the table will be too thin. This difficulty has been overcome by reversing the process which caused the deformation of the table, in bringing it back into proper alignment. A heavy iron floor-plate is used for this purpose, provided with bolt holes for clamping down the work. The planer table is laid on this plate, face down, and is then clamped tightly against the surface of the plate. After remaining in this position for two or three days, it will be found that most of the inaccuracy has been removed. During the time that the table is clamped to the floor-plate, work can be progressing on other parts of the planer.

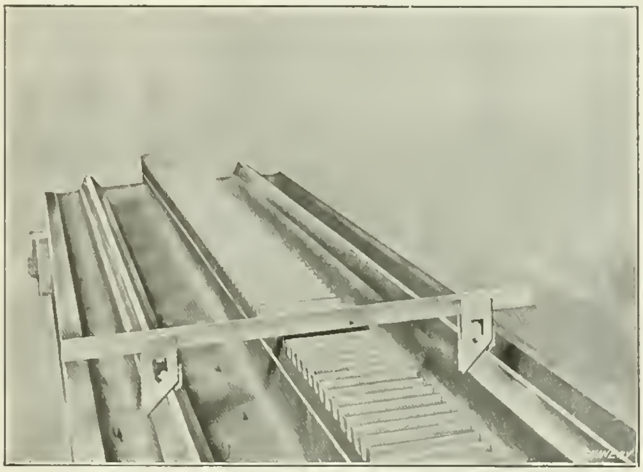


Fig. 3. Testing the Distance between the Planer Table Bearings

Improper methods of oiling often cause serious wear in the vees in the bed and on the table bearings which run in them. Where the bearings have worn quite smooth, there is little chance for proper lubrication, as the oil cannot be held between them. This cause of wear can be easily overcome by taking off the table about once a year, and scraping the vees and bearings. The scraper marks form small pockets which hold the oil and allow it to be distributed over the bearings as required. The bed is tested for inaccuracy of this kind with a straightedge, and if there is found to be any serious amount of wear in the vees, it must be placed on a planer and planed down to approximate accuracy, before scraping to a final finish.

The special gage shown in Fig. 1 is used to maintain the proper distance between the vees during the re-finishing operations. The blade of this gage is a 2-foot steel scale of the kind used on the Brown & Sharpe combination square. The position of the blocks *A*, at either end of the gage, can be adjusted to meet the requirements on different sizes of planer beds and tables; these blocks are secured in any desired position by means of the binding nuts shown. The angle at the bottom is 45 degrees, to fit the standard form of vee. The small triangular plates *B* slide in grooves cut in the inclined edges of the gage blocks, and can be secured in any desired position by means of the binding nuts provided for this purpose. These nuts are carried by bolts which have a slot milled in their sides to fit over the flanges *C* on the plates *B*. In adjusting this gage for use on a given planer bed, blocks *A* are set so that their inclined edges are at the same distance apart as the corresponding sides of the vees, the graduations on the blade of the gage being used for this purpose. The plates *B* are then adjusted with a micrometer caliper so that the distance *h*, from the top of the blade to the bottom of the plates, is the same at each end of the gage. It will be seen in Fig. 2 that plates *B* rest on the top of the bed, the purpose being to steady the gage and bring the blocks *A* into proper alignment with the sides of the vees.

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[*] See also MACHINERY, July, 1911, "Repairing Lathes and Milling Machines."

[†] Address: 9620 Hoyne Ave., Chicago, Ill.

In starting to re-finish the bed, the first step is to plane and scrape the horizontal surfaces at the top of the vees. Accuracy in two directions is necessary; each surface must be finished so that it tests up to a straightedge, and all four surfaces must be in transverse alignment. After each of these surfaces has been accurately finished, their transverse alignment is tested with the dial test indicator, which is mounted in the planer head. The indicator is traversed over each of the four surfaces, and if the proper alignment has been secured, its reading will be the same for each surface; if either surface is found to be too high, however, it must be scraped down until the test gives satisfactory results. The accuracy obtained in this operation is important, because these surfaces of the bed are used in adjusting the housings and to bring the crossrail into proper alignment with the table.

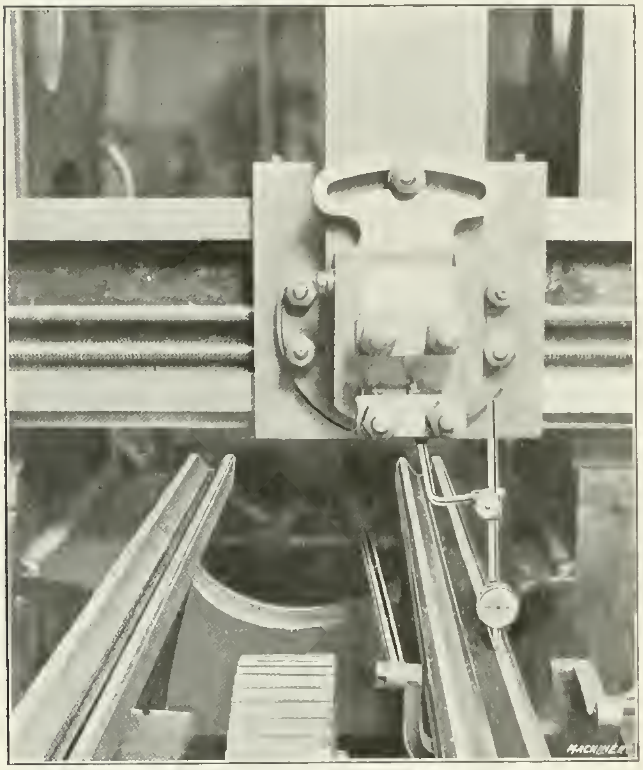


Fig. 4. Method of Aligning the Crossrail with the Planer Bed

It is only in extreme cases that it is necessary to resort to planing the vees in the bed; the wear at this point is usually so slight that it can be removed by scraping. In performing this operation, the outside surface of one vee is scraped down and tested with a straightedge, and this surface is then used as a standard of reference for the gage in re-finishing the corresponding surface of the other vee. The method of using the gage for this purpose is shown in Fig. 2, the gage being moved along the bed to determine the amount of metal which must be removed at different points. The surface is then scraped down to an accurate finish, as determined with the straightedge, the gage being used at frequent intervals to make sure that too much metal is not removed. The opposite sides of the vees are then re-finishd in exactly the same manner—the surface of one vee is first scraped down to a straightedge and is then used as a standard for the gage in re-finishing the remaining side of the other vee. It is evident that the gage need only be turned end for end to make it available for this operation.

The same general method of procedure is followed in re-finishing the table bearings, the use of the gage providing a method of obtaining exactly the same distance between them as that between the vees; this insures having the table fit properly on the bed. The table is removed from the floor-plate and mounted on the table of a planer, where the bearings are lined up with the dial test indicator to determine the amount of inaccuracy which still exists. If this inaccuracy is great enough to require planing, care must be taken not to remove any more metal than is absolutely necessary. The outside surface of one of the bearings is then scraped and tested with a straightedge, and this surface is then used as the standard of reference for the gage in re-finishing the corresponding surface of the other bearing, as shown in Fig. 3. This latter surface is scraped down to a straightedge, the distance between the bearings being maintained constant with the gage, as previously described for the vees in the bed. The opposite sides of the bearings are then re-finished in exactly the same way.

It is evident that the use of this special gage for both the table bearings and the vees in the bed, assures that they will fit together with absolute accuracy. Far greater precision is attainable in this way than when male and female templets are used on these operations. If any considerable amount of metal has to be removed from the table bearings, it will bring the rack too low to mesh properly with the driving pinion. In such cases, the rack must be removed from the table and have a corresponding amount of metal planed from its bearing.

The crossrail and the bearing of the saddle upon it are subject to uneven wear, owing to the fact that most planer work is done with the head near the center of the rail. To remove the error produced in this way, the crossrail is planed on its face and sides, and then scraped until the re-finished surfaces line up properly when tested by the dial test indicator. The saddle bearing is then scraped to an accurate fit on the re-finished crossrail.

The planer housings are not often subject to any appreciable amount of wear, but their adjustment is sometimes inaccurate, thus throwing the crossrail out of alignment with the table.

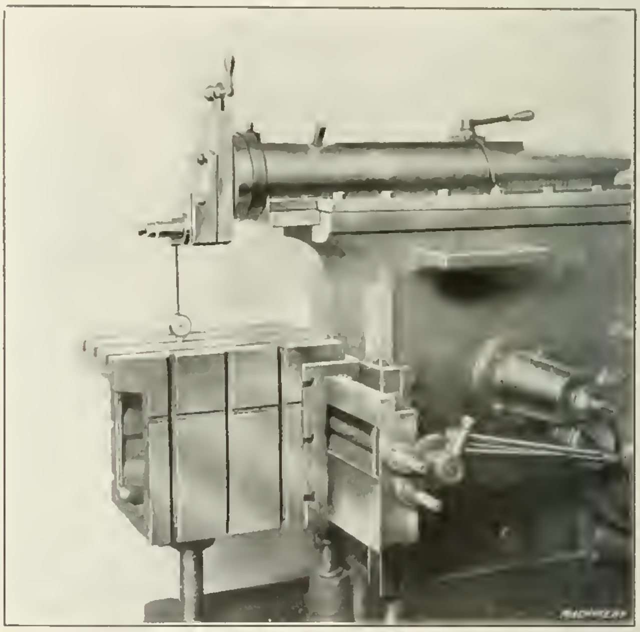


Fig. 5. Proving the Accuracy of a Re-finished Shaper Table

In re-assembling the planer, the re-finished surfaces at the top of the vees in the bed are used as a standard of reference in adjusting the housings, a millwright's steel square being used to bring them into a perpendicular position. After making these adjustments, the bearings of the crossrail are scraped to an accurate fit on the housings; the crossrail is then mounted in position and lined up with the bed. The dial test indicator is used for this purpose, as shown in Fig. 4, the indicator being brought into contact with the surfaces at the top of the vees, first at one side of the bed and then at the other. Corresponding readings of the indicator show the rail to be in proper alignment, but if this test cannot be made with satisfactory results, it is necessary to readjust the housings. The test is then repeated and further adjustments are made on the housings, if necessary, until the proper alignment of the crossrail has been secured. It is, of course, understood that this alignment of the crossrail with the bed provides for having the table and the crossrail in proper alignment with each other.

Any inaccuracy in the bearings which carry the driving shafts will set up a vibration which manifests itself in an uneven finish on the work. Where such inaccuracy has been caused by wear in the bearings, it must be removed—by scraping, if possible, or by re-bushing the bearings, if they have been too badly worn to be adjusted by scraping.

A small amount of wear on either the rack or driving pinion is not a serious matter, as it does not impair the smooth running properties of the drive. Owing to the greater speed of the pinion, however, it will frequently be worn to a point where the smoothness of the drive is impaired, and in such cases, a new pinion must be provided. Where individual teeth of either the rack or pinion have been damaged, they can be economically repaired by adding metal with an autogenous welding torch and then recutting the teeth. This plan can be followed by sending the work out to a shop which makes a specialty of welding operations, if a torch is not included in the equipment of the plant in which the planer is being rebuilt.

After all of these operations have been completed, the planer is ready to be re-assembled. The machine is then placed in operation to plane down the face of its own table for removing any inaccuracy which exists. The lightest possible cut is taken, and when the operation is completed, the accuracy of the finish is tested by means of the dial test indicator held in the planer head. When these methods are carefully followed, a machine which is so badly worn that it is practically worthless, can be put into condition to produce accurate work.

Method of Adjusting a Worn Shaper

In starting to adjust a shaper for the inaccuracies which have been produced from the wear of its parts, the same general steps are followed that were outlined for a planer. After dismantling the machine, all of the bearings which take part in transmitting power to the ram are examined for wear, and they are either scraped or re-bushed to meet the requirements of individual cases. Where a shaper has been subjected to severe service for a considerable length of time, it will usually be found that the pinion which drives the bull-wheel is badly worn. If this is the case, this pinion must be replaced by a new one.

The ram and its bearings in the frame of the machine are the points where the greatest wear is likely to occur. In compensating for the inaccuracy which is found in these parts, the bearings in the frame are first scraped to a straightedge. The ram is then planed down just enough to remove the wear which has developed, the dial test indicator being used to insure proper alignment of the re-finished surfaces. The ram is then scraped to fit accurately in the bearings in the frame of the shaper.

The crossrail is next mounted on the planer, where it is first planed and then scraped to an accurate finish, as determined by means of the dial test indicator. After this operation has been completed, the saddle bearing is scraped to an accurate fit on the crossrail.

The completion of these operations provides for the smooth operation of the machine. After re-assembling, a light cut is taken over the surface of the table, to provide for having it in proper alignment with the ram, any inaccuracy in the alignment of the crossrail being compensated for in this way. The precision of the finish obtained on the table is proved with the dial test indicator, as shown in Fig. 5; the table is then scraped, if necessary, until an accurate finish has been secured.

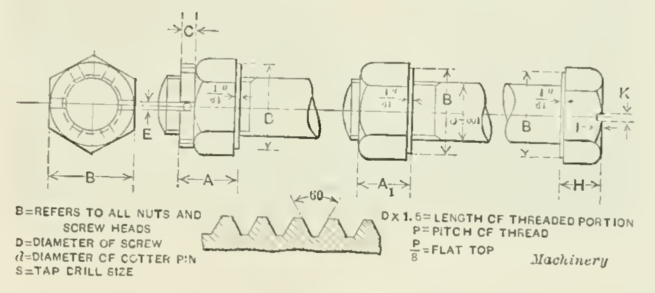
It cannot be too strongly emphasized that the greater part of the wear which develops in machinery is due to improper operating conditions. This is particularly true when machine tools are operated by men who are not trained mechanics, and in such cases, careful inspection should be made at frequent intervals to see that every machine is properly oiled, and that it is not exposed to unnecessary strains. The methods described for proving the accuracy of different planer and shaper parts, can also be used to advantage in detecting wear in the different members of the machines, and when this is discovered before it has assumed serious proportions, it can easily be remedied by a little scraping. Such a course will add greatly to the life of all classes of machinery.

* * *

A. L. A. M. SCREW STANDARD AS REVISED BY THE S. A. E.

The Society of Automobile Engineers has announced the details of the S. A. E. screw standard, which supplants the A. L. A. M. screw standard adopted by the Association of Licensed Automobile Manufacturers in April, 1906. (See MACHINERY'S Data Sheet, No. 63, November, 1906.) The revised list is given in the accompanying table. The only changes which have been made are the distances across the flats of ¼-, 7/16-, and 3/4-inch screws and nuts, the changes being from 3/8 to 7/16 inch, from 11/16 to 5/8 inch, and from 1 1/8 to 1 1/16 inch, respectively. The A.L.A.M. screw standard did not go beyond 1 inch in diameter for standard screws, but the S. A. E. standard proceeds by eighths of an inch for screws over 1 inch up to and including 1½ inch in diameter.

S. A. E. STANDARD SCREWS AND NUT



Number of Threads Per Inch

Sizes	28	24	24	20	20	18	18	16	16	14	14	12	12	12	12
	Dimensions in Inches														
D	1/4	5/16	3/8	7/16	1/2	9/16	5/8	11/16	3/4	7/8	1	1 1/8	1 1/4	1 3/8	1 1/2
A	9/32	21/64	13/32	29/64	9/16	39/64	23/32	43/64	13/16	29/32	1	1 5/32	1 1/4	1 13/32	1 1/2
A1	7/32	17/64	21/64	3/8	7/16	31/64	35/64	19/32	21/32	43/64	7/8	63/64	1 3/32	1 13/64	1 5/16
B	7/16	1/2	9/16	5/8	3/4	7/8	15/16	1	1 1/16	1 1/4	1 7/16	1 5/8	1 13/16	2	2 3/16
C	3/32	3/32	1/8	1/8	3/16	3/16	1/4	1/4	1/4	1/4	1/4	5/16	5/16	3/8	3/8
E	5/64	5/64	1/8	1/8	1/8	5/32	5/32	5/32	5/32	5/32	5/32	7/32	7/32	1/4	1/4
H	3/16	15/64	9/32	21/64	3/8	27/64	15/32	33/64	9/16	21/32	3/4	27/32	15/16	1 1/32	1 1/8
I	3/32	7/64	1/8	1/8	1/8	1/8	1/8	1/8	1/8	1/8	1/8	7/32	7/32	1/4	1/4
K	1/16	1/16	3/32	3/32	3/32	3/32	3/32	3/32	3/32	3/32	3/32	5/32	5/32	3/16	3/16
d	1/16	1/16	3/32	3/32	3/32	1/8	1/8	1/8	1/8	1/8	1/8	11/64	11/64	13/64	13/64
S	7/32	17/64	21/64	3/8	7/16	1/2	35/64	39/64	43/64	25/32	29/32	1 1/64	1 9/64	1 17/64	1 25/64

The material from which the screws and nuts are made is steel having a tensile strength not less than 100,000 pounds per square inch, and an elastic limit of not less than 60,000 pounds per square inch. The screws as well as the screw-heads are to be left soft, and the plain nuts are to be left soft, but the castle nuts are to be casehardened. It is assumed that when screws are to be used in soft materials, such as cast iron, bronze or aluminum, U. S. standard pitches will be used.

* * *

ERICSSON'S MEMORY HONORED

The American Society of Swedish Engineers celebrated the near fiftieth anniversary of the battle between the *Monitor* and the *Merrimac* in connection with its annual dinner at the society's house in Brooklyn, N. Y., February 17. The celebration commemorated Capt. John Ericsson, the famous Swedish-American engineer who invented and designed the *Monitor.* Mr. Erik Oberg, associate editor of MACHINERY, spoke on "John Ericsson the Man," and W. L. Axel Warn, Albany correspondent of the New York *Times*, briefly described the famous engagement between the two vessels which took place in Hampton Roads, Va., March 9, 1862.

THE MANUFACTURE OF STEEL BALLS

INSPECTING, GAGING AND TESTING

By ROBERT H. GRANT*

In the previous articles on the making of steel balls in the February and March numbers, the making of the blanks, the rough-grinding, the hardening and the finish-grinding of steel balls has been taken up. In the present article it is proposed to treat of the inspection, grading, gaging, and testing of the balls, and also to review the various uses of steel balls, as well as to give some advice to purchasers and users regarding the quality of balls.

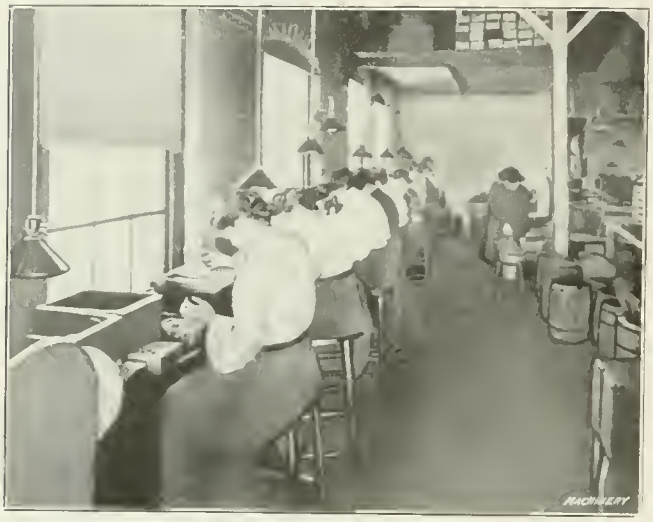


Fig. 1. Inspecting the Balls

The Burnishing and Tumbling Processes

When the balls come from the oil grinders, they have a dull finish and must be burnished or tumbled. The burnishing can be done in the oil grinder with a set of rings having grooves in them the exact size of the balls. A light oil is used, and after a very short run of the machines, a finely polished surface will be produced. This process, however, is expensive, and the ordinary tumbling method is most generally used. The tumbling barrel universally adopted is of is most generally used. The tumbling barrel universally adopted is of the regular iron tilting type. The balls are placed in the barrel in sufficient quantities so that, when they roll over and over, their weight will cause enough friction between them to polish them. A polishing material is placed in the barrel, and the latter is allowed to run at least ten hours to produce a good surface. The balls are then cleaned off by tumbling them in sawdust, and are later placed in another barrel with finely cut kid leather. This final tumbling brings out the high polish.

Inspection

The balls are now ready to be inspected, which is done almost exclusively by girls. The skill and rapidity which can be obtained in doing this work is certainly most remarkable. One girl can inspect fifty thousand ¼-inch balls, picking out seven or eight different grades, in ten hours. This inspection, as indicated in Fig. 1, is done on glass plates which are about ten inches square and inserted in a frame so that the balls cannot roll off. The under side of the glass is painted so as to reflect the light. The plate is about half filled with balls and is placed upon a box which is tilted slightly towards the inspector. This causes the balls to always roll to the front. The inspector holds in her hand a magnet resembling in shape a knitting needle. The end is sufficiently magnetized to raise one ball of the size being inspected from the glass. In the other hand the inspector holds a piece of heavy white paper 4 inches wide by 8 inches long, which she slides under the balls. This makes the balls revolve, and with the magnet defective balls are picked out. The defects consist of pits, bands, dents, scale, rough grinding marks, etc.

The different grades are separated in boxes, placed to the right of the inspector, and they are used for different purposes according to the requirements placed on the balls. It is evident that different grades of balls may be used when it is remembered that ball bearings are employed in so many different kinds of devices, such as bicycles, clothes-wringers, hand trucks, sash pulleys, hinges, etc.

After the balls have been inspected for defects they are rolled back and forth on the glass plate in order that those that are out of round may be picked out. As the balls which are not perfectly spherical will take a zigzag motion when rolling down the plate, and the true balls will run straight, it is comparatively easy for the inspector to pick out the imperfect ones. An expert inspector does not stop each time she picks up a ball to place it in the boxes, but will usually toss it into the palm of her hand, which will generally hold all of one grade that she will pick out from the batch of balls on the plate. Balls larger than ¾ inch in diameter are generally taken up by hand and looked over. Those that are out of round in the larger sizes are taken out while measuring the balls.

Grades of Balls

Balls are generally graded into four main classes, known as alloy, and A, B, and C grades. The steel for the alloy balls contains chromium, and these balls have the greatest crushing strength. They must be absolutely free from defects as regards material and finish, and must not vary in size more than 0.0001 inch. Balls classified as A-grade are made from high-grade tool steels, accurately finished, and thoroughly inspected, and must not vary over 0.001 inch above or below the exact dimension. The balls known as B-grade are the seconds taken from the two higher grades mentioned. These are the balls which show slight, almost invisible, defects, and which vary from 0.001 to 0.002 inch. The C-grade, commonly known as hardware balls, are those picked from the higher

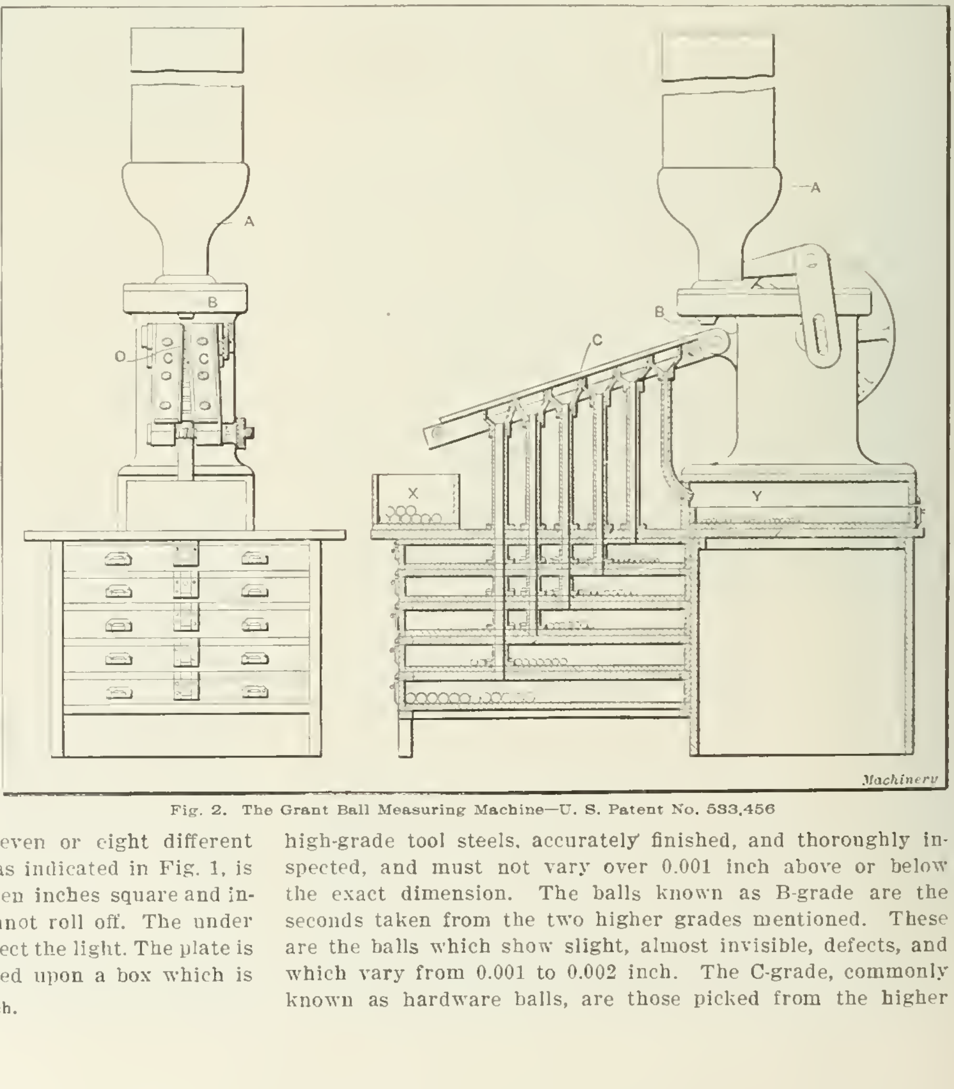


Fig. 2. The Grant Ball Measuring Machine—U. S. Patent No. 533,456

grades when these show a defective surface. Whether these balls are gaged or not depends upon the use to which they are to be put.

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The Gaging of the Balls

After the inspection, the balls are automatically gaged, the gaging being done in a gaging machine in which the balls are fed from a hopper and allowed to roll down between two hardened straightedges and to fall into tubes which carry them to the proper drawer, as indicated in Fig. 2. This illustration shows the Grant ball measuring machine. At *A* is shown the automatic dropping machine, and at *B* the delivery spout through which the balls drop into the measuring slides *C*, provided with a longitudinal slot or opening *O* between them. The sides of the slot may be accurately separated any desired amount by the micrometer adjusting screws provided at both ends. Consequently, the flare of the slot may be adjusted so that it is possible to determine exactly what the diameter is of the balls that will drop into each of the tubes and drawers beneath the measuring slide as the balls roll down along it.

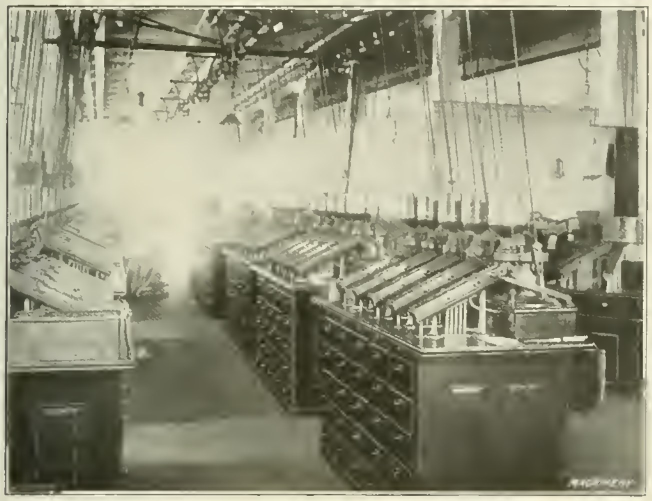
Fig. 3. A Battery of Grant Gaging Machines

As is clearly shown in the illustration, pockets are arranged successively beneath the inclined slot, and are connected by pipes with the drawers of the cabinet underneath. It is evident that in this way balls of the same size will go into the same drawer each time, the balls that go into the middle drawer being those of correct size, those that go into the upper drawers being those that are too small, while the large balls will go into the lower drawers. The balls that are entirely too large will run down the full length of the measuring slide and will be deposited in the box *X*. Those that are deposited in the drawers of the cabinet will be from 0.0025 to 0.005 inch too large or too small, according to the setting of the slides.

The exact arrangement of these measuring devices varies somewhat. In Fig. 3 is shown a group of the type of machines just described. A rack is run through the center of the machine. In this rack, directly under the hopper, there is a hole having a bushing in it of the size of the ball to be gaged. The ball drops from the hopper into this bushing and is carried forward until it comes to an opening which is connected with a tube for carrying the ball to the measuring slides. The rack is operated by a sector of a gear mounted on a shaft having an eccentric pin on one end and a pulley on the other. Inside of the hopper there is a small tube which is operated up and down by two levers, one being attached to the eccentric pin and the other to the tube. This arrangement prevents the balls from clogging so that the bushing in the rack is always ready with a ball to carry forward, thereby constantly feeding balls to the measuring slides.

In Fig. 4 is shown the writer's machine with the measuring slides removed. This particular machine is worked by a worm and worm-wheel instead of by a rack. There are two disks, beneath the balls in the hopper, the upper one of which is keyed to the shaft fastened to the worm-wheel and hence revolves. This disk has a series of holes drilled near the periphery, these holes being 0.005 inch larger than the ball to be gaged. The lower plate has a hole in it directly above the measuring slide, so that when the upper disk carrying the balls presents a hole directly above the hole in the lower disk, the ball will drop through the hole and tube onto the measuring slide. As the hopper is full of balls there is a liability of clogging, because two balls may have a tendency to drop through the hole at once when the opening is presented. The clogging tendency is overcome by a cut-off made of a thin piece of tool steel with beveled edges, which covers two holes in the revolving disk, the holes covered being the one directly over the lower disk and the one next to follow. This prevents jamming of the balls. The remainder of the machine and cabinet is substantially the same as the machine shown in Fig. 2.

In the Putnam gaging machine the hopper is worked practically the same as in a machine for slotting screws. Fingers raise the ball, allowing it to fall into a trough, and then through a tube onto the measuring slides.

This mechanical gaging and sorting of balls is applied to all sizes up to and including ⅝ inch. The large sizes are measured by hand by micrometers. The girls employed for this work pick them up one by one and measure each ball separately over several diameters, throwing them into small boxes placed before them, each of the boxes containing a certain size of balls between the limits of measurements adopted. This work is very rapidly done, as the operators become very skillful.

Counting the Balls

The next operation is the counting and boxing of the balls which at first sight might be assumed to be a tedious and very slow operation. So it would be were it not for the mechanical means adopted for doing this work. Balls up to ⅜ inch in diameter are counted by means of a counting board, as indicated in Fig. 5, which has holes sunk in it 0.010 inch larger than the ball. Around the board is tacked a narrow strip of wood to prevent the balls from rolling off. The balls are then poured upon the board and all balls which do not find a hole to enter are allowed to run off. As there is an exact known number of holes in the board, the counter immediately knows how many balls she has, and she transfers them immediately from the counting board into a pasteboard box in which the balls are packed. In this way one girl can easily count a million balls a day and do other work besides.

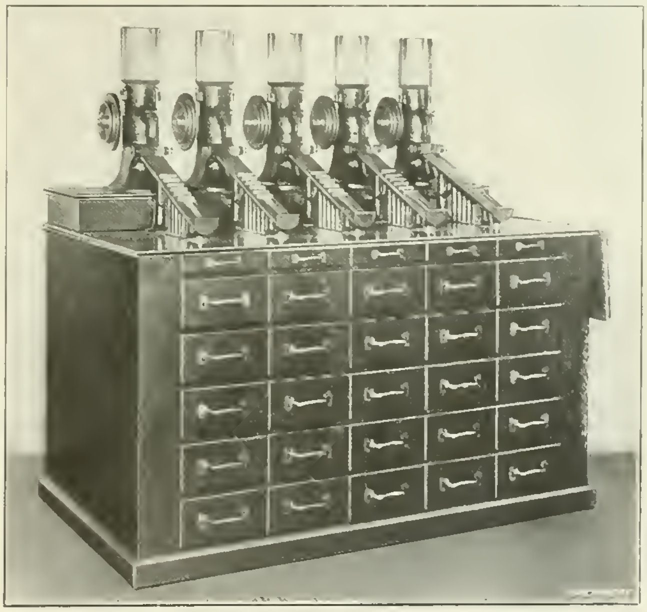
Fig. 4. A Modified Type of Grant Measuring Machine, with Gaging Slides removed

The pasteboard boxes are made of a telescoping form and lined with paper which is free from acid and which has previously been soaked in an anti-rust compound. The balls, which have a very high polish, would otherwise easily rust on account of sweating, which is caused by the difference in temperature of extreme heat and cold. It is very essential that steel balls should be kept in a room properly heated.

The Testing of Balls

The testing of a steel ball for crushing strength should be done between hardened plates by placing three balls in a tube into which they nearly fit. The center ball is the one that will be tested. The upper and lower balls will, of course, sink into the plates, and this will give them more of a surface bearing than the middle ball, which bears only in two points upon the upper and lower balls; hence the middle ball will ordinarily give way first. As the pressure is applied, a double pressure cone will be formed inside of the ball, this cone having its apexes where the outside balls bear on the middle ball. If properly hardened, a ball will break into several pieces. This method is the proper way to test a ball, but there seldom are two balls that will stand exactly the same load when tested. This is caused largely by the methods in which the ball blank is made. As will be remembered from the description of the making of the blanks in the February number of MACHINERY, the balls in the forging process are much more dense at what might be called the "poles," that is, where they join the next ball forged, than at the "equator." Therefore, if the center ball being tested has the point of contact on the "equator," it will not stand within ten or twenty per cent of the load that it would stand if the points of contact were at the "poles." The same method of reasoning may be applied to stamped and turned balls.

Through the means of this testing operation and the appearance of the fracture, it can be determined whether the balls have been properly hardened. Every batch of steel, no matter how carefully made, usually requires a slightly different treatment in hardening, and what this treatment is must be determined by the man responsible for the hardening work. The accompanying table shows the crushing load ordinarily required by ball manufacturers for regular tool-steel balls.

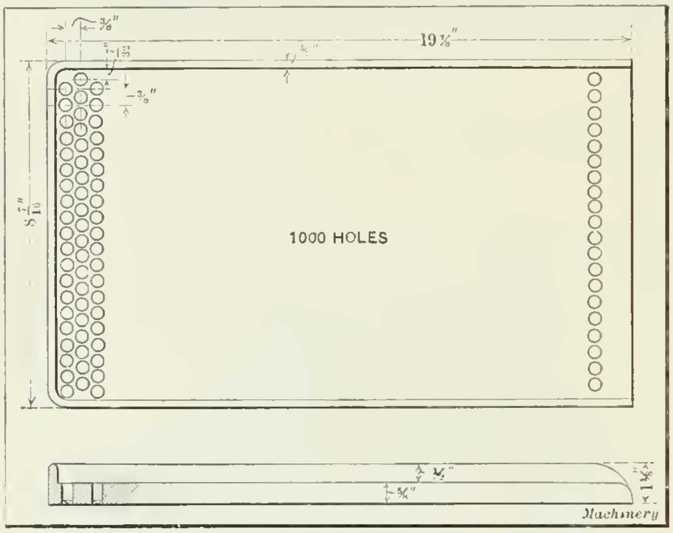

Fig. 5. Counting Board for 5/16-inch Balls

Size of Ball in Inches	Ultimate Strength of Ball in Pounds	Size of Ball in Inches	Ultimate Strength of Ball in Pounds
1/16	390	5/8	39,000
3/32	875	3/4	56,250
7/64	1,562	13/16	66,000
1/8	2,450	7/8	76,000
3/16	3,496	15/16	88,000
7/32	4,780	1	100,000
1/4	6,215	1 1/8	125,000
5/16	9,940	1 1/4	156,000
3/8	14,000	1 1/2	225,000
7/16	19,100	1 5/8	263,000
1/2	25,000	1 3/4	306,000
9/16	31,500	2	400,000

The figures above have been adopted after a great many years of testing and are considered by the manufacturers safe figures with which to calculate. Of course, in selecting a ball for a bearing, a factor of safety of ten should always be adopted unless the bearing is used in an extremely narrow space. The grooves in which the balls run when heavy loads are imposed should be round instead of V-form. No figures can be given relating to tests of balls made from alloy steel, because these steels give such irregular results that the manufacturers have been unable to compile any data that would be in any way satisfactory. It is, however, safe to state that the alloy-steel balls will stand from 25 to 50 per cent more than the regular tool-steel balls.

Balls of Other Materials than Steel

Balls are made of a great many other materials, brass and bronze, for instance, being used extensively for oil-well devices where acid is found in the crude oil. Such balls are also used in valves where the material to be pumped will rust steel balls and cause corrosion, and also in electrical work. German silver balls are used in Yale locks to prevent corrosion when used on shipboard or in other places where they would be subjected to the damp sea air. Casehardened machine steel balls are used extensively in agricultural implements and similar apparatus on account of being inexpensive. Chilled cast-iron balls are used in turntables, trucks, and for similar requirements.

The Uses of Steel Balls

It may be said without exaggeration that balls are used in nearly every kind of article that it is possible to name provided it revolves. They are used in the cheapest kind of hardware and in the finest mechanisms and surveyors' instruments. Balls 1/16 inch in diameter are used in electric meters and typewriters. The number of balls being used for these purposes alone is from fifty to seventy-five millions per year. German silver balls 3/32 inch in diameter are used under the tumblers of a Yale lock to prevent the tumblers from becoming worn by the constant sliding of the key into the lock. Steel balls 1/8 inch in diameter are most extensively used in bicycle pedals. Some people think that the bicycle industry is no longer of the importance that it once was. This is a mistake. More bicycles are made at the present time than ever before, and about fifty million steel balls are used yearly in the pedals alone.

Sewing machines are now being provided with ball bearings. Millions of 3/16-inch balls are used for this purpose yearly. Some fifty million 1/4-inch balls are used every year in clothes-wringers; 1/4- and 5/16-inch balls are used exclusively for bicycle bearings, and the quantity used runs into hundreds of millions per year. Balls of the same size are used in thrust bearings in motor boats. Balls from 3/8-inch to 3/4-inch diameter are used extensively in automobiles. The quantity of balls so used is estimated at not less than five hundred millions a year. Larger balls of, say, 1 1/8 inch in diameter are used in oil-well pumps, road rollers and traction engines. The quantity being used for these purposes is not less than five hundred thousand a year. One of the most important uses for 1 1/4-inch balls is that in the side bearings on trucks for steam and electric cars. Still larger balls are used for a great many other purposes, including waterwheels, step bearings, locomotive cranes, drawbridges, etc.

Balls are made up to six inches in diameter, and some are used in very peculiar places. Balls of from 4 to 6 inches in diameter are now used by a Canadian concern in a whistling buoy. This buoy has a large tube in which the ball is placed, evenly balanced on the top. The end of the tube has a whistle. The ball, as the tube dips on account of the waves, rolls to the lower end, compressing the air by its weight, and thus blows the whistle. Then it rolls to the opposite end and causes the whistle to blow again.

As already mentioned, brass and bronze balls are used extensively in valves, electrical meters, and bearings where dampness or acid is likely to come in contact with the balls. The number of balls made from these materials is not less than fifty millions per year.

Points for the User and Purchaser of Steel Balls

In the following the essential points relating to the manufacture of balls which should be kept in mind by a purchasing agent or consumer are given. Nothing but a tool-steel ball should be used for high-grade work, and it is very important that it be properly heat-treated. Do not be deceived by a finely polished ball, as high polish and deep scratches (which show only under a magnifying glass) do not necessarily indicate a good ball. In fact, the outside appearance has little or nothing to do with the wear of a ball, for a dull looking ball may be just as good as one with the highest polish. The polish is merely the result of the tumbling process.

The first requirement is that the right material has gone into the balls. It costs but little to have the steel analyzed so that the purchaser may know whether he is getting a tool-steel ball or a machine-steel ball. The fact that the ball has only a point bearing makes it the more important that it be made from good material in order to stand the pressure to which it may be subjected. Casehardened machine-steel balls ought not to be used when heavy duty is required. Naturally there is some difference in the quality of the steel that costs thirty-five dollars per ton from that which costs one-hundred-fifty dollars per ton.

It is true that a ball can be casehardened very deeply, in fact, almost through to the center, but it should be remembered that casehardening implies adding carbon to the steel under a high heat, which causes the pores in the steel to open so that the carbon can enter. The process, however, does not remove the injurious elements, such as phosphorus, sulphur and silicon, of which the cheaper steel contains a large percentage. It is, of course, perfectly satisfactory to use casehardened balls for many purposes, but when it comes to a really high-grade article, the highest class of steel is to be preferred.

In order to determine whether a ball has been properly heat-treated, place the finished ball in a piece of waste on an anvil and break it open with a heavy blow. The waste prevents the pieces from flying around. If the ball is properly heat-treated, the break will show a soft silky-appearing surface—the grain of the steel being fine. If it has not been heat-treated, it will look coarse and granular, having more the appearance of cast iron. As a further illustration of why the ball should be heat-treated, the following tests made by the writer when with the New Departure Mfg. Co., may be of interest. The balls tested were made of tool steel; they were ¼ inch in diameter and drawn to 420 degrees F.

Ground; not Annealed before Hardening	Headed and not Ground; Annealed before Hardening
4800	7500
5700	8150
6300	8200
6150	7200
5800	6880
5600	7300

It will be found that the average crushing load of the balls that were not annealed before hardening is 5725 pounds, while the average crushing load of the balls that had been annealed before hardening is 7538 pounds; hence the heat-treated ball is some 1800 pounds or nearly 30 per cent stronger than the balls which were not heat-treated. The heat-treatment not only strengthens the balls, but prevents them from flaking off, crumbling, etc. It distributes the molecules so that the steel is at rest.

If during the test the ball should break in half, it would indicate that it had not been properly drawn after hardening, but was still subjected to internal stresses. If such a ball is placed in a bearing, it would easily break if subjected to a severe shock or strain. If a ball has been properly drawn it can be touched with a fine Swiss file, and under the blows of a heavy hammer it will dent slightly and break into several pieces.

Balls over 5/16 inch in diameter that have been turned or headed should not be used for heavy duty, as they are not as good as balls for which the blanks have been forged. The headed ball, on account of the severe shock to which the metal is subjected when cold, cannot be treated so as to stand the strain that the forged ball will stand. A turned ball is cut from a rod which is rolled, so that the grain of the steel is in a lengthwise direction; hence when a ball is turned from this bar the surface of the ball consists of a mass of exposed fibers. When put under a heavy strain, as in a thrust bearing, it will pit and flake off. The surface of the ball should be smooth, that is, all the marks from the rough-grinding process should have been removed in the finish-grinding. If this has been done it can be readily determined by a magnifying glass.

A ball made from a forged blank cannot be hardened properly unless the decarbonized surface has been wholly removed. Some manufacturers attempt to keep the forgings as small as possible in order to save material and time in grinding, and in many cases it is then impossible to remove all of the decarbonized surface. Hence when the ball is hardened, rough marks and soft spots can be detected. The soft spots are much brighter than the properly hardened surface.

If balls are to be used for special purposes, this should be designated in the order sent to the ball manufacturer. In order to be able to supply a ball that will give satisfaction, it is necessary that he be furnished with information as to what the ball is to be used for, the speed and load at which it will be used, and the kind of bearing employed. Then the balls can be drawn to a degree of temper adapted to the particular purpose in view, and thus satisfaction can be guaranteed to the purchaser. It is also very important to see that the balls that are furnished are not out of round, as this would cause the bearings to "catch" and "jump." The resulting bearing will run unsatisfactorily, and will rattle on account of the fact that the balls are loose at one point and tight at another. The actual size of the ball does not make a great deal of difference, provided the balls are all of the same size. In other words, in a lot of one-hundred-thousand balls, if they are found to be 0.0005 or 0.001 inch under size they will give satisfaction if they are all used before the next shipment can get mixed up with them.

It has already been mentioned that the temperature of the room in which the balls are stored must not be too low. The temperature of the stock-room should be kept the same at all times, and on Sundays and holidays, when the factory is closed, it should be especially heated, for a ball which becomes very cold and then is brought back to a warm temperature will soon begin to rust and cause a great deal of trouble.

Summary of Ball-making Processes

In order to fix in the reader's mind the various processes that a ball passes through, from the time that the blank is produced from the rough stock until the finished ball enters the stock-room, a general summary of the processes described in the three articles comprising the present treatise on the manufacture of steel balls will be given.

There are several methods for producing the ball blank. One is that of turning the ball blanks in a special automatic machine. This method is rapid and makes it possible to produce a blank which requires less grinding than the blanks produced by other methods, but on account of the fact that the fibers of the stock from which the blank is turned are cut and exposed at the surface, a ball so made is of inferior strength after hardening as compared with balls the blanks of which are made by other methods.

Another method commonly used for producing ball blanks is to form the blank in a heading machine. A bar is fed into the machine and pieces of the required length are cut off and headed between dies to a ball shape. This is a very rapid method, and balls up to, say, 5/16 or 3/8 inch in diameter can be made advantageously by this process. As there is no waste, this process for smaller sizes of balls must be deemed the best as well as the cheapest of the methods used at the present time.

The best method of making ball blanks from 3/8 inch to 2 inches in diameter is known as string forging. This method is very extensively used and the balls so produced, when properly heat-treated, are strong and tough in their structure. The balls which have been produced by the heading or forging process must have the fin or flash ground off before they pass to the grinding machines. The process by means of which the fin is removed is called "flashing," and the machine in which it is done is ordinarily termed a "rotary" file. Large balls are flashed separately in a special fixture by an ordinary emery wheel.

The balls are now ready for the dry-grinding process, the grinding being done by an emery wheel acting upon the balls which are held and rotated by suitable means. After being dry-ground, the balls are annealed and then hardened, the smaller balls being quenched in cotton-seed oil, while the larger ones are immersed in brine. After hardening, the balls are washed in boiling soda and then tempered in oil.

After the tempering the balls are ready to return to the finish dry-grinding department, and are finish dry-ground in machines of the kind that performed the rough dry-grinding, but a finer grade of emery wheel is used. From the finishing dry-grinders the balls pass to the oil grinders, where the final grinding operation is performed and where the balls are brought to exact size. The oil grinding operation is practically a lapping process, no grinding wheel being used. The machine has merely two plates, one of which is grooved, between which the balls roll. The grinding medium is fine emery and oil.

When the balls have been brought to size in the oil grinders, they are given their final finish either by burnishing them in machines similar to the oil grinders, or by being tumbled in a tumbling barrel with a polishing medium. Next they are tumbled in sawdust, and finally in a barrel with cut-up kid leather to obtain the high polish. The balls are then inspected, graded and gaged. The smaller balls are gaged in gaging machines, while the larger are measured by micrometers. Next the balls are counted and packed into boxes and sent to the store-room, which finishes the operations.

* * *

DOURTE VALVELESS PUMP

The pump which is illustrated in Fig. 1 has no suction or discharge valves and is designed especially to handle very trashy matter. Weeds, pieces of rope and other foreign material which may be drawn into the pump are sheared off by the edges of the ports which are located in the piston. This type is being used to pump trashy water out of irrigation ditches and to handle slimes in reduction works. It is also planned to use this pump for handling syrup and heavy oils. The sectional view, Fig. 2, of one of the cylinders of a horizontal type, shows the general arrangement of the piston and ports. A miter gear keyed on the end of the crankpin meshes with the mating gear keyed to the end of the connecting-rod, and the latter is attached to the piston by means of a universal coupling. This mechanism imparts a constant rotary movement to the piston in addition to the reciprocating action. The piston is of the trunk type with an opening at both ends and a partition in the middle. The head end at the left of the partition has a port, as the illustration shows, which alternately registers with the suction and delivery ports. When the piston is in the position shown, both ports are closed, but as soon as the pump rotates in the direction indicated by the arrow, the suction port begins to open. When the crank has moved 90 degrees and is on the "top quarter," the piston port will be exactly over the suction port, and when the opposite "dead center" is reached, both ports will again be closed. When the crank is on the bottom quarter, the piston port will be exactly under the delivery port. It will thus be seen that the piston by its rotary movement regulates the suction and discharge openings. If the pump is reversed or one miter gear is turned through 180 degrees, the pump will operate from the delivery to the suction side or, in other words, the flow will be reversed. The delivery port is formed in a separate saddle which rides on the piston and is held down by adjustable spiral springs, as shown. The suction port is cut out of the solid cylinder. This pump is made at Longmont, Col., and was designed by George L. Sullivan, Bozeman, Mont.

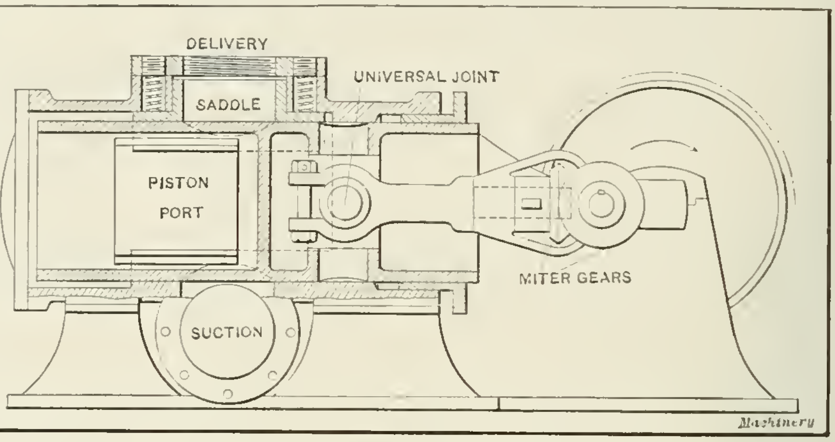

Fig. 2. Sectional View of Valveless Pump of Horizontal Type

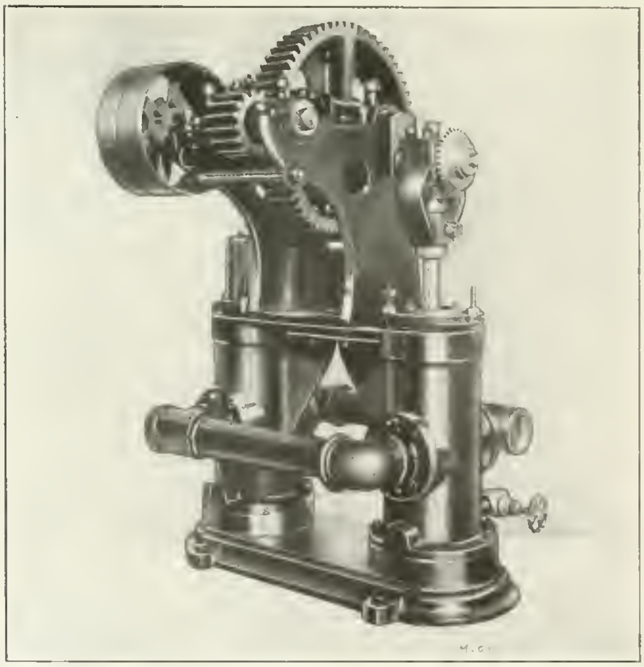

Fig. 1. Duplex Pump without Suction or Discharge Valves

* * *

ENERGY THE MOVING FORCE

Many business concerns that have been organized with ample capital and to outward appearance well equipped to succeed, in the course of a few years have gone into the hands of receivers. Other concerns have started with very small capital, under adverse conditions and have prospered. What was the difference in the organization of these typical concerns which meant success for one and failure for the other? Largely brains and energy.

An incident from the career of a well-known machine tool manufacturer in the Middle West is an illustration of the point. Thirty years ago this manufacturer started in business with a small capital, and his hostages to fortune were "a wife and two kiddies on the hill." His money was soon tied up in the business, and no immediate cash returns were in sight. In the emergency he solicited some job work from a large concern and was "turned down," but being insistent and forceful finally secured an order for two hundred flask-pins at ten cents each. They had to be tapered at one end, turned down, shouldered and threaded at the other end, and provided with a hexagon nut. This was before the days of automatics, and after the order was taken the job hunter realized that he was in for a loss if he followed the regular method of production, so he set his brain to work. He went to a dealer in bar iron, got two hundred pieces cut off while he waited, took them in a box on his shoulder to his shop and then rigged up an engine lathe for the job. A boy hired at fifty cents a day, who had never worked in a shop, with the aid of simple tools and the expert assistance of the boss, turned out the job complete in a day at a cost of $2 for stock, 50 cents for nuts and 50 cents for labor, making the total cost $3, not including a small overhead expense.

The brains and energy used in this case were characteristic of the man and the concern he organized. Starting out in this small way it showed $7000 in assets at the end of the first year, and $32,000 the second year, increasing until the investment now represents over a million dollars, and its product is known and used all over the world.

* * *

A user of high-speed drills complained to the maker that he could not get results. The production was not much higher than with carbon steel drills, and much time was lost in grinding. Examination showed that the cutting speed was high, but the feed very fine. The speed was reduced and the feed doubled, the result being that the output of drilled holes was doubled and the squealing and heating of the drills disappeared entirely.

VARIATION IN MACHINE TOOL POWERS

By T. BARTON*

The wide divergence in the power put into machine tools by different makers is a fact not often commented upon, but a walk through any average shop will reveal many instances of it. The writer recently noticed an 18-inch turret lathe on chuck work, with a single-pulley drive, having a pulley 12 inches in diameter for a 5-inch belt, running at 200 R.P.M. Close by was a 2-inch bar lathe, having exactly the same size pulley, but running at 500 R.P.M. It will be seen at a glance that the bar lathe has two and one-half times the power of the turret lathe. Is not this somewhat of an anomaly? The bar lathe operates on work of small diameter, has only one tool cutting at a time, and that tool has a very keen cutting edge. The turret lathe handles work of large diameter, has frequently several tools in action simultaneously, and the cutting edge of the tools is not as keen. Either one machine is under-powered, or the other has a surplus of power which it can never hope to convert into useful work. Both these machines are of standard make, are good sellers, and do good work.

If the power of a machine is in reasonable proportion to the work to be done, then if anything goes wrong, the belt will slip or be thrown off, but if it is very much over-powered, this safeguard is lost. If a machine has twice the power that it needs, it means that, as the driving gears have to be strong enough for the belt, they must be made twice the width otherwise required. This increases the distance between the bearings, and consequently the diameter of the shafts must be increased to retain stiffness. In short, the whole machine must be made larger and heavier, and the belt up-keep cost is increased. The contrast between these two machines led the writer to investigate more thoroughly. Some of the results of this investigation are given in the following: A 3½-inch bar lathe was driven by a 10 H. P. motor; a 3-inch bar lathe was satisfied with a 3 H.P. motor. A 2-inch bar lathe had an 8 H.P. motor; another make of 2-inch bar lathe was content with a 2½ H.P. motor. It will be seen that here is a difference of over 3 to 1 on two machines made for doing identically the same size and class of work.

The increase in belt speed, and use of wider belts, which a geared drive allows, permits a great increase of power, compared with the old cone pulley drives, and in some cases it would appear to be the practice, when cone-driven machines are converted into single pulley drives, to put on a pulley as large in diameter, and as wide as the machine will stand, and run it at the highest permissible speed, without comparing the power thus obtained with that given by the old cone drive, which has probably stood up well to its work.

Below are given particulars of a few single-pulley machines. The first three figures have been multiplied together, giving a result which facilitates comparison:

	Diam. of Pulley, *A*	Width of Belt, *B*	R.P.M., *C*	*A*×*B*×*C*
2 -inch Bar lathe	12	5	500	30,000
18 -inch Turret lathe	12	5	200	12,000
3 -inch Bar lathe	10	3	800	24,000
3½-inch Bar lathe	14	5½	500	38,500
3½-inch Bar lathe	10½	4½	300	14,175
18 -inch High speed lathe	13	4½	300	17,550
21 -inch High speed lathe	16	5	300	24,000
22 -inch Combination turret lathe	10	4½	450	20,250
30 -inch Boring and turning mill	12	3½	400	16,800
4 -foot Boring and turning mill	12	4	575	27,600
4-foot 6-inch Boring and turning mill	13	5	400	26,000

From this it will be seen that 50 per cent more power is put into a 3½-inch bar lathe than into a 4-foot 6-inch boring and turning mill. The weight of the work and table of a boring and turning mill is considerable, and the machine itself is less efficient, the power being taken through one, and often through two pairs of bevel gears.

To obtain the same tool pressure, or take the same cuts, at the same surface speed, would, neglecting the increased friction of the larger machines, require the same horsepower on any diameter; but as larger machines take heavier cuts, and the weight of the moving parts is greatly increased, they, of course, require more power. From the figures given in the foregoing, however, the reverse would appear to be the case in some instances.

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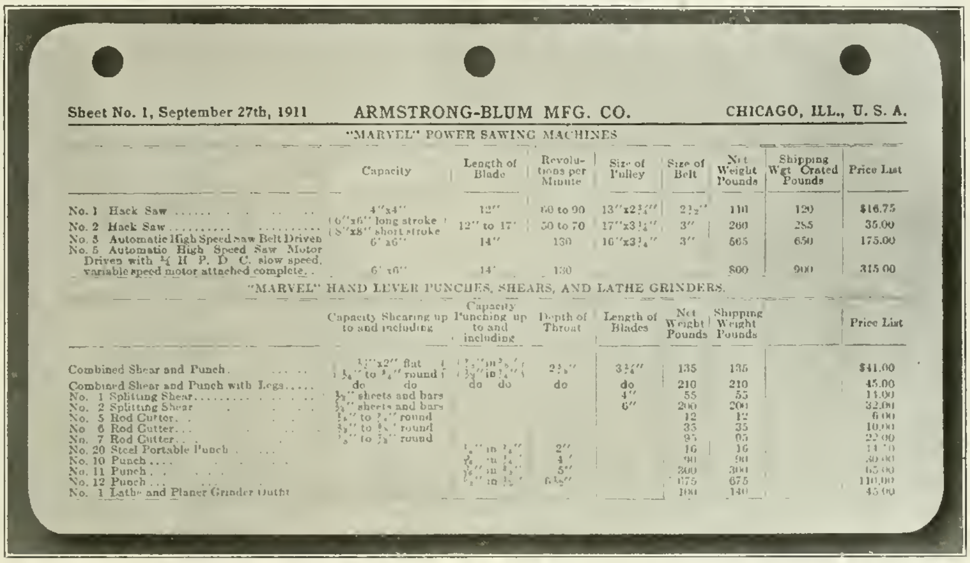
* Address: 22 Augustus Rd., Coventry, England.

* * *

PRICE SHEET FOR SALESMEN

Manufacturers of light machinery sold by jobbers and dealers find it advantageous to issue price sheets printed on thin paper with rounded corners, 4 by 7½ inches perforated, as shown in the reproduction of the sheet issued by the Armstrong-Blum Mfg. Co., Chicago. These sheets fit the loose-leaf price sheet books commonly carried by salesmen, and most of them are glad to add it to their regular lists though they would not think of carrying an extra circular or catalogue.



Sheet No. 1, September 27th, 1911 ARMSTRONG-BLUM MFG. CO. CHICAGO, ILL., U. S. A.

"MARVEL" POWER SAWING MACHINES

	Capacity	Length of Blade	Revolutions per Minute	Size of Pulley	Size of Belt	Net Weight Pounds	Shipping Wgt Crated Pounds	Price List
No. 1 Hack Saw	4"x4"	12"	60 to 90	13"x2¾"	2½"	110	120	$16.75
No. 2 Hack Saw	6"x6" long stroke 8"x8" short stroke	12" to 17"	50 to 70	17"x3¼"	3"	260	285	35.00
No. 5 Automatic High Speed Saw Belt Driven	6"x6"	14"	130	16"x3¼"	3"	565	650	175.00
No. 5 Automatic High Speed Saw Motor Driven with ¼ H. P. D. C. slow speed, variable speed motor attached complete	6"x6"	14"	130			800	900	315.00

"MARVEL" HAND LEVER PUNCHES, SHEARS, AND LATHE GRINDERS.

	Capacity Shearing up to and including	Capacity Punching up to and including	Depth of Throat	Length of Blades	Net Weight Pounds	Shipping Weight Pounds	Price List
Combined Shear and Punch	[illegible]x2" flat [illegible] to [illegible] round	[illegible] in [illegible] [illegible] in [illegible]	[illegible]	3¼"	135	135	$41.00
Combined Shear and Punch with Legs	do do	do do	do	do	210	210	45.00
No. 1 Splitting Shear	[illegible] sheets and bars			4"	55	55	14.00
No. 2 Splitting Shear	[illegible] sheets and bars			6"	200	200	32.00
No. 5 Rod Cutter	[illegible] to [illegible] round				12	12	6.00
No. 6 Rod Cutter	[illegible] to [illegible] round				35	35	10.00
No. 7 Rod Cutter	[illegible] to [illegible] round				95	95	22.00
No. 20 Steel Portable Punch		[illegible] in [illegible]	2"		16	16	[illegible]
No. 10 Punch		[illegible] in [illegible]	4"		90	90	30.00
No. 11 Punch		[illegible] in [illegible]	5"		300	300	65.00
No. 12 Punch		[illegible] in [illegible]	6½"		675	675	110.00
No. 1 Lathe and Planer Grinder Outfit					100	140	45.00

Price Sheet for Salesmen

* * *

STANDARD HEADS FOR SMALL SCREWS

The Engineering Standards Committee (Great Britain) has issued report No. 57, dealing with standard heads for small screws. The report standardizes the heads for small screws in five classes—countersunk, instrument, round, cheese, and fillister. For all classes of screws, the diameter of the head has been fixed at 1.75 times the full diameter of the thread. The committee recommends the adoption of a standard angle of 90 degrees for both countersunk and instrument heads. The depth of the coned portion has been determined at 0.375 times the full diameter of the thread. For instrument-head screws the committee recommends that the radius forming the curved surface of the upper portion of the head be equal to twice the full diameter of the thread. It follows from this that the depth of the curved portion of the head will be approximately equal to 0.2 times the full diameter of the thread. In the case of screws with round, cheese or fillister heads the committee recommends that a plain cylindrical portion having a length not exceeding twice the pitch, be left on the shank immediately underneath the heads of the screws. When determining the depths of the saw cuts or screw-driver slots the committee has endeavored to follow existing practice as far as possible, and has grouped them together in convenient sizes according to the gage of the metal from which the saws used are manufactured. The committee recommends a standard depth of saw cut equal to half the total depth of the head in all cases, this depth to be measured at the center of the head.

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We solicit contributions from practical men on subjects pertaining to machine shop practice and machine design. All contributed matter published exclusively in MACHINERY is paid for at our regular space rates unless other terms are agreed on.

APRIL, 1912

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MACHINERY is published in four editions. The practical work of the shop is thoroughly covered in the Shop Edition, $1.00 a year, which comprises approximately 700 reading pages. The Engineering Edition—$2.00 a year, coated paper, $2.50—contains all the matter in the Shop Edition, about 300 pages a year of additional matter and forty-eight 6 x 9 Data Sheets filled with condensed data on machine design, engineering practice and shop work. The Foreign Edition, $3.00 a year, comprises the same matter as the Engineering. The Railway Edition, $2.00 a year, is a special edition including a variety of matter for railway shop work—same size as Engineering and same number of Data Sheets.

THE UNIT SYSTEM OF MACHINE CONSTRUCTION

A feature of machine construction that has been widely adopted during the past decade, especially in machine tools, is the so-called "unit system." The principle of the system is simply that of dividing a machine into groups of closely related mechanisms and constructing them with independent frames or boxes in which the shafts, studs, clutches, gears, etc., are assembled. These units of mechanisms are assembled on the main frame to form the complete machine. The natural divisions of the engine lathe, for example, are the headstock, tailstock, carriage, apron, feed-box, change-gear box, etc. These, mounted on the bed, require only the lead-screw, feed-rod and legs to complete the lathe. This admirable system has several marked advantages.

In the first place it is the logical development of the interchangeable system of manufacture which has so greatly reduced the cost and improved the quality of manufactured products. The units are made independently in departments suited to the character of the work, by men who, specializing on each particular unit, become experts. Refinements of design and construction are developed that could hardly come into existence in a building shop.

In the second place the units being interchangeable can be replaced by the user in case of accident with a minimum of trouble; they can be removed, returned to the factory for repairs at small expense for freight and handling.

A third advantage to the machine tool builder is the ease with which units can be incorporated in various designs. The builder, say of milling machines, can use the same feed-box in several sizes and styles, thus enabling him to produce a variety of designs at a minimum cost for jigs and fixtures, all in harmony with the general design.

These advantages, particularly the last, are slowly being grasped by the builders of special machine tools. This business, as everyone knows who has ever been in it, is conducted on a close margin of profit, and its returns, when compared to straight manufacturing, are hardly commensurate with the thought and energy required for success. More of the manufacturing element can be introduced by the development of unit designs of speed- and feed-boxes, tool-slides, elevating mechanism, etc., which can be worked into special designs with little trouble. These units can be made in lots of fifty or a hundred, using jigs and labor-saving appliances that are out of the question when making up parts specially for each machine. The reduction in cost and the more even distribution of labor over a given period incident to the unit system should make the conditions of special machinery building easier than they are now.

* * *

CLEAR THINKING AND WRITING

Given good ability, the one faculty that an ambitious man should cultivate is that of expressing his thoughts clearly in speaking and writing. Compared with one of equal ability who cannot express his ideas clearly, the possessor of a good vocabulary has a great advantage. This fact has been recognized in all times, and yet it is not as fully appreciated by many who are striving to rise in the world as it should be. The successful salesman sells goods because of his ability to secure an audience with buyers and to hold their attention. He holds attention because his story is interesting. He talks of the quality of his goods, how they are made, when they can be delivered, the terms of sale, meets arguments in a kindly spirit, and overcomes opposition by attractive manner and expression. That ability is certainly a great asset to any man. Not all of us can be salesmen in the sense of selling goods, but most of us have to market our abilities in some form of service. The man who can make his service appear to the best advantage usually gets the highest wages, other things being equal.

The machinist who can turn out a perfect piece of work in the average time or less, is a man whose ability will be recognized in most shops in the highest wages paid to journeymen. If he possesses the ability to plan a job and to tell how to perform it he will stand still higher and will, in fact, be rated as having executive ability, simply because he can tell someone else what to do.

With the foreman the telling of what to do and how to do it is the principal part of the day's work. The journeyman who aspires to fill higher positions must cultivate the faculty of imparting knowledge to others. If he practices writing out the plan of procedure for all the jobs that come under his observation, he will be surprised to find that the simplest piece of work is generally made up of several elements, each of which must be clearly known before the work can be carried to a successful conclusion. Describing a piece of machinery either orally or in writing develops logical thinking and leads to investigations of the principles of elements which are the fundamentals of all machines.

With understanding comes the joy of mastery and the common desire of broad-minded men to impart their knowledge to others. That imparting knowledge is profitable to the giver is common experience. It is proved by the rapid advancement of many contributors of MACHINERY who have started in a humble way to tell the readers about some interesting piece of machinery and how it was made. Their mental horizons expanded rapidly, and with expansion of mind came better appreciation of the meaning of what they read and the ability to assimilate ideas and use them. Soon, to our regret, they have ceased to write, because their time and energies have become absorbed in the duties of the executive positions to which they have been promoted.

* * *

One of the fascinating subjects to the theoretical engineer is the Schiele curve as applied to step bearings. The curve is a beautiful design in theory to equalize the wear on all parts of a thrust bearing. In practice, however, it is another story. The cost of producing it compared with an approximate form is so high that its advantages are *nil*. A well-known builder of boring mills formerly made the spindle bearings of his mill tables with the Schiele curve, and fitted up at heavy expense to produce them accurately. But after using the Schiele curve bearing for a few years it was abandoned for a conical bearing and plain step, the two approximating the shape of the Schiele curve spindle. The result has been entirely satisfactory and the cost is much reduced.

TARIFF REFORM

Although many American industries have attained their present strength under protection, this result has been accompanied by abuses from which consumers have suffered, and the majority of voters want a reform. They will have their way; but business men who favor a reduction want it brought about in a businesslike way, by a competent tariff commission not composed of politicians. Our machine tool builders in 1908 not only consented to, but favored, a reduction in the tariff on machine tools, and if a similar policy had been adopted by manufacturers generally the present disturbance to business might have been avoided.

There is a marked difference between the position occupied by machinery manufacturers and almost any other American industry, in that a machine usually represents years of thought, labor, experiment and outlay before a single one is sold. Yet this is hardly on the market before its vital points are imitated by foreign manufacturers who, except for the tariff, would be able to undersell the originator in his own market on account of the difference in the labor cost. Freights also favor the foreign manufacturer as the rates to New York City from almost any of the English or German industrial centers are less than from Cincinnati.

Our tariffs should be reduced; but the changes should extend over a period of years so as to enable our manufacturers to readjust their prices and methods to the new conditions. Any radical change in the tariff on machine tools, such as the proposed one to place them on the free list, would result in disaster to the entire machinery and allied industries; and the losses would fall as heavily on the workman as on the employers. Immediate free trade in this industry would mean destruction, not reform.

* * *

TURNING SHAFTS IN TURRET LATHES

Some manufacturers of machinery who have put turret lathes to all possible uses have occasionally met with serious difficulties when trying to turn shafts, say, 1 inch diameter and 30 inches long. The shape of the shaft at the chuck end where the cut is started will be turned round and true; but as the tool travels away from the chuck a quasi-hexagon, octagon or other polygonal shape may be developed under certain conditions, which gradually grows worse, until it is so pronounced at the finish end that ordinary allowances for grinding may not be sufficient to remove the tool marks. Although this is an old trouble, and the causes, and means for eliminating them, were discovered long ago, a knowledge of the facts is not as common as it should be in view of the widespread use of the turret lathe.

Where roller back-rests are in use, the first surmise of course is that one of the rollers is eccentric or worn flat, but other elements more obscure may cause the trouble. A well-known turret lathe builder states that the trouble is wholly overcome by using a back-rest of the old style, which embraces about half the cylinder and is of a dimension fairly close to the size to be turned. But these back-rests are not adjustable, and are subject to roughing up, which becomes a serious trouble. The V back-rests and roller back-rests seem to be superior, notwithstanding the possibility of the work's becoming slightly polygonal at times.

One of the principal elements in establishing the tendency to turn polygonal is produced by the varying depth of cut which of course is the result of eccentricity of the stock. The effect of varying the depth of chip can be almost wholly neutralized by setting the cutting face of the tool perfectly square to the travel or a trifle "under," so that the variation in radial thrust is reduced to a minimum. The surface of the back-rest should make contact very close to the front edge, and the cutting tool should be set slightly in advance of the back-rest. If the back-rest does not touch the stock at the front, because of being a trifle bell-mouthed, or if the tool stands too far ahead of the back-rest, or again, if the tool is beveled so that the outer edge is in advance of the point, then the stock will spring away from the tool under the heaviest part of the cut. A round-nose tool, or a tool in which the point is behind the cutting edge, of course gives the greatest variation in radial resistance when the depth of the cut varies. This applies to turning cylindrical work in either direction, but the action is especially pronounced in turning away from the chuck when the outer end of the stock runs free.

Attention to these details of setting the tools and back-rests will generally eliminate the tendency to turn polygonal shapes entirely. The case is but another of many in machine shop practice in which apparently minor adjustments play an all-important part in producing satisfactory work.

* * *

THE DISAPPEARING TOOL-CHEST

By A. P. PRESS

Those of us whose heads are white well remember what was the first thing to be done after we had got a new job. That was to hunt up an express man to move the tool-chest. The machinist who did not possess a good set of tools and a good looking chest, even if it did not contain a "mike" or a vernier caliper, was considered a "poor stick."

One of the first requisites for the tool-chest was a pair of good stout handles for each end—handles that would stand a strain of 100 pounds or more. Inside of the chest you would find a 2-pound chipping hammer, a 1-pound or a 1½-pound light hammer, three or four smaller riveting hammers, most of which were homemade; three or four cape chisels, and an equal number of broad-faced chisels for straight chipping; a 12-inch and a 6-inch monkey-wrench; a 24-inch straightedge about ¼ inch thick with one edge beveled down to 1/16 inch or less; and a 12-inch scale usually round at one end and square at the other. These scales were imported from England. A 24-inch scale was beyond the machinist's wildest dreams. Besides there would be in the tool-chest six or eight pairs of calipers; a surface gage with a 4-inch base that weighed about 2 pounds or more, and a standard not less than ⅜ inch in diameter; a hacksaw on which the teeth had to be filed every time it was to be used; and a box level (not a protractor).

If the man claimed to be a millwright as well, as many of the oldtimers were then, there would be an 18-inch level and a plumb-bob with a line around it. Under all circumstances there would be a box of drills or "flats," and one or two choice twist drills, besides an indescribable amount of scrap that invariably accumulated.

Now what does the new man that comes in to-day bring along? He has a little hand-bag, about the size my lady uses when she goes downtown shopping, and inside there will be one or two sets of "mikes" and possibly a full assortment of scales from 9 inches down. There will also be a bevel protractor and a pair of spring calipers, and possibly a chipping hammer about 1½ pound in weight. Of a dozen men to-day, not more than two will bring a tool-chest, and the foreman does not view them with approval. When you have only 3½ or 4 feet of bench room for each man, the space is too valuable to be taken up with a big tool-chest. There are several shops with which I am personally acquainted where the tool-chest is not tolerated unless it is kept under the bench, but it is preferred, by those in charge, to have it left at home.

* * *

STRENGTH OF THICK HOLLOW CYLINDERS

A formula for calculating the bursting pressure of thick hollow cylinders, which agrees closely with the results of experiments undertaken by Messrs. Cook and Robinson, is given in *Engineering*, issue of January 5, by F. van Iterson.

Let $P =$ bursting pressure, in pounds per square inch,

$F =$ ultimate strength of material, in pounds per square inch,

$R =$ ratio of external to internal diameter.

Then

$$P = F \text{ hyp. log } R$$

This formula, of course, is not applicable for values of R which make hyp. log R greater than 1, as in that case the bursting pressure P would be greater than the ultimate strength of the material F.

NOTES AND COMMENT

One discriminating dealer in second-hand machinery pays more for Eastern tools, claiming that the harder iron used in the East gives appreciably longer life to lathe shears and other sliding parts. This dealer, however, handles only second-hand tools that are in prime condition—those that have been well used and employed on a variety of work which has given nearly uniform wear to the shears, etc.

Milling carbon steel at a peripheral speed of 500 feet a minute and producing a surface like polished silver is what the National Twist Drill & Tool Co., Detroit, Mich., is doing on small drills. A high-speed cutter about 3 inches in diameter, having teeth of 3/16-inch pitch and cut at an angle of 15 degrees, is run at the given speed to mill the drill clearances. The drill is supported directly beneath the cutter by a V-rest and the cutter rotates against the cut. Lard oil of the best quality is used for lubricating.

An international exhibition will be held at Liverpool, England, from May to October. The textile, electrical, machine building, general manufacturing, and shipping industries, as well as arts and crafts, will be represented. The exhibition, it is claimed, will be of international importance and similar to the successful exhibition at Glasgow, where the number of people attending exceeded 11,000,000. Copies of the prospectus and application forms for exhibit space may be secured from the Bureau of Manufactures, Department of Commerce and Labor, Washington, D. C.

A change in the equipment of modern drop-forging plants that is being made in the interests of greater efficiency and better product, is the substitution of steam drop-hammers for board or other free falling hammers. The steam hammers work quicker, are under better control and deliver a harder blow for the same weight of drop. They are not as efficient, however, in the use of power as the mechanically-operated hammers. The steam is not as effectively expanded as in an efficient engine cylinder and there are large wastes in steam lines due to condensation. The power cost is, however, a small item compared to the labor cost and general overhead charges.

Few mechanics have an adequate idea of the great cost of some experimental aeroplane engines that have been built to develop great power with low weight. One came to our notice lately that has cost over $12,000 and is not yet completed. The cylinders are made from solid chrome-nickel steel bars, and are marvels of fine and accurate machine work. The weight of the engine, complete, is about 180 pounds and it develops 65 horsepower when all the seven cylinders are chugging. The cost is in inverse ratio to the weight. To illustrate, take one part made of alloy steel which in the rough weighed 115 pounds; when finished, the weight was 6 pounds and the labor cost was over $250.

It is reported that the White Star Line has commissioned Harland & Wolff, Belfast, to build a transatlantic liner which will be 990 feet long, with a beam of approximately 110 feet, a displacement of 70,000 tons, and a gross tonnage of over 50,000 tons. The liner is to be named the *Gigantic*. It will have twelve or thirteen levels or decks, the highest of which will be 75 feet above the water line. The vessel is to be designed with accommodations for over 4000 passengers, 1000 of which can be carried in the first cabin. The new vessel will be a seven-day boat, provided with a combination of reciprocating and turbine engines. It is stated that a cricket field, tennis court, golf links (?), and ball-room will be included. The cost of the vessel will be nearly $10,000,000.

Pensions are granted by the American Steel & Wire Co. to employes who have reached the age of seventy, and who have been in the service of the company or any of its predecessors for ten years. A pension is also paid to employes who have reached the age of sixty and are physically disqualified for further service, provided they have been employed during the preceding ten successive years. The pensioners are allowed to seek employment elsewhere, should they so desire, and can live wherever they please. Some of the retired pensioners, it is said, are living in England, Ireland, and Sweden, besides in various parts of the United States. The pension fund is maintained entirely by the company without any form of contribution from the employes.

A correspondent of the *Frankfort Gazette* draws attention to what seems to be a rather common practice of some German steel-making concerns. It appears that machine tool builders are practically compelled to accept deliveries of steel, instead of cash payment, in return for orders of machine tools. The great iron and steel works thus place the machine tool makers in a difficult position, as the latter have often to choose between losing a contract or laying up a stock of material which they may not be able to use for a long time to come. Sometimes they are forced to use material which they perhaps otherwise would not employ.

The wonderful effect of harvesting and other farm machinery, on the world's food supply is but dimly appreciated by those who have given it only casual thought. A pamphlet called "The Story of Bread," published by the International Harvester Co., is authority for the following statement that almost staggers belief: "A modern farmer, with the practice of scientific knowledge, and the use of modern machines, can, with three months' labor, raise as much wheat as could an old Roman had he worked ten hours a day, six days a week, for all the weeks of his three score and ten years. In the time of Nero it took four and a half days' labor to raise a bushel of wheat; when the reaper was invented it took three hours; and in the time of Roosevelt it takes ten minutes."

For many years past there has been a tendency to mark cutlery and other goods similar to those produced in Sheffield, England, with the word "Sheffield," in order to convey to the purchaser the idea that they have actually been manufactured in or near Sheffield, and that they carry with them the traditional high quality of Sheffield goods. A fund of $55,000 has been raised, and has been placed at the disposal of prominent citizens of Sheffield to prosecute in all cases where the name "Sheffield" is being fraudulently used as a trademark. It is proposed to increase this fund as occasion may arise. The results of the prosecution will be widely advertised, especially in the localities where the firms using the fraudulent marks are located.

Specialization in industries effects innumerable economies and cheapens production. Centralization of some of the functions of a community increases their efficiency. An exception is electric lighting in the case of large buildings. Many of the office buildings, hotels and other large buildings of New York and other cities have their own lighting plants. The exhaust steam is used for heating in winter and carries nearly as many heat units as the same weight of steam used direct from the boilers. If the lighting is charged at the lowest rate that the central lighting plants will quote, the heat costs nothing; if the heating is charged at the cost of live steam as furnished by the boiler, the cost of the current for lighting and power drops to less than a cent a kilowatt in New York City.

A type of machine construction that is much used in Germany is that employing steel plates and structural shapes for the frames. Castings of simple form are placed between the plates to act as separators and give stiffness and strength where most needed. The advantage of this construction is greatest on special machines of rough character, such as boiler shop tools. The cost of large and complicated patterns is avoided, as is the delay incident to making them and getting the castings. A variety of castings that experience has shown can be largely used are kept in stock, and these are modified by machining where needed. Sometimes a large machine for shearing and punching structural shapes will be built up in this manner in a few days, using plates, angles and gussets principally, that would require weeks if built with cast-iron frames in the usual manner.

THE DIESEL ENGINE*

By S. M. HOWELL†

To save the first cost of the igniting devices used on internal combustion engines and to avoid the additional expense and trouble incident to their employment, is an attainment of great practical value; an engine that is self-igniting and which also embodies other important advantages, is certainly a very desirable form of construction. The fact that the heat of compression is capable of firing the charge in a gas engine cylinder is, of course, a self-evident proposition in the science of thermodynamics, as well as a matter of common experience, and the idea of its utilization for this purpose no doubt occurred to some early designers; but the first prominent example of a self-igniting gas engine was that of Rudolf Diesel, of Germany, and it is probable that his was the first engine in which ignition was thus effected. The Diesel system, however, is not the only method of operation which is capable of self-ignition. Several patents have been secured by other inventors since the date of the first Diesel patent, in which the heat of compression generated by means of an auxiliary high-pressure air pump is used to fire the charge in engines of the impulse or explosion type. In the original Diesel patent, No. 542,846, of July 16, 1895, the inventor does not claim this feature of his motor, but he afterward claimed it in combination with other elements in his patent, No. 736,944, of August 25, 1903. The self-ignition, however, in the Diesel engine, is merely an incident in the operation of the cycle. The motor as a whole differs in its operative principle from all other gas engines, belonging to that general class known as the continuous combustion type. This type was first exploited many years ago by a number of inventors whose productions never came into general use, and it was for a time displaced almost entirely by the impulse form of gas motor.

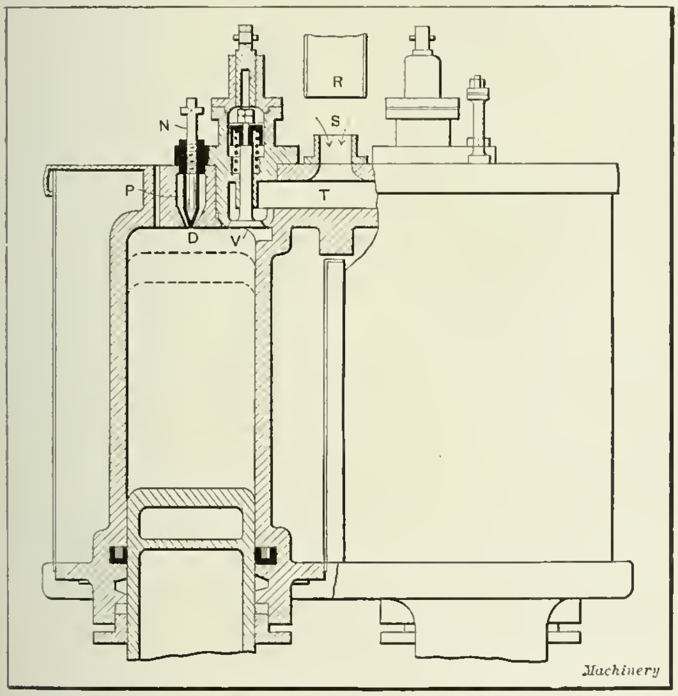

Fig. 1. Diesel Engine using Oil Fuel—U. S. Patent No. 542,846

The primary idea of the Diesel system is to compress a charge of air by the in-stroke of the piston, to such a degree that the resulting heat will equal the highest temperature subsequently attained by the burning charge. The fuel is injected during a first fractional part of the power stroke, and is self-ignited and burned in a volume of air considerably in excess of the quantity actually required to consume it. By this means the mean working temperature of the cylinder is so reduced that the use of a water jacket is unnecessary. Thus the loss due to the abstraction of heat by water cooling, is avoided, and the highest degree of efficiency is secured from the thoroughly consumed fuel.

In considering the theory of this system of operation it would seem at first thought that to produce by means of compression alone a temperature equivalent to that of normal combustion, would require an excessive degree of pressure, so high indeed as to be altogether impracticable; and it may also seem that the heat generated by the combustion of the fuel would simply be added to that already existing in the body of compressed air, and that the resulting temperature would be still higher. Ordinarily this would be the case—that is, if the charge of fuel could be instantly introduced, but this action is not contemplated by the theory and does not occur in practice. Nor is the degree of initial compression as high as would be required to produce a temperature equal to that of combustion under ordinary conditions. The reasons for this are, first, that the burning charge is diluted, and the heat greatly modified by the superabundance of air, and second, that the fuel is forced into the cylinder while the charge is expanding on the power stroke, and is so regulated that the heat added by combustion is only sufficient to counterbalance that lost by expansion as the piston moves forward. Thus both the temperature and the pressure of the initial air charge are maintained, without material change, to the point of cut-off. This point is determined by the governor or control lever, and from thence to the end of the power stroke the pressure falls in an adiabatic curve, and the burnt gases are finally exhausted at the temperature of the atmosphere. The heat is absorbed and transformed into work by the expansion of the charge from the point of cut-off to the termination of the stroke.

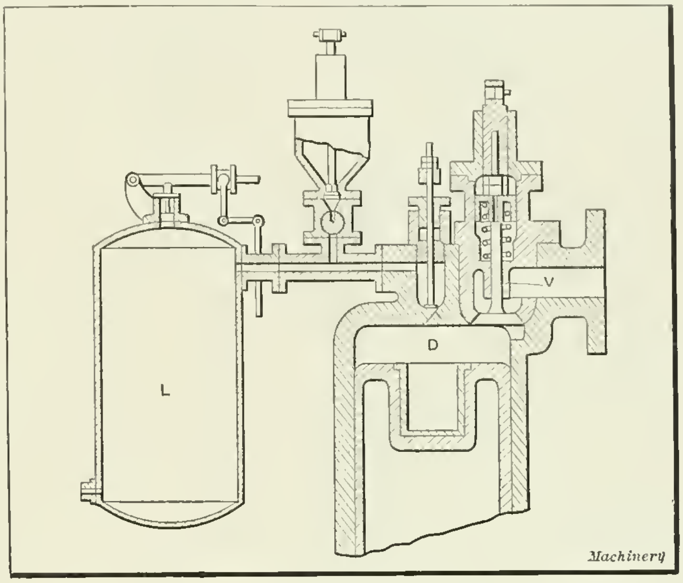

Fig. 2. Section of Diesel Engine having Compressed Air Tank for Starting

The object of the system is to promote a more perfect combustion, and to secure a working fluid of comparatively low temperature, expanded to the full limit of its useful effect. It should be observed, however, that while this is the theory of this celebrated motor, it is not fully carried out in the prevailing practice of the present day. A theory can seldom be accurately followed, and must always be subject to the requirements of practice. In the models originally demonstrated by the inventor, the initial air charge was compressed to 1500 pounds per square inch, with a resulting temperature of 1500 degrees F., and the fuel admission was accurately adjusted to maintain the theoretical conditions; but in many cases the Diesel engines now built depart somewhat from the first standard in this respect, and operate partly upon the system of the impulse or explosive cycle. The water jacket discarded by Diesel is now generally restored, and a pressure of 500 pounds per square inch is considered the proper degree of initial compression to secure the best all-around results in practical service. The thermal efficiency may be slightly reduced by this practice, but durability and ease of lubrication are improved by it, and commercial efficiency is secured to a more satisfactory extent than would be the case if the exact conditions demanded by theory were made the governing motive of the design.

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* For further information on this and kindred subjects, see MACHINERY, February, 1912, engineering edition: "Points in the Design of Two-Stroke Cycle Engines," and also the previously published articles there referred to.

† Address: Oroville, Cal.

For the purpose of automatic ignition, the extent to which the initial compression of the air charge should be carried depends upon the character of the fuel—that is the temperature at which it ignites; but as the fuel is usually crude oil or one of its heavy constituents, such as distillate or kerosene, there is but slight difference in the igniting points of these liquids. It is, of course, absolutely essential that the injection fuel be instantly and unfailingly ignited, and for obvious reasons it is certain that the compression of an engine in continuous use will not always be as high as when first installed. It is, therefore, good policy in designing a Diesel engine to take the safe side in this matter, by providing a degree of compression which is sufficiently high to include a margin of safety, in anticipation of the probable effect of wear and use under unfavorable conditions.

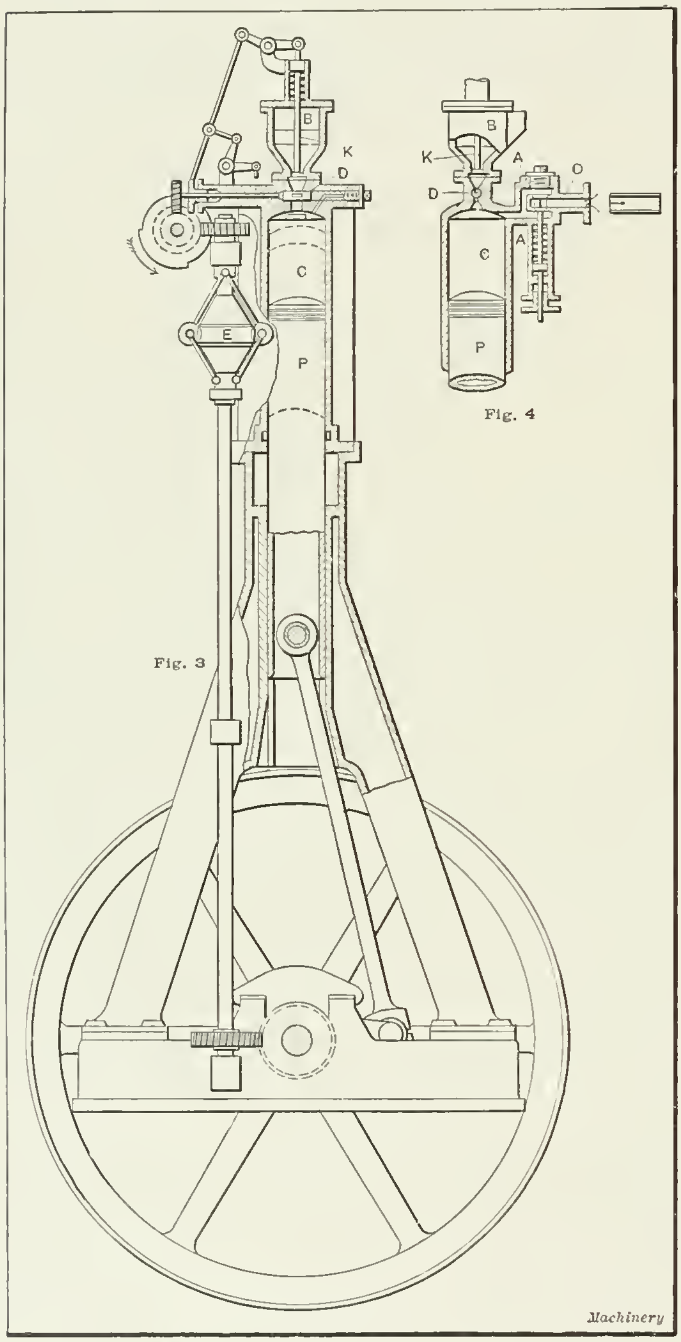

Fig. 3

Fig. 4

Figs. 3 and 4. Diesel Engine using Solid Fuel

The manner in which this cycle differs from that of the more familiar impulse or explosion type of motor, and the chief reasons of its greater efficiency, may be seen at once by comparison. In the impulse motor the volume of the clearance space usually equals about one-third of the piston displacement. The in-stroke compresses the charge of mixed air and gas to, say, 75 pounds per square inch. At the moment this action is completed the charge is fired, and the pressure instantly rises to perhaps 300 pounds per square inch and a temperature as high as 3000 degrees F.; the gases are exhausted at the termination of the stroke at a temperature of at least 500 degrees. This makes the mean working temperature quite high, and a considerable portion of this heat must be absorbed by the water of the jacket in order to moderate the temperature of the cylinder and piston.

In a Diesel engine, however, the clearance does not exceed 7 per cent of the piston displacement, and the in-stroke forces the entire body of the air drawn in on the previous out-stroke into this space, at a pressure of 500 pounds and a temperature of about 1000 degrees. The injection of fuel begins with the power stroke and continues (if the engine is running under full load) until the piston has completed about one-fourth of its outward movement. The quantity of fuel is just sufficient to maintain the original pressure during the combustion interval, that is, from the beginning of the stroke to the point of cut-off. The volume of air is about double the amount required to consume the fuel, and the resulting temperature is correspondingly low. From the point of cut-off the charge expands to the end of the stroke, where it is exhausted at low temperature and pressure. As a result of this method of operation, the mean working temperature of the charge is lower than that of any other gas engine cycle. Consequently less heat is taken up by the jacket or lost by radiation, and a larger proportion of the heat energy of the fuel is utilized for the production of power.

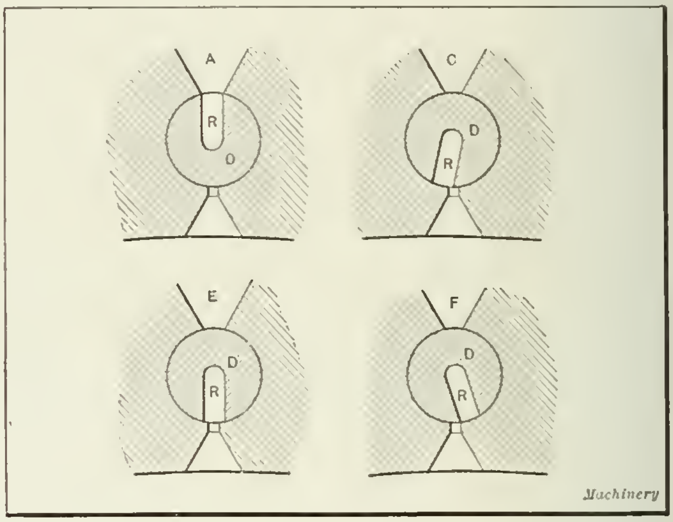

Fig. 5. Section showing Action of Valve D, Figs. 3 and 4

The means of introducing the fuel into the cylinder of a Diesel engine in a suitable physical condition and in a regulated amount is one of the most important features in the design and operation of the motor, and has received a large share of the attention given to the construction of these engines by engineers and inventors. Several methods have been devised by the original inventor of the engine, as well as by others, and two or three of these are now in use. In most cases the engine comprises an auxiliary air or injection pump, capable of producing a degree of pressure considerably in excess of the cylinder compression; this higher pressure is used to force in the liquid fuel through a minute opening controlled by a needle valve in the cylinder head. In one arrangement the fuel opening is located at the bottom of a cup-shaped chamber in the head of the cylinder, the stem of the needle valve standing in a vertical position. This chamber is in communication with the injection pump, the suction stroke of which draws a charge of oil fuel into the chamber. The lift of the needle valve is effected by a device operated by a cam on the main shaft of the engine, and the extent and duration of this lift, and also the quantity of fuel drawn into the chamber, is controlled by the governor. At the proper moment the needle valve opens and the high-pressure air drives the oil, in a finely divided spray, into the hot-air charge within the cylinder.

In the first American patent of Diesel, No. 542,846, the mechanism used for delivering the oil fuel is practically the same as that just described, and is shown in Fig. 1. This illustration shows an engine with two cylinders just alike, and designed to be connected to the same shaft. The crankpins are in the same line, and the movements of the reciprocating parts are parallel. One cylinder is shown in section and the other in elevation. The spring closed valve *V* is used for both admission and exhaust; *R* is the exhaust pipe, and just below the open end of this pipe is the nozzle *S*, communicating with the passage *T* which leads to the valves *V* in both cylinders. Combustion takes place alternately in the cylinders, producing a working stroke at each revolution, and since the exhaust follows immediately after the drawing in of the air charge, the valve *V* remains open during a full revolution and is then closed during a full revolution. At *D* is shown the fuel nozzle; at *N* the needle valve; and at *P* the fuel cavity into which the charge of oil fuel and a small body of highly compressed air are first delivered by the injection pump and then passed through the nozzle *D* by the needle valve and sprayed into the heated air of the cylinder charge in the manner already described. The exhaust is nearly cold and of nearly even tension with the atmosphere, and the return of the piston drives out the products through the nozzle *S* into the open end of the exhaust pipe. The fresh air for the next stroke enters the same nozzle from the open space around it.

The claims of the American patent of July 16, 1895, were previously granted in England, April 14, 1892, and expired by limitation April 14, 1904. The three claims broadly covered the principles involved in the operation of the cycle as above described, and as the field is now open to all who wish to use the Diesel cycle in combination with their own designs, this patent is the key to the situation as far as general principles of operation are concerned. The specifications of this patent were largely devoted, however, to a description of certain methods of using solid fuel (coal dust), as then contemplated by the inventor, and we will consider this feature further on.

The second American patent of Diesel, Reissue No. 11,900, dated April 2, 1901, contemplated the employment of solid fuel injected with a mixture of gas and air in order to insure instantaneous ignition and more complete combustion. It also described a method of starting the engine with compressed air stored in tank *L* in Fig. 2, the compression having been effected by the engine on a previous run. In this arrangement, a lever-operated clutch controls a system of shifting cams, by which, when the engine is first started, the valve *V* is made to admit the compressed air from tank *L* to the cylinder at each out-stroke of the piston, and to exhaust the same upon the in-stroke. After a few revolutions the flywheel acquires sufficient momentum to effect the compression of the charge, and by a movement of the clutch-lever, the action of the cams is so altered that the valves are operated in the usual manner, and the regular cycle is taken up. This patent specification further provides for a method of automatic ignition without the use of the extra high-pressure air pump. In this modification ignition is effected as follows: The opening of the fuel valve is delayed until the piston has receded slightly from the dead point, and the pressure first produced by the initial compression of the air charge has fallen somewhat. The fuel valve then opens and the air previously compressed in tank *L* forces in the fuel charge as usual. The remainder of this patent specification is devoted to descriptions of burners, fuel spraying devices, etc., evidently designed in anticipation of their possible adoption by others, but probably never constructed.

The next Diesel patent is No. 708,029, dated September 2, 1902. The object of this specification is to reduce the usual size of the auxiliary air or fuel injection pump. For this purpose the pump receives its air from the compression space of the engine cylinder at a high pressure, and thus a pump of much smaller size may be employed than would otherwise be necessary. The next patent, No. 736,944, dated August 25, 1903, relates to the construction of a two-cycle engine and certain means of scavenging the cylinder of the burnt gases before the admission of the fresh air for the succeeding charge.

The last patent of this inventor, No. 890,620, dated June 16, 1908, deals with the introduction of the liquid fuel, the leading idea of this specification being to heat the oil fuel and to saturate it as far as possible with highly compressed air, prior to its admission to the cylinder of the engine, in order to facilitate atomization and promote a more thorough admixture of the fuel with the air of the charge. The oil fuel is continuously pumped into a receiver where it is submitted to the action of air at the working pressure of the engine, and then delivered to the cylinder by the means already described.

Figs. 3, 4 and 5 of patent No. 542,845 show the construction of the original Diesel engine designed for the use of solid fuel. The stroke is long in comparison with the bore, and the compression of the charge is very high. The air is drawn in on the suction stroke at valve *O* (as in the engine shown in Fig. 1), and this valve serves also for the exhaust. The powdered fuel is supplied to the hopper *B*, and is fed by valve *K*. The lift of this valve is controlled by the governor, and the consumption of fuel is thereby proportioned to the demand for power. The delivery of the fuel to the combustion chamber is effected by the rotating plug valve *D*, shown in Figs. 3 and 4, and in transverse section in Fig. 5. This valve has a slot *R*, on one side, and is revolved by the worm-gear shown in Fig. 3. When in position shown at *A*, in Fig. 5, the slot *R* receives a charge of fuel from valve *K*, and while in positions, *C*, *E*, and *F*, delivers the same to the cylinder during the combustion interval.

The inventor states in regard to the use of coal dust fuel that, "the residues of combustion being suspended in a finely divided state in the whirling gases are blown out with the same." If such an engine was ever successfully operated, however, it was probably run at a slow speed.

The Diesel cycle is easily adapted to the use of gas fuel of almost any description. The injection pump receives and compresses the gas to about 750 pounds per square inch, and the injection valve operated under control of the governor, delivers this compressed fuel to the cylinder.

* * *

AN ANALYSIS OF LATHE ACCIDENTS

The gathering of statistics by labor inspectors and inspectors of factories is accumulating a vast store of interesting information. In England, for example, a very complete report has been published covering facts elicited on inspection and in reports, in the Northeastern division of the work of factory inspection.

The total number of accidents reported with lathes in the year 1910 was 670. The classification of the sources of these accidents and the numbers in each group are given in the following table:

From the driving belt of the lathe..............	24
From the cone-pulley, or belt of the lathe proper..	46
From spindle-gear and back-gear................	17
From the change gears at the headstock.........	17
From other gears in apron and feed mechanism..	8
From the driving dog	71
From the faceplate or chuck	23
From projecting set-screws about the lathe or work	8
From the tool point or article being turned.....	297
From the flying chips, or articles being turned flying out	127
From other causes, including falls upon the workmen	32
	670

It is interesting to notice that nearly one-third of these accidents occurred in connection with the work being turned; next to these are the accidents incident to the dog or driver catching the arm or clothing of the workman, and doubtless the chuck or faceplate accidents might be taken together, making up nearly 15 per cent of the entire list.—*The Journal of Industrial Safety.*

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To illustrate the progress of the introduction of machinery in different manufacturing industries, a notable example is cited in a factory in Waterville, Me., where paper pie-plates such as are used by bakers are made in automatic machines that cut, form and emboss plates, turning them out at the rate of 840,000 per day.

PREVENTION OF INDUSTRIAL ACCIDENTS[*]

By FREDERICK REMSEN HUTTON[†]

Prof. Frederick Remsen Hutton[‡]

It should require no argument to prove that an accident in a shop or factory is an economic blunder. It costs the owner, the victim, and the community more to produce the staple article in that establishment than if accidents were prevented. The owner or manufacturer pays at least four costs.

1. The proper compensation of the victim who for a longer or shorter period is unable to earn wages.

2. The cost of litigation where questions arise respecting the responsibility for the accident; or the cost of liability insurance, if the owner follows this method of protecting himself from more costly attack.

3. The cost of the diminished rate of production which follows the nervous shock to everyone who witnessed the accident or ran to the help of the sufferer.

4. The cost of the time to train a new operative to the speed and skill of the disabled one, and such loss as there may be from defective work in that process.

If the seller properly charges these costs to the prime costs of production, he is unable to meet the competition of a rival who has no accidents. In the second place, the community as a whole wastes its resources in the care of the disabled one in the hospital and the charity doled out to any dependents he may have. The community suffers indirectly also, because the victim's children are held back from their full schooling in order to go to work. In the third place, the victim himself spends his savings, laid aside for old age, to say nothing of the pain, the sorrow, the disappointment, the broken spirit, and the quenched ambitions, which the victim has to bear.

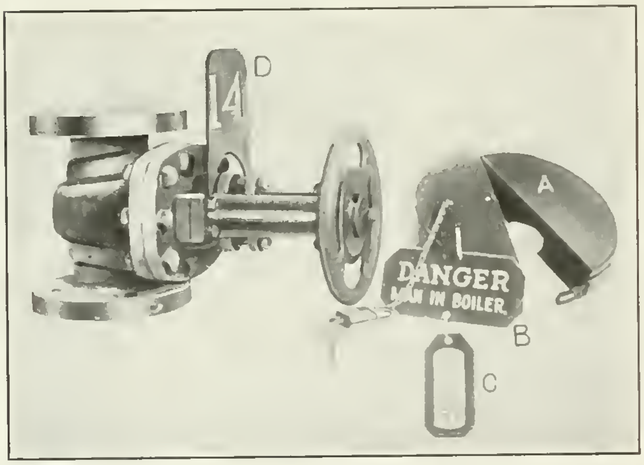

Fig. 1. Safety Lock for Steam Valvee

Are industrial accidents preventable? The answer must be conditioned upon the definition given to an accident. An industrial accident may be defined as something which happens to a man, or to a machine, which incapacitates either for the process of production. The accident to the machine may involve an accident to its operator, or he may escape. So far as the operator is concerned, an industrial accident is one by which a mechanical force acts upon the non-resisting tissues or structure of the human body and wounds, bruises, lacerates, or crushes such parts of the body as are in the path of that force. It is the mechanical forces which are responsible for the injuries in industrial accidents. The accident to the machine may be the result of a poor design or of a failure in the material of a properly designed part, from an excessive stress. Prevention of accidents would therefore seem to be a matter which concerned the designer, the inspector, and the works-manager, foreman or superintendent.

The accidents outlined above are in the nature of a sudden disablement. It is no less the duty of the designer and manager to take steps to prevent a gradual disablement, or a premature wearing out of the wage-earning capacity, by slow physiological causes incident to the character of the work; or, to put this in other words, the producing interests need as an economic proposition, to have their human factors in the "pink" of physical condition. They should take care that no conditions in the works itself are responsible for lowered vitality.

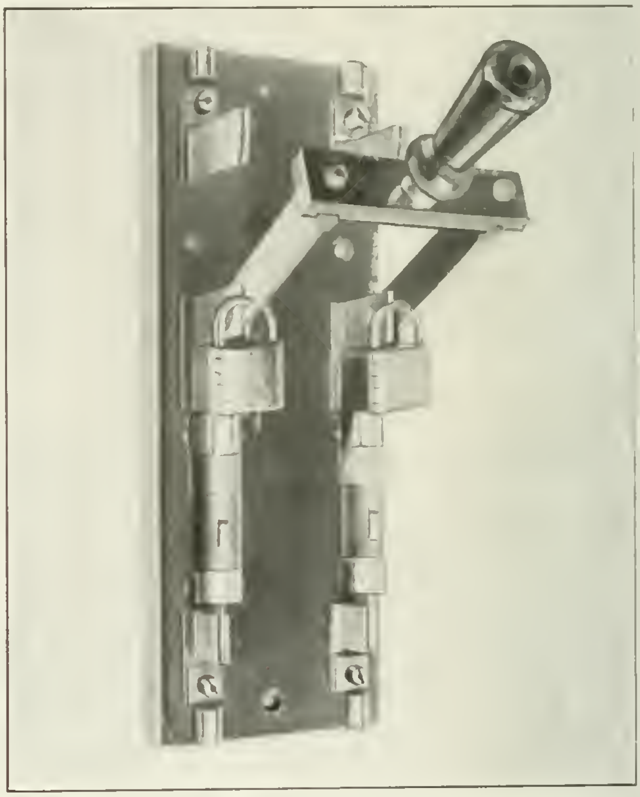

Fig. 2. Safety Lock for Electric Switch

Preventing Accidents in Boilers, and around Engines and Motors

If the foregoing contentions are sound, the motor energy on which all modern production is based, is the prime cause of industrial accidents. Accidents do not happen when the works are shut down. It is so common to surround the moving parts of the power plant by railings, that it seems scarcely necessary to illustrate safeguards in this class. A disaster, however, hangs over the workman around a boiler, which the safety device shown in Fig. 1 seeks to prevent, and against which it has been found entirely effective. This device for preventing a steam valve from being opened upon a line where

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The illustrations used in this article have been furnished by the American Museum of Safety, 29 West 39th St., New York City.

[*] For previous articles on safety devices and accident prevention published in MACHINERY see November, 1911, number and the articles there referred to.

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people are at work, consists of a sheet-steel casing which fits around the handwheel. It is locked in place, and the key given to the man most interested. The engine down the line on which men are working cannot be started; steam cannot be turned into a boiler within which a man is working; acid cannot be turned into a tank or vat within which repairs are in progress; and a wide group of most distressing accidents are precluded where this safeguard is used.

Fig. 2 shows a safeguard identical in principle and operation where the danger may come from an unauthorized closing of an electrical switch which the repair-man opened when he went to work. The key of the padlock is, as before, in the pocket of the man most interested, and the current cannot be turned on the line until he unlocks the lock.

The next great avenue of disaster is to be found in the belts or gears through which power is passing. The main belt is usually massive enough to act as its own warning sign. The smaller transmissions, however, are those with which the workman is usually more intimate, and from which his greatest danger arises.

In Fig. 3 is illustrated a form of safeguarding against belt accidents, and, of course, the same principle can be extended to gears. A slippery floor or a loose end of a garment may be the cause of throwing a man into the path of the belt, and he may be maimed or killed before the motion can be stopped.

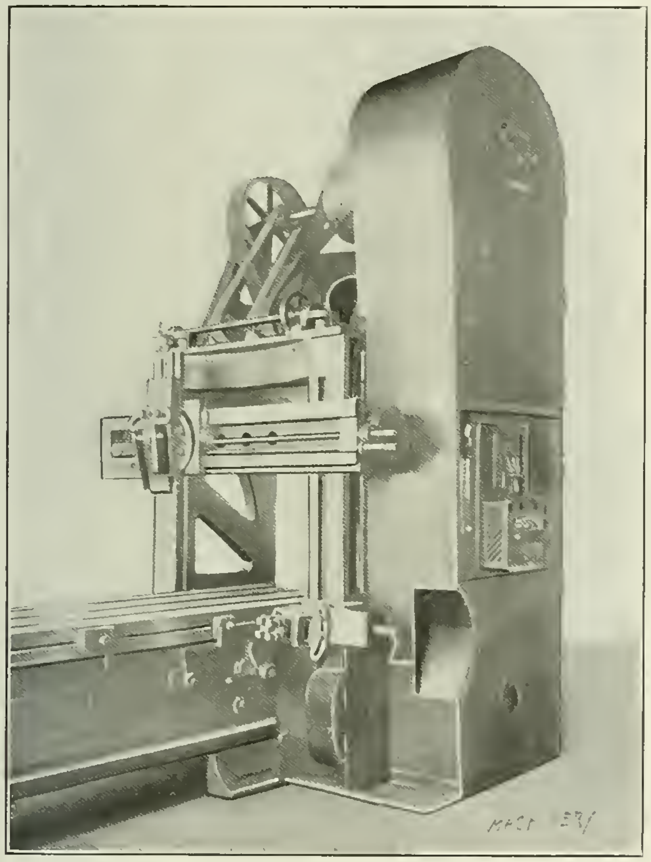

Fig. 3. Guard over Belting and Gears

The wood-working or pattern shop is a place where dangerous cutting edges are moving at high speed. These conditions make the circular saw, the jointer or buzz-planer, the molder or sticker, and the band-saw, sources of most distressing accidents, which seem almost worse by reason of their suddenness of attack without warning. Fig. 4 illustrates the trend of modern prevention of accidents of this kind. The lower part of the band-saw is completely encased, and the upper wheel covered with a guard. The accident from the breakage of the saw, and the danger to the forehead of the workman are practically eliminated. He can still, however, lose a finger in the danger zone of the tool. Improved designs of cutter-heads for planers have greatly reduced the dangerous character of the accidents which happen about it, and many forms of guards for the villainous circular saw have been widely installed.

Preventing Accidents in Punch Presses

The punch for boiler and bridge plate is not in itself so very dangerous a tool, but Fig. 5 illustrates a principle of actuating such tools which will make them still safer. Without going into the detail of mechanical construction, it will be plain that by using the electrical wire to put the punch into commission, the fingers of the workman can be kept entirely outside of the danger zone, and he is much less liable to accident than when the design compels that the clutch be thrown in by a second man who may not know just exactly where his comrade's fingers are. Probably, however, the most dangerous of the tools in the punching class are the ordinary punch presses used in stamping and drawing sheet metals and similar work. If the ram reciprocates continuously, and the workman feeds the stock by hand, there is always the danger that something will distract his attention, resulting in his leaving a finger where the stroke of the ram can catch it. The designs in Figs. 6 and 7 show a collapsible guard forming a safety device, the intention being that the fingers of the operator shall never get within the guard, while it gives freedom for presenting the stock to the press. Other forms of safeguards cause a steel finger to sweep over the die of such a press, just as the ram descends, forcing the careless finger out of the danger area. A recent clever inventor has proposed to electrify the die as the punch starts to descend, so that any man whose fingers rest on it will get a sharp shock, and automatically draw the fingers away, due to the involuntary contraction of the muscles.

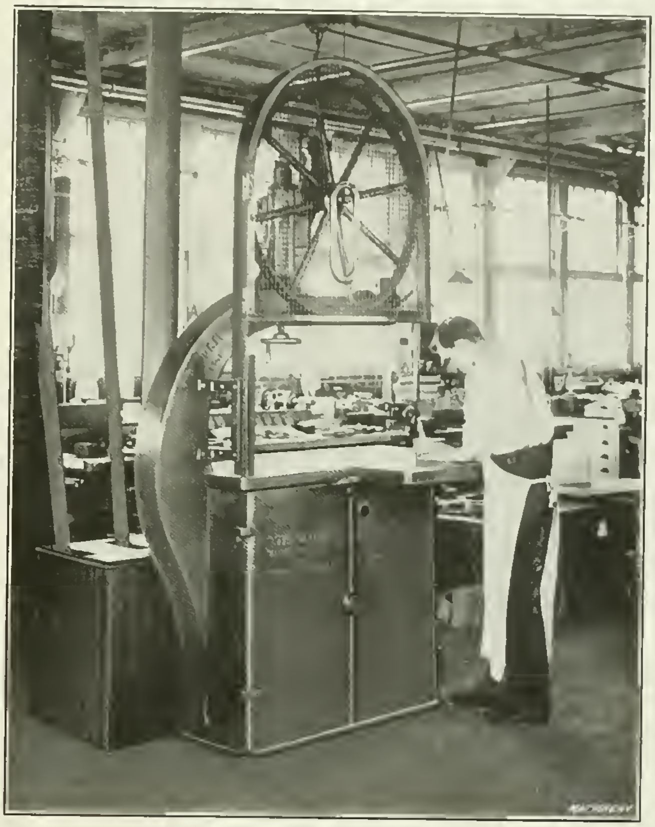

Fig. 4. Guards for a Band-saw

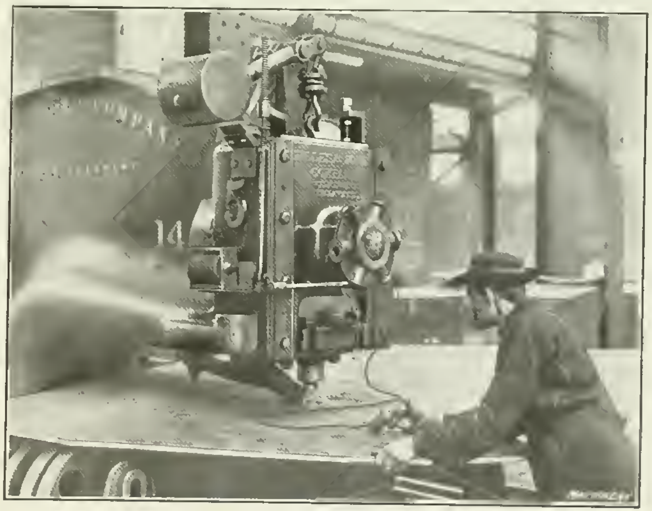

Fig. 5. Operating a Boiler-plate Punch by means of an Electric Hand-switch

Guarding Emery-wheels

The emery-wheel is a dangerous center of possible accidents. The danger is first from a bursting of the wheel, either by the pressure of the work at the periphery of the wheel, or, more rarely, simply from the action of the centrifugal force. A twofold safeguard against these accidents can be secured by the use of large disks or washers which grip the wheel at a considerable distance from the revolving axis. If, further, the wheel is thicker at the center than where the washers bear, the danger of a centrifugal flinging of the parts of a broken wheel is materially lessened. Furthermore, the wheel can be covered, except just at the working sector, by a steel guard strong enough to keep in any fragments of the wheel if it should burst.

Fig. 9 shows a safeguarded emery-wheel with the belt protected within a steel shield, and the eyes of the workman shielded by screens either of glass or of fine wire mesh. If exhaust currents of sufficient strength to overcome the centrifugal tendency of abraded particles are led away from the wheel, the respiratory tract of the workman is saved from the slow deterioration which it would otherwise suffer.

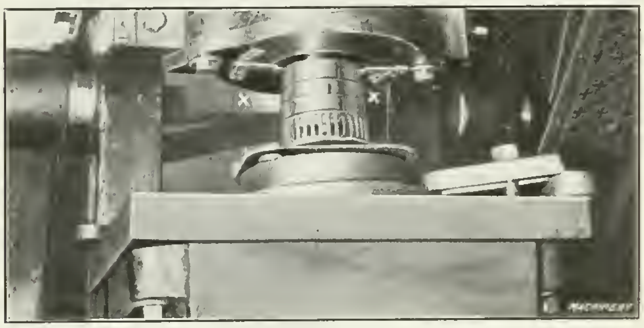

Fig. 6. Punch Press with Telescoping Guard

Miscellaneous Safeguards

The lathe, working on small diameters, or with work in its chuck or on its faceplate, is particularly liable to entangle the sleeve of the workman and break or lacerate his arm. In Figs. 8 and 10 are shown two suggestions for safeguarding the man. The drum *A* in Fig. 8 should keep his clothing from the projecting points of the chuck or faceplate, while Fig. 10 shows how the common dog can be prevented from his vicious biting.

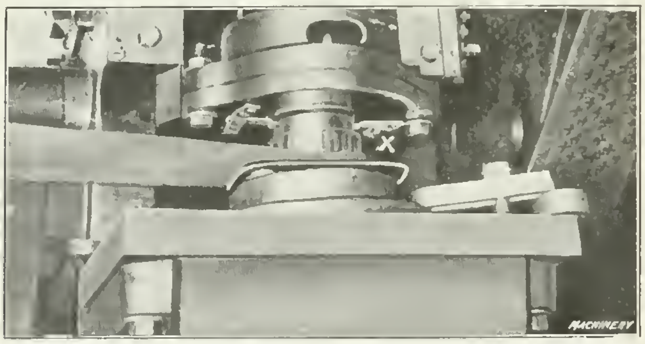

Fig 7. Punch Press Guard in Fig. 6 with the Ram in its Lower Position

It is not the custom in the United States to make such common use of women in the shops as the German practice does. The safeguarding the women's hair from being caught in belts or other moving parts should, however, not be neglected. The electrical zone surrounding a fast moving belt is particularly fatal to loose strands, and the entanglement of hair between a belt and a pulley can result in a most distressing accident, which is usually severe enough to be fatal. The wearing of close-fitting caps, covering all of the hair, prevents accidents of this kind.

Accidents in the shop do not originate alone in the danger zone of a power driven tool. The process of chipping often sends a flying particle with considerable force over quite a distance, and the delicate tissues of the eye can easily be pierced by such a barbed missile. In Fig. 11 is shown a safeguard in simple form; a screen of burlap is stretched upon a light frame in the path of such steel particles. The fibrous character of the screen catches what is thrust against it, and the particles drop harmlessly to the ground.

It must not be overlooked that the mechanical force which may strike a man down is not alone manifest or developed at the operating point of the tool. The means of transportation within the shop and about the yard, when operated by power, can be as fatal as the machine tool. The door into one of the plant buildings may open directly upon the line of a railway. On a stormy day when the wind is high, or late in the afternoon when the shop is bright, but outdoors is dark, a man may step from the door directly into the danger zone of the railway. He may be intently thinking of something else, or young lads may be full of the thought of release from toil at the end of the day. The simple expedient of a gate which shall compel a man who comes out through the door to turn and face parallel to the building before he attempts to cross, will at least direct his attention to the danger of the railway line by compelling him to pass around the end of the gate.

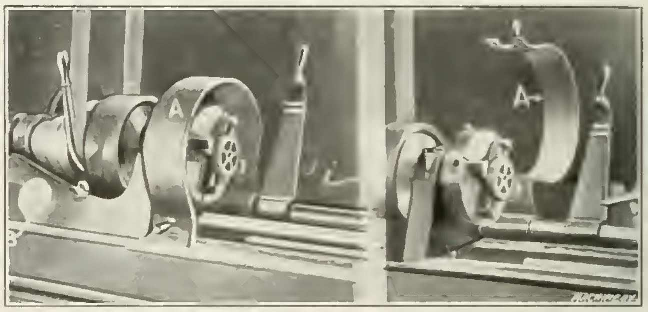

Fig. 8. Guard for the Lathe over Faceplate or Chucks

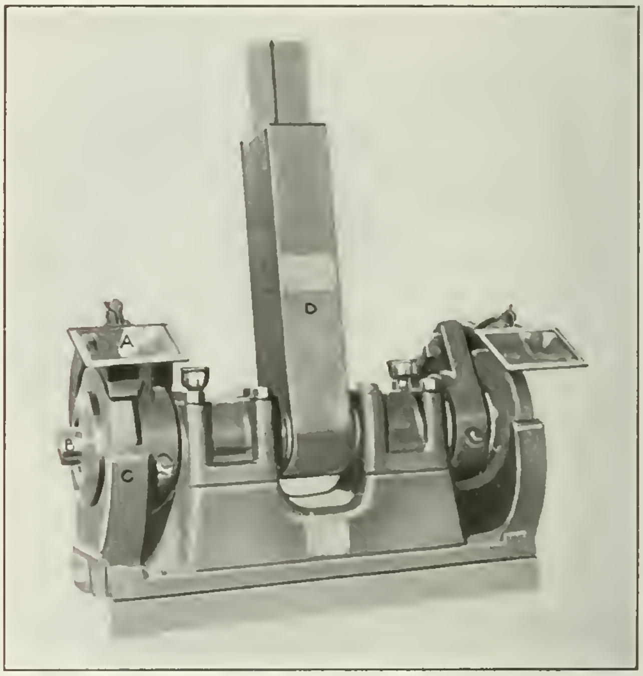

Fig. 9. Emery-wheel Head Effectively Guarded

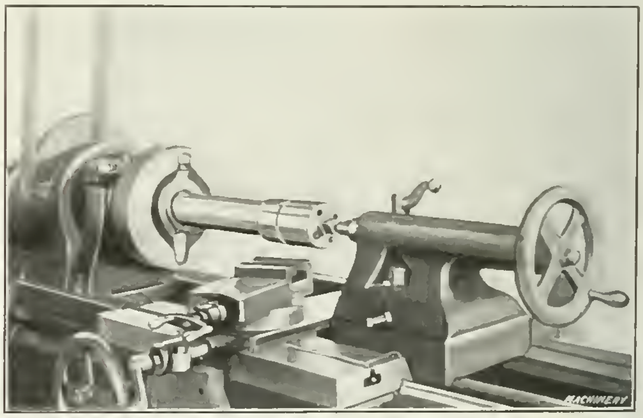

Fig. 10. Lathe Dog Guard

The workman whose business it is to oil shafting may meet with an accident by placing his ladder at rather an acute angle with the floor, and a slippery surface may permit the ladder to fall, bringing the man and his tools to serious injury, particularly if he should fall into moving machinery. It is a good safety device to equip the foot of such a ladder with large contact areas (Fig. 12), and to fit this with a rubber or other surface of high frictional resistance. The protection of traveling cranes, of hoistways and hatches, and of safety hooks and gangway railings, all belong in this general class.

Interlocking Safety Devices

It will be apparent, however, from a consideration of most of the foregoing devices for safety that, even when they are used, it is entirely possible for industrial accidents to occur if the workman is careless or uninterested. The highest principle in safety devices is that which in other departments of engineering is called the "interlocking" principle; that is, it may be made mechanically impossible for the operator to have his fingers in the danger zone and have the tool set in motion while his fingers are there. This principle is introduced in two ways. The first is to have the engaging device require a concurrent action of both hands, in order that the machine may function. In a press, for example, it may be arranged so that the belt has a tendency to pass to the loose pulley unless a counterweight attached to the shifter is held in a certain position by the right hand. When the right hand has gripped this one lever, it still requires that the left hand shall throw the clutch lever to make the machine operate. Obviously, the workman has no hand free to put in the path of the plunger of the press. The engagement may also be pneumatic, and require that two valves be opened, one of which is worked with the right hand and the other with the left.

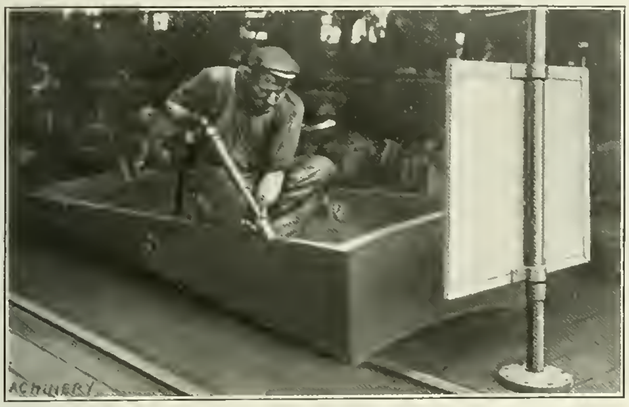

Fig. 11. Screen for Preventing Chips from flying around

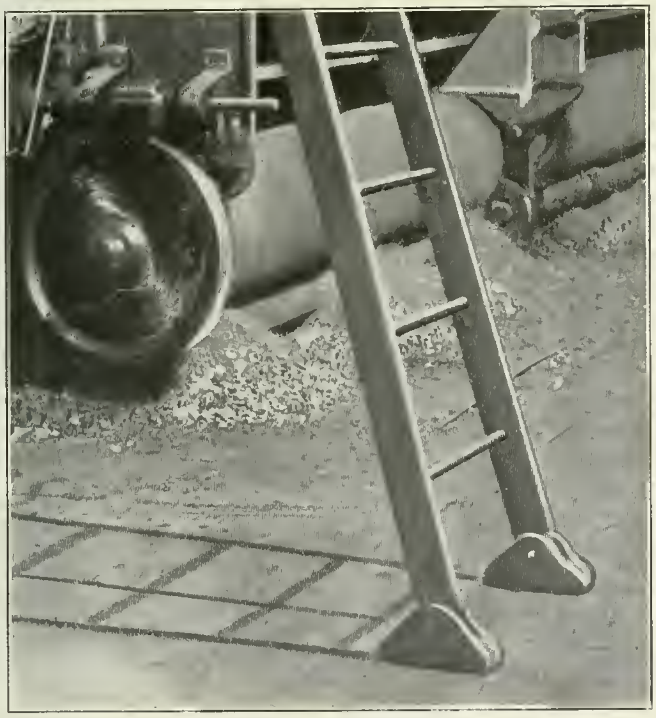

Fig. 12. Large Special Feet for Ladders, with Rubber Soles to increase Frictional Resistance

The second interlocking principle is applied in centrifugals or kneading machines which are fitted with a cover. It can easily be made mechanically impossible to throw on the power until the protecting lid has been closed down over the working parts. When this has been done, the belt may be shifted or the clutch thrown in. Conversely, when the clutch is in or the belt is driving the machine, the lid cannot be lifted until the power has first been shut off. For the machines to which this principle can be applied, there is nothing additional to be desired in the way of a safety provision.

It is, however, impossible to apply interlocking to all machines, and there remains, therefore, the necessity for getting the workmen interested in preventing accidents. One of the most satisfactory agencies to this end has been the formation of Safety Committees in the works, of which the workmen themselves are made members in rotation, serving with a certain number who do not change from week to week. While it is true that no soldier makes a good captain until he has first served as a private, it is equally true that no man makes so good a private as one who has carried the burdens of a captain. Service on the Safety Committee and familiarity with the line of thought which reaches after safety, makes the men themselves far more willing to take precautions.

We need an educational process which shall, on the one hand, inform the manufacturer as to what safety devices and systems of shop rules have worked well in other plants, and on the other, instruct the men as to the precautions and safeguards which they have a right to expect in their plant. The labor union may very properly exert itself to protect its members by an insistence upon adequate provisions for safety. The factory inspector may properly insist that every works manager lives up to that standard in safety matters which has been found practical in other establishments of the state.

* * *

The Machine Tool and Engineering Association of Great Britain announced at its last annual meeting that eighty firms had joined the association. A communication had been received from the Home Office, one of the governmental departments in Great Britain, with respect to the question of adequately guarding the gears of machines. It was stated in this communication that British firms had lost several orders owing to the inadequacy of the guards over gears, and that machine tool manufacturers in other countries supplied their machines with better guards. A prominent man in the machine tool trade, speaking about the way in which some of the gears and parts were indiscriminately arranged around a machine, to the danger of the operator, suggested that the builders should look at the human frame as a model to which to build their machines, since in this all the important elements are carefully concealed within perfect guards. A designer, he intimated, should make a machine a pleasing thing to look at besides being an article of utility. Mr. Walter Deakin of Messrs. H. W. Ward & Co., Ltd., called attention to the fact that the reason why the British mechanical industries were not in the lead, as they had been in the past, was chiefly due to the narrow view that the members of the trade had entertained. They had, he said, rather kept to themselves and thought that it would be the best policy to cultivate their own little patch, without attempting to recognize the general bearing of questions concerning the whole industry. Evidences, however, indicate that this feeling is disappearing among British manufacturers.

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Radium emits three kinds of rays which for convenience are called alpha, beta, and gamma rays. Of these the gamma rays, which greatly resemble the Roentgen or X-rays, are of tremendous penetrating power. It has been possible to obtain fine photographs with these rays through 12 inches of steel. The alpha rays emitted by radium are in reality small particles of matter that can be detected when the radium is exposed to a zinc sulphide screen; the bombardment of the screen by these particles, which travel at a very high velocity, produces scintillations which under a magnifying glass, look like millions of shooting stars or sparks. Through the constant giving off of particles, the radium atom gradually breaks up, but the process is so slow that only one-half of the atom is broken up in about 1300 years.

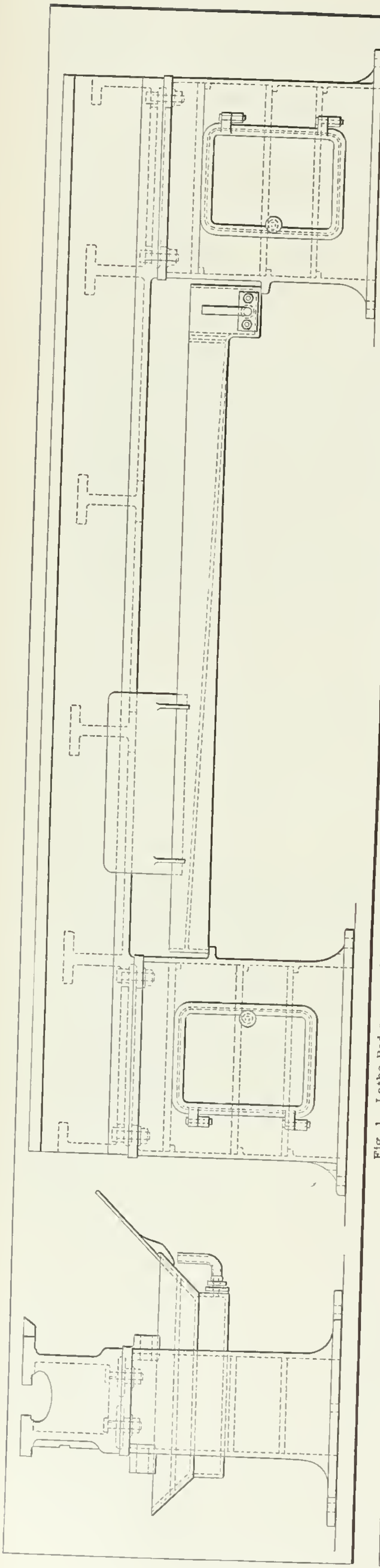

Fig. 1. Lathe Bed supported on Cabinet Standards or Legs with Provision for Lubricating the Cutting Tool

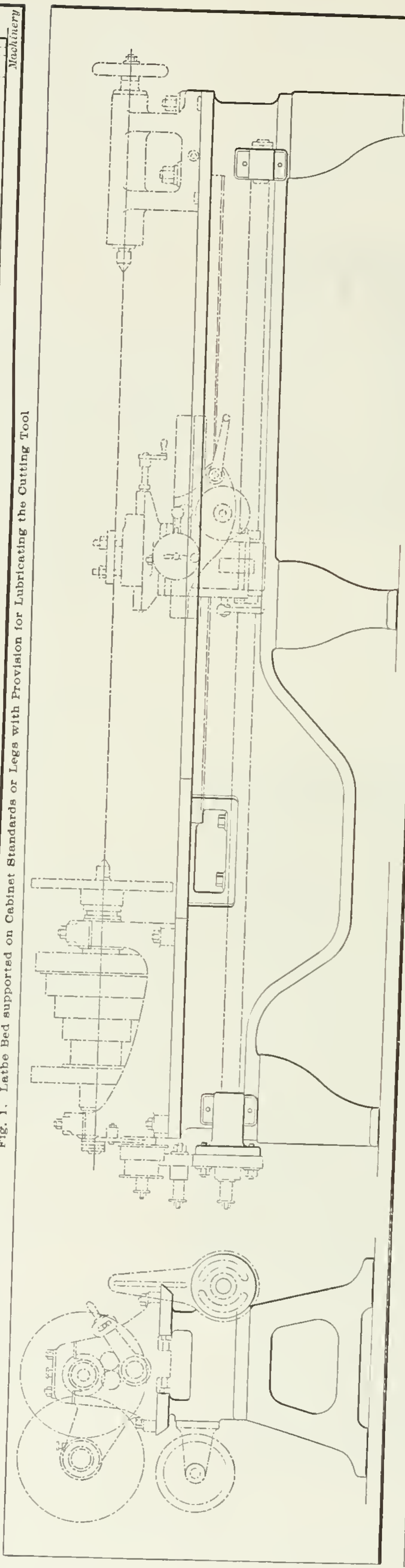

Fig. 2. Gap Bed supported on Three Legs

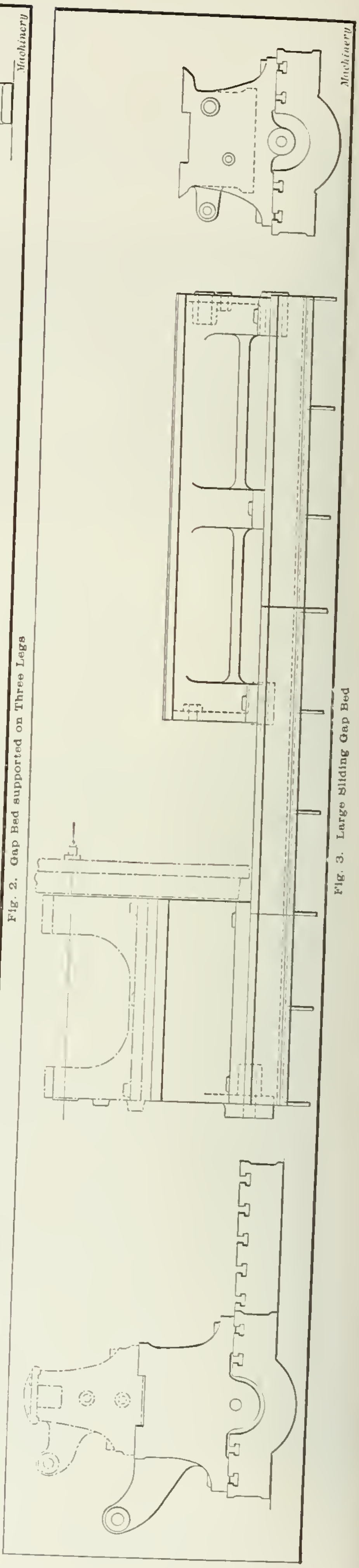

Fig. 3. Large Sliding Gap Bed

THE FORMS OF LATHE BEDS—3

THE LONGITUDINAL FORMS OF BEDS

By JOSEPH G. HORNER*

The remarks made in the previous installments relative to the flexure and torsion of lathe beds need not be repeated here, but we shall consider, with the aid of the representative illustrations, how flexure is best resisted, and how the longitudinal shapes are modified to serve different functions. The principal differences which are made in the forms of beds are those arising from variations in dimensions, while subsidiary differences are produced by special designs of lathes, or additional functions, or by the particular class of work which is done in the lathe. Thus, the shapes of beds of similar dimensions for ordinary screw-cutting or engine lathes and those for turret lathes are very often radically different. In the one case provision has to be included for the screw-cutting and feeding devices, for the carriage motions, and for the tailstock, while in many turret lathes these features are absent, and the bed is plainer, with provision only for clamping the turret base and the cross-slide. On the other hand, the arrangements for lubricating the cutting tools and work often introduce complications into the design of turret lathe beds, and the casting is of a more elaborate character below the bed proper—around the top of the legs or standards.

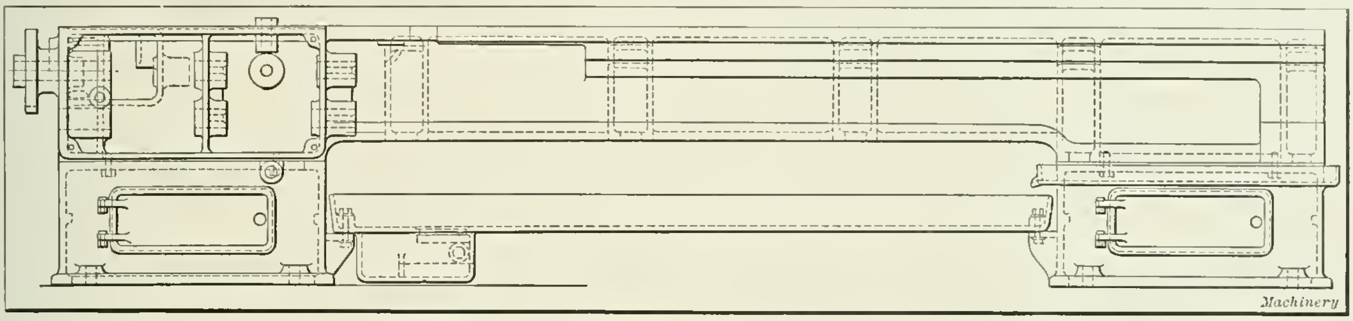

Fig. 4. Bed for 20-inch High-speed Lathe built by Smith & Coventry, Ltd., Manchester, England

The length of a bed has an important influence upon its construction and the number of supporting points, and if a gap is included, this also modifies the form to a considerable degree. The number of supports ranges from the single cabinet standard in some small lathes, and the two standards or legs in those of ordinary dimensions, to the three or more supports in longer beds. A continuous bed of full depth for the whole length is employed in lathes for heavy work and large swing, and is supported solidly on concrete foundations. The truth and rigidity of a lathe bed depends to a certain extent upon how it is fastened down. Ordinarily, beds are bolted rigidly to their foundation, which may be a wooden floor or a stone or concrete base.

Many years ago Prof. Sweet suggested the adoption of a tripod support for lathe beds, and this suggestion has been acted upon in practice. One end of the lathe is bolted down by the usual means, and the other is pivoted on a pin which passes through lugs in the bed and in the leg. The only support at that end is the pin on which the leg is free to adjust itself. Many firms also adopt the three-point support principle without any pivoting device: sometimes there are three points of contact with the foundation, and sometimes the bed is united to the legs at three points. The effect of an untrue foundation is thereby neutralized. Another method of affording good support is that of casting the bed with, or bolting it to, a single column of box form, which makes the lathe self-contained, and obviates any risk of distortion or winding. This construction is employed both for small ordinary lathes, and for turret lathes up to fairly large dimensions.

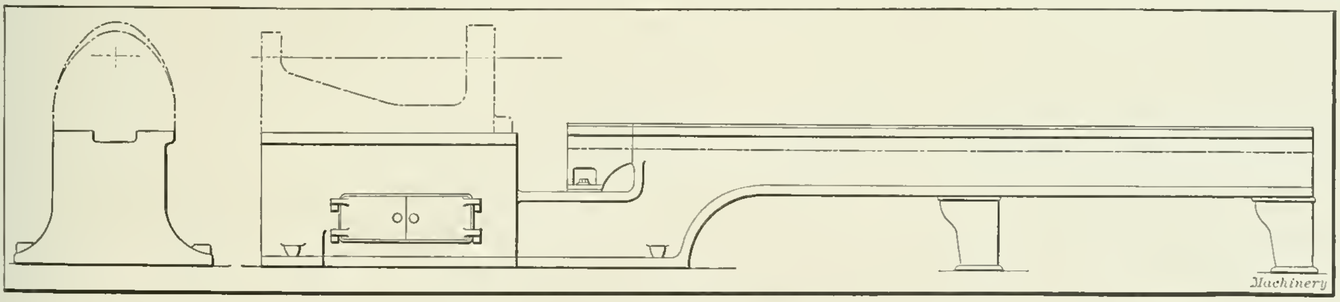

Fig. 5. Gap Bed with Support under the Gap

Legs or Supports for Lathe Beds

When legs are used to support the bed, it is the custom of some makers to spread the legs under the head to a greater extent than those under the right-hand end, to resist the vibration, which is more pronounced at the headstock end. Other firms do not put ordinary ribbed legs at all under the headstock, but prefer a boxed cabinet support, even when there are legs at the other end. The principle of this seems faulty, since, if it is considered necessary to put a box support under the headstock end, the use of a flimsy support at the other end of a heavy bed appears unreasonable. Many makers view the matter in this light, and place the bed on equally solid and substantial supports at both ends; sometimes the supports are of identical pattern, but frequently they are a little larger at the headstock end, in order to afford more cupboard room for tools and appliances.

The practice of placing the supports a certain distance inward from the ends, mentioned in a previous installment, is followed in many instances, and a further development of this principle is found in the case of some lathes, particularly those with gaps, where the metal of the boxed bed is carried down to a considerable depth under the headstock, gradually tapering off towards the ends. A great many turret lathes have their supports placed some distance inward from the ends of the bed, and the under side of the latter is often tapered or curved upward from the outside of the legs to the ends of the bed.

Gap Lathes

The question of forming a gap in a lathe bed has long been the subject of controversy. A gap lathe bed is practically as common in England as a straight bed. Theoretical considerations have been urged against it, chiefly on the ground that the bed is weakened, because its continuity is broken; but an English lathe maker would argue that the metal which is removed can be more than compensated for by extra metal placed underneath and beyond the gap, and in the heavier lathes by metal brought down to the ground in the form of a broad foot. The real objection to a gap is its unalterable dimensions—it is wider than is required for some jobs, and not wide enough for others. The fitting of the bridge-piece is also liable to become slightly inaccurate when a lathe has done much service, but this can be rectified.

The gap is nevertheless a great favorite because of the general and miscellaneous character of the work which has to be handled in most shops. Thirty or forty years ago such lathes predominated over all others, but gradually, with the growth in specialization, they have been displaced, to some extent, by straight-bed lathes on the one hand, and by regular facing lathes, and vertical turning and boring mills, on the other. Nevertheless, the rigid gap bed retains an important place in nearly all English shops, and is likely to do so because of its adaptability to so many varied classes of work. Usually, the makers now supply identically the same lathe with and without the gap. In some designs a sort of compromise is made, in that the metal immediately in front of the headstock is recessed to a moderate depth and width, leaving a gap which very considerably increases the usefulness of the lathe, but no gap-piece is required. The metal removed at the recess is compensated for by carrying the bed down deeper underneath, or by casting it with a continuous foot extending from the end of the bed to a certain distance beyond the gap.

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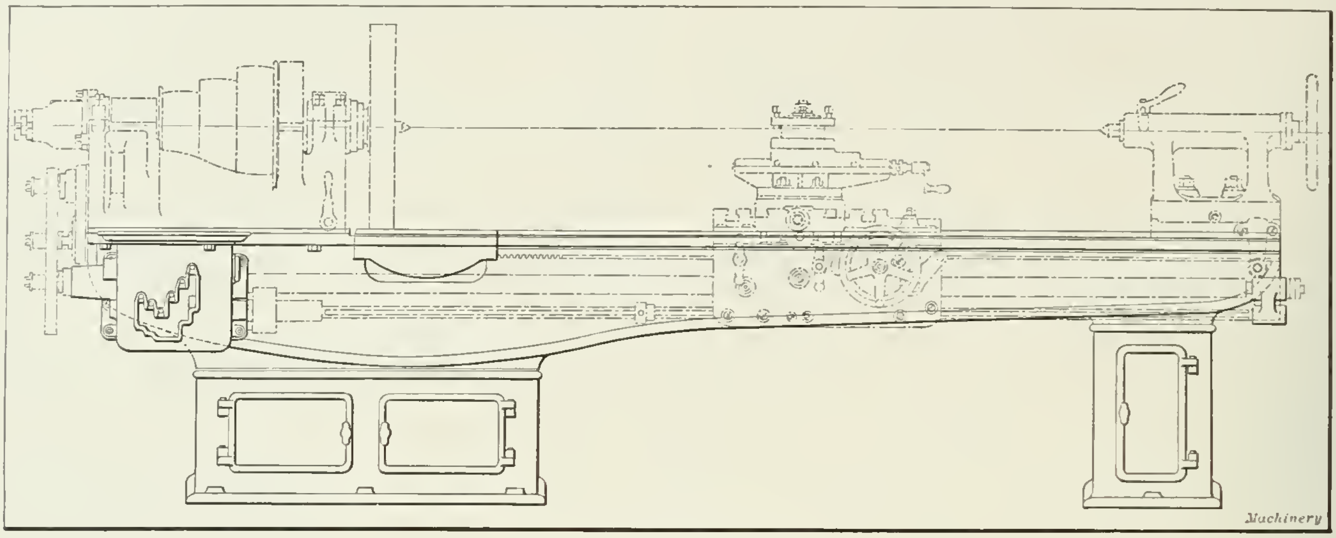

Fig. 6. Gap Bed of French Design

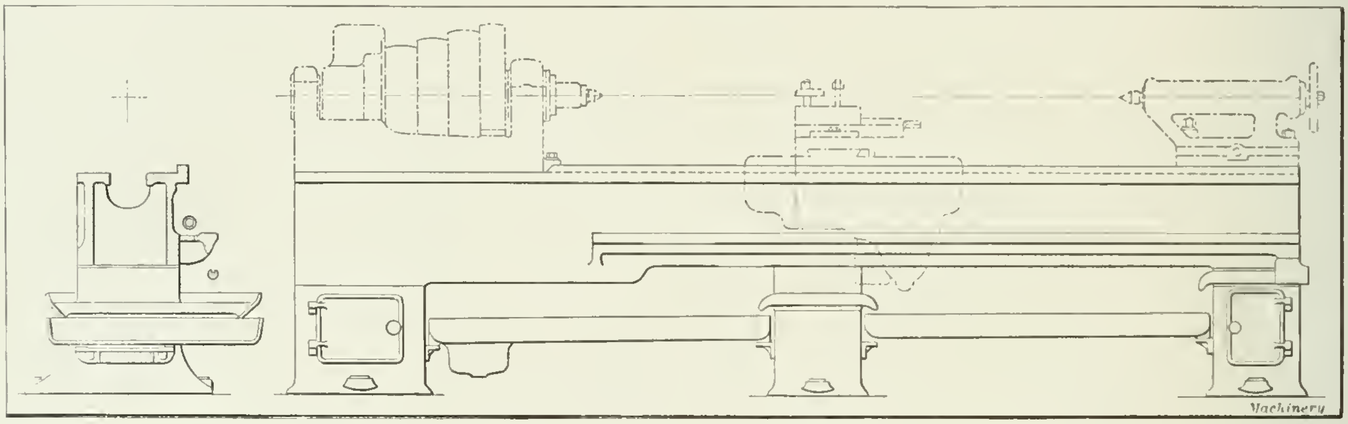

Fig. 7. High-speed Lathe Bed with Three Supports, as built by Darling & Sellers, Ltd., Keighley, England

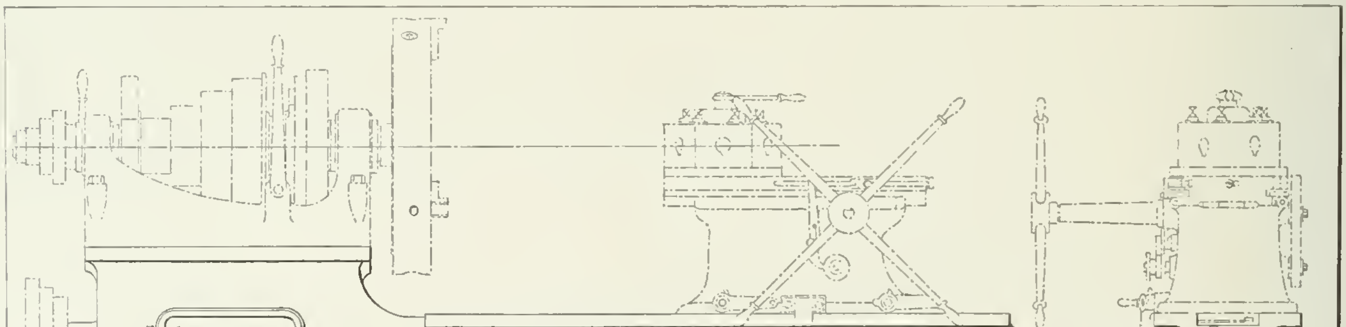

Fig. 8. Type of Bed used for Chucking Lathe

The movable-gap is used to a moderate extent, in medium and large sizes of lathes, and would be adopted more extensively but for the fact of the ever-growing specialization. The breadth of gap is adjustable within a wide range, or it may be closed up entirely, the object being, of course, to support the carriage as close as practicable to the cutting point of the tool under all conditions. The most serious defect in gap lathes, perhaps, is the fact that the lead-screw has to be kept low down to be out of the way. In the movable-gap lathes another difficulty arises in the driving of the lead-screw, which has to be done from gears at the right-hand end of the bed.

Types of Lathe Beds

The first illustration, Fig. 1, shows the form of a good type of bed, supported on box standards at both ends. The bed is equipped for the use of cutting lubricant or oil, though not in such a perfect manner as some beds shown later. A more elaborate type of bed for a 20-inch high-speed lathe, built by Smith & Coventry, Ltd., of Manchester, England, is shown in Fig. 4. The cross-sectional shape of this bed was shown in a previous installment of this article. The details of the boxing and cross-ribbing and the joining of the bed to its standards will be observed. The right-hand standard is surrounded by an oil rim which conducts the lubricant into the trough, and at the top of the bed, close to the headstock, a space is left for the oil and chips to drop down into the trough.

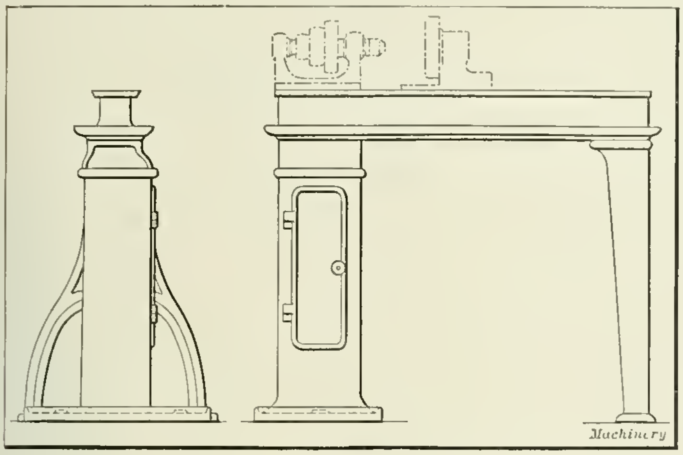

Fig. 9. Bed for Small Lathe

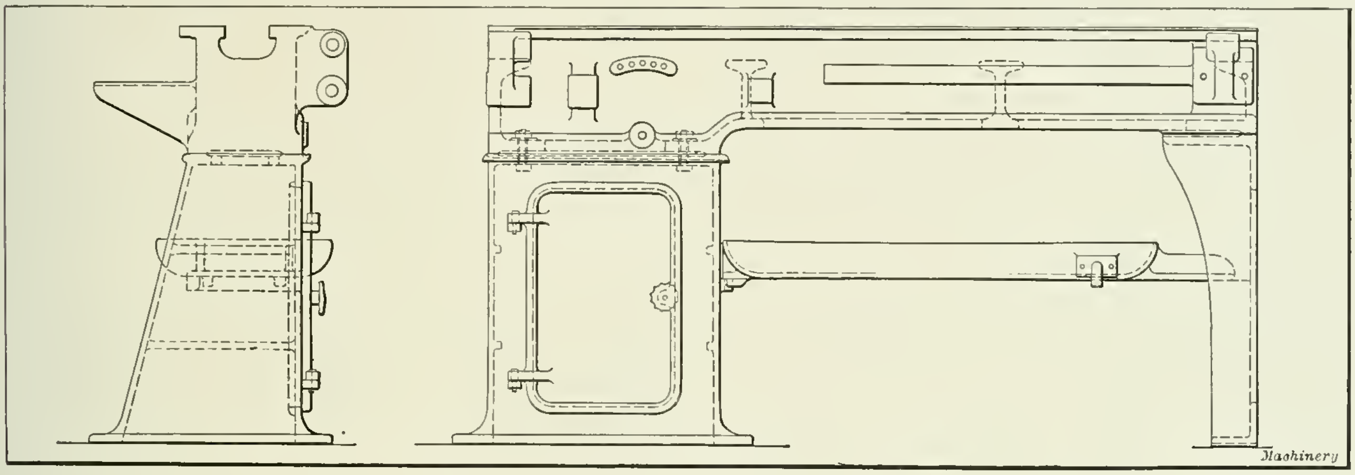

Fig. 10. Bed with Wide Cabinet Standard at One End

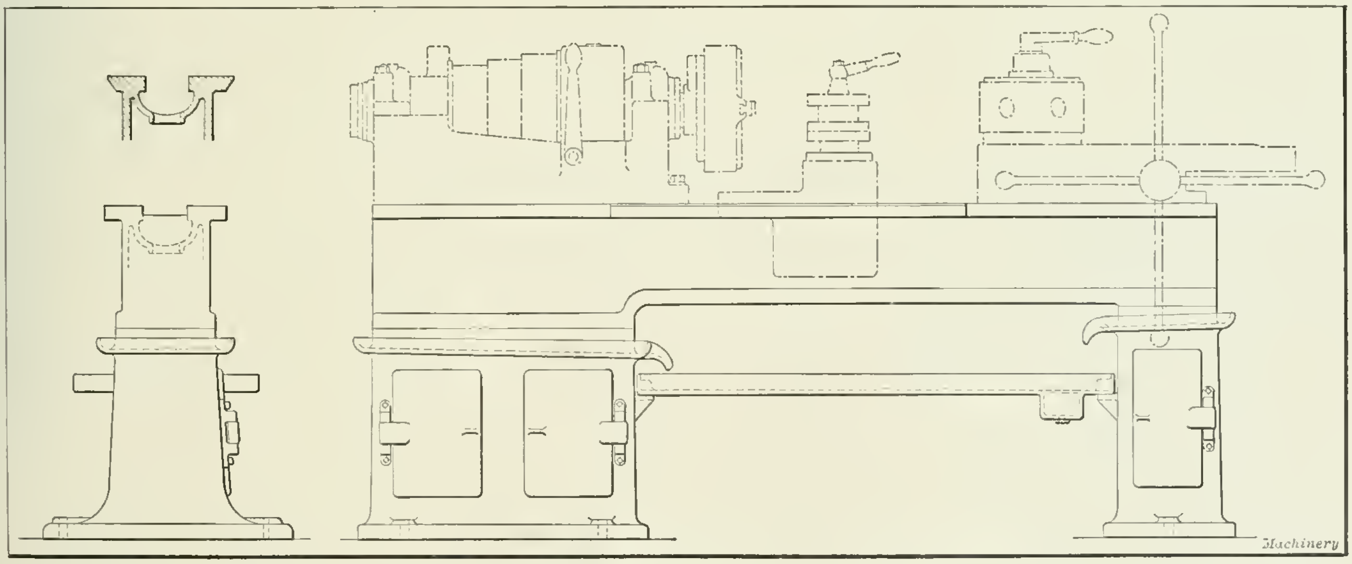

Fig. 11. Bed with Two Cabinet Standards of Unequal Size

The two principal designs of gap lathes are represented in Figs. 2 and 5, the first having the gap compensated for by the usual deepening underneath, and the other having a continuous base, such as is adopted for heavier lathes. In each case an intermediate leg is located under the bed, owing to its length. It will be noticed that in one case the gap-piece entirely fills the opening, while in the other it only partially does so, leaving a space for a large face-plate or chuck to remain in place, and still providing sufficient length for the support of the saddle.

Fig. 6 shows a French design of gap bed in which the metal is carried down in a graceful curve under the gap. The bed is well supported at this point on the wide cabinet base. An example of a straight bed supported on three equidistant bases is shown in Fig. 7, this being the bed of a Darling & Sellers' lathe, the section of the bed and saddle for which was shown in a previous installment. It will be noted, from the elevation, how the lower tier or guide rail would support the carriage if a gap were used. A design of bed for a chucking lathe is illustrated in Fig. 8; this is of the box type, with ample support underneath the headstock.

Two designs of beds which embody the same idea, with different proportions, are shown in Figs. 9 and 10, the first being for a small lathe, and the second for a larger one. A cabinet leg is used under the headstock end in each case. For beds of the proportions shown in Fig. 9 it is not generally the practice to use a cabinet base, but regular ribbed legs at both ends are used instead.

The arrangements for lubrication of the cutting tool and work, as mentioned before, affect the extent to which the bed is provided with oil-catching devices. The most complete method, short of placing the entire bed in a tray, is that represented in Fig. 11, with each base surrounded with an oil rim, leading into the trough between them. This arrangement does not provide for splashing, unless a sloping guard is fitted in front, or in both front and rear. A step further, as shown in Fig. 14, consists in fitting a single tray large enough

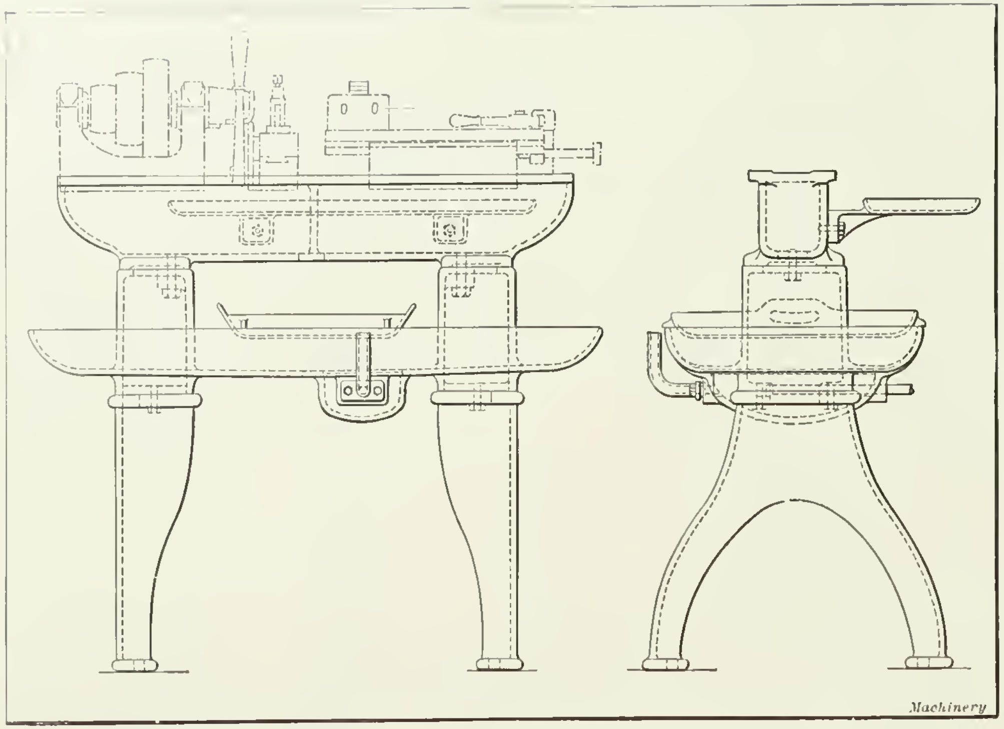

Fig. 12. Bed for Turret Lathe, showing Complete Cutting-tool Lubrication Arrangement

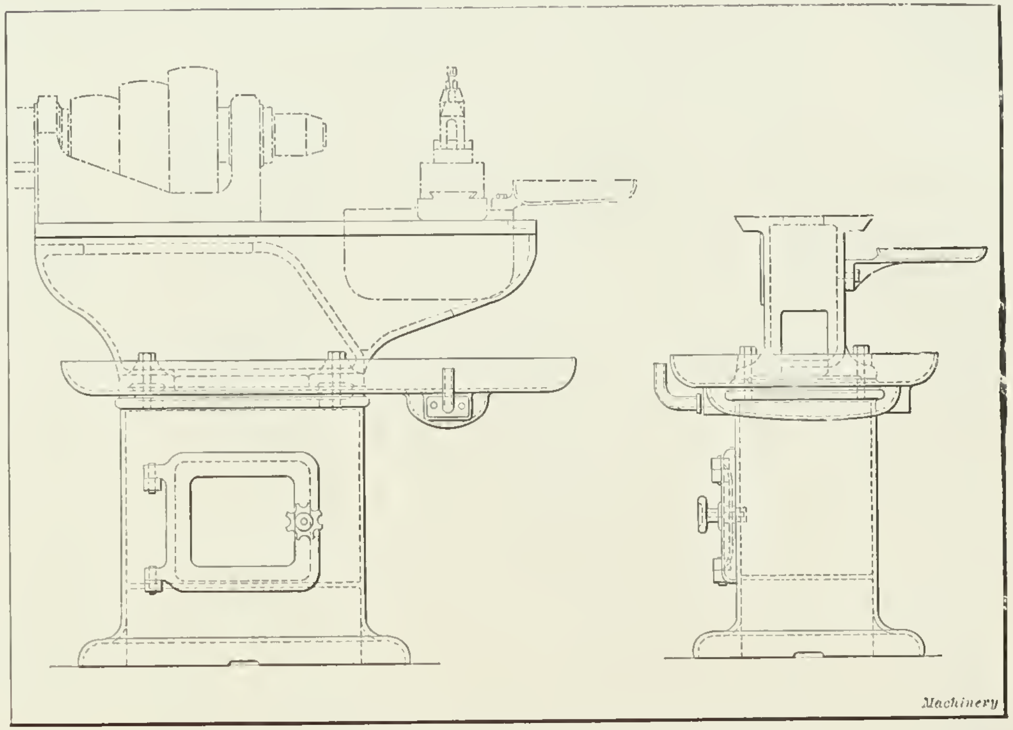

Fig. 13. Bed for Shaving Lathe with Single Cabinet Standard

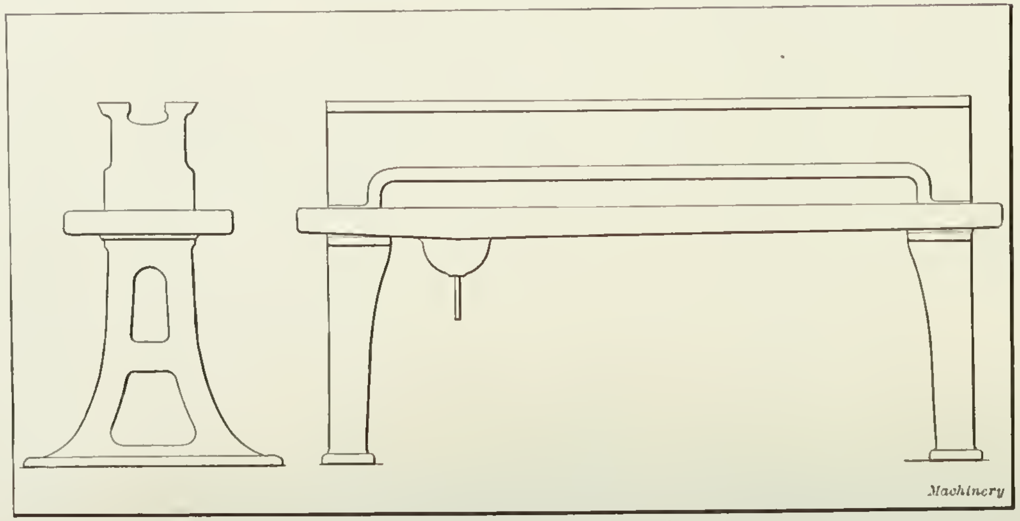

Fig. 14. Light Lathe Bed with Plain Leg Supports and Oil Tray

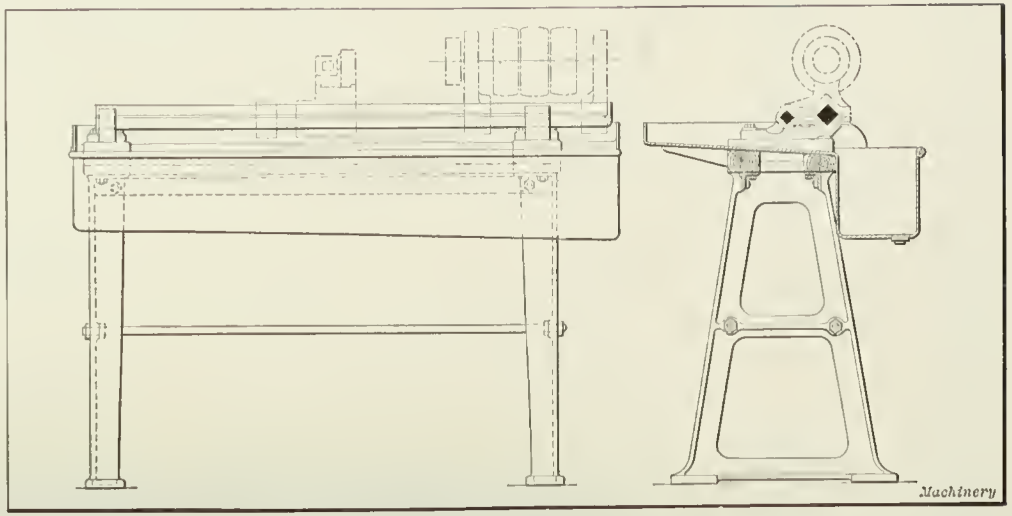

Fig. 15. Double-bar Type of Lathe as built by Brenot, Buronfosse & Cie., Paris, France

to extend around the entire bed. A more elaborate design is illustrated in Fig. 12, in which the tray is of ample capacity. An addition is sometimes made in the shape of sloping guards or oil catchers hung on the rim, not only at the front and the rear, but also at the ends. Single-standard beds, Fig. 13, are fitted in the manner shown, and for lathes of a size suitable for this design, are admirably adapted as regards steadiness and convenience.

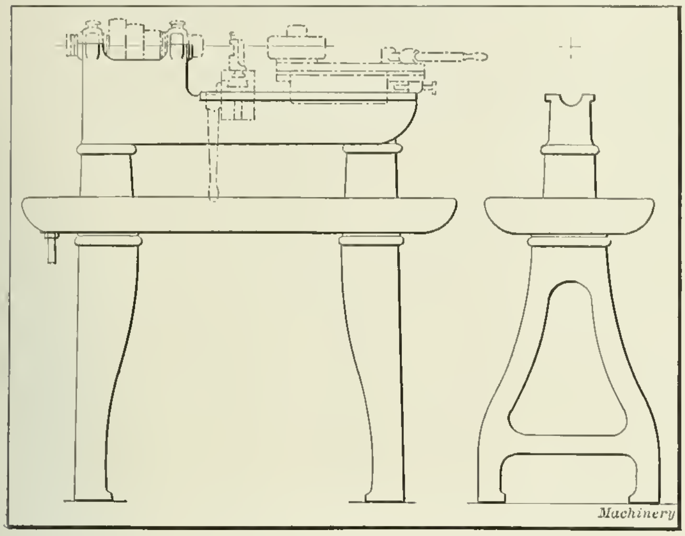

Fig. 16. Turret Lathe Bed with Head cast Solid with it

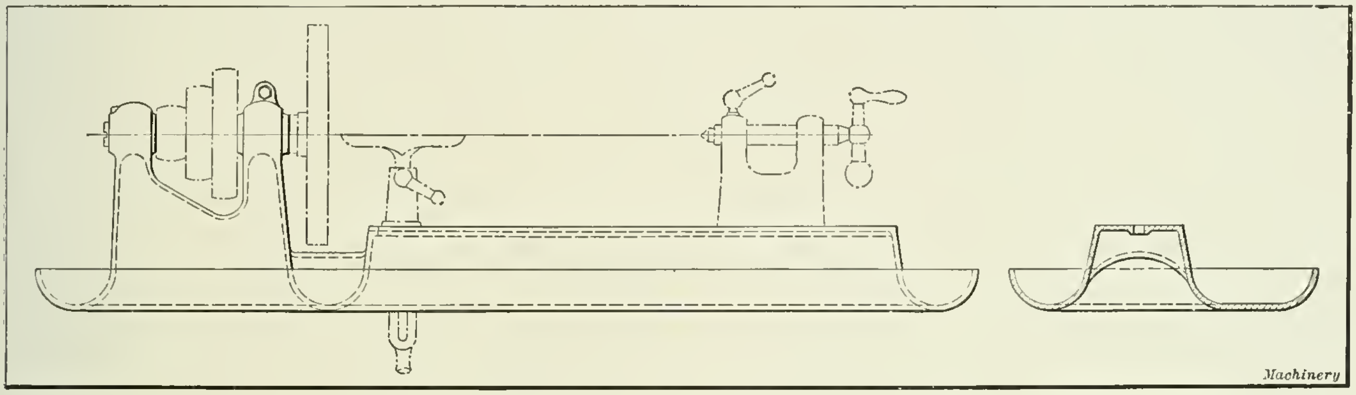

Fig. 17. Bed for Small Lathe with Head and Oil Pan cast Solid with it

The practice of casting the headstock in one piece with the bed is becoming more and more common both in ordinary lathes and in those of the turret type. It is not always cheaper than to make the head separately and bolt it on, but it may be so if quantities of similar beds are cast. In this case the machining will be cheaper also, provided there are proper facilities for dealing with the work. The principal idea, however is to gain greater rigidity and strength and consequent freedom from vibration. By carrying the webs up between the two bearings, as in Fig. 16, the two bearings are firmly tied together. This design is adopted largely in high-speed lathes with all-geared heads, the webbing extending up from the bed to form the lower half of the gear guards. There is then an opportunity of coring out a cavity large enough to receive big cone pulleys or gears, which could not be done if the head were made separately.

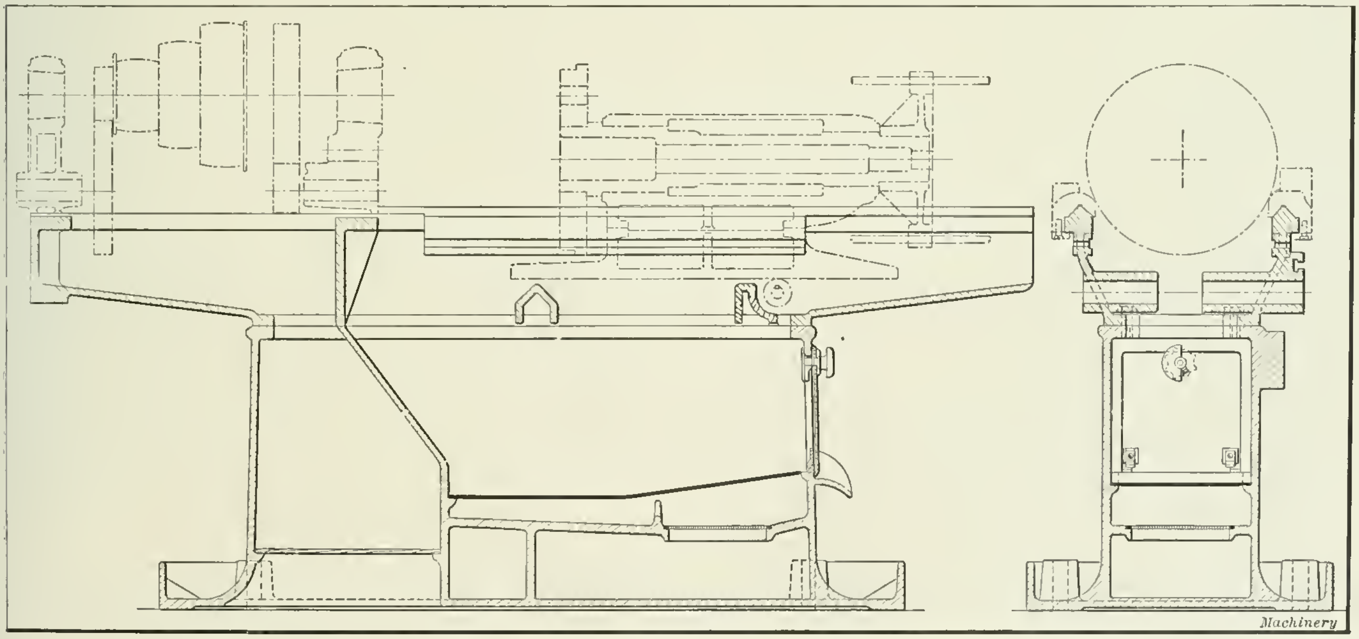

Fig. 18. Bed for the Pittler Turret Lathe as built by the Leipziger Werkzeug-maschinenfabrik, Leipzig-Wahren, Germany

As a contrast to the foregoing examples, Fig. 15 seems like a reversion to primitive construction; this is the Brenot, Buronfosse & Cie screw-making lathe, with the two steel bars for a bed, illustrated in a previous installment. These bars are clamped in brackets at both ends; the brackets are supported on wooden bearers resting on A-shaped legs, tied together with distance bolts. The tray and tank are of galvanized plate.

A neat design of bed and head for a small lathe is shown in Fig. 17, cast with the tray for tools around it. Fig. 18 shows the bed used in some of the German Pittler turret lathes which are supported on a single box base arranged as shown with a strainer and trough for the lubricant and a receptacle for tools, etc. The cross-sectional view shows the jointing of the bed on the standard, and the section of the ways, which carry the turret saddle on vees. The dotted circle indicates the diameter of the vertical turret.

Beds for lathes of large size embody the general principles which have been stated, but they are subject to a number of modifications which are not met with in those of medium and small size. Supporting legs are necessarily absent, the under side of the bed resting on its foundations for its whole length. Joints in the longitudinal direction as well as in the cross direction become necessary on account of convenience in casting, machining or transportation. Gaps or pits are used for lathes required for swinging large diameters, and sometimes the head is independent of the bed, except that it is mounted on the same foundation, that is, the cast-iron bed is not continuous. In some facing lathes the bed does not extend in the longitudinal direction, but comprises merely a support for the slide-rest. The slide movements are obtained only from the rests, and not from the bed. Sometimes the longitudinal extension of the bed from the headstock carries only a tailstock or a boring head, and the rests are supported on wings extending toward front and back. In the sliding-gap lathes there is a pillar or pillars on the wings extending out from the front of the gap to carry rests, in addition to the regular saddle on the slide bed.

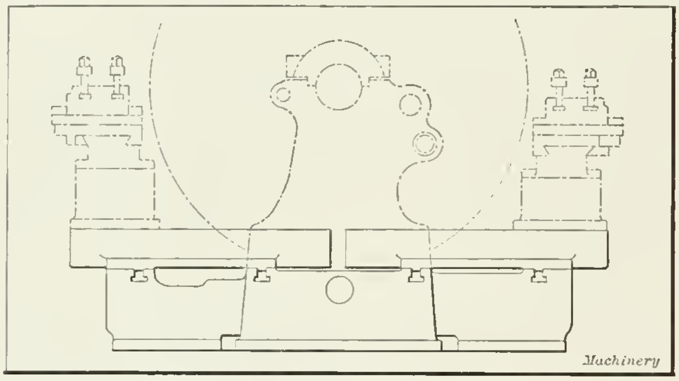

Fig. 19. End View of Bed for Wheel Lathe

Figs. 19 and 20 show a bed for a wheel turning and boring lathe which has supplementary extensions to receive the four slide beds that carry the saddles. These beds are adjusted independently on the main bed; this is typical of a great many beds for different kinds of lathes.

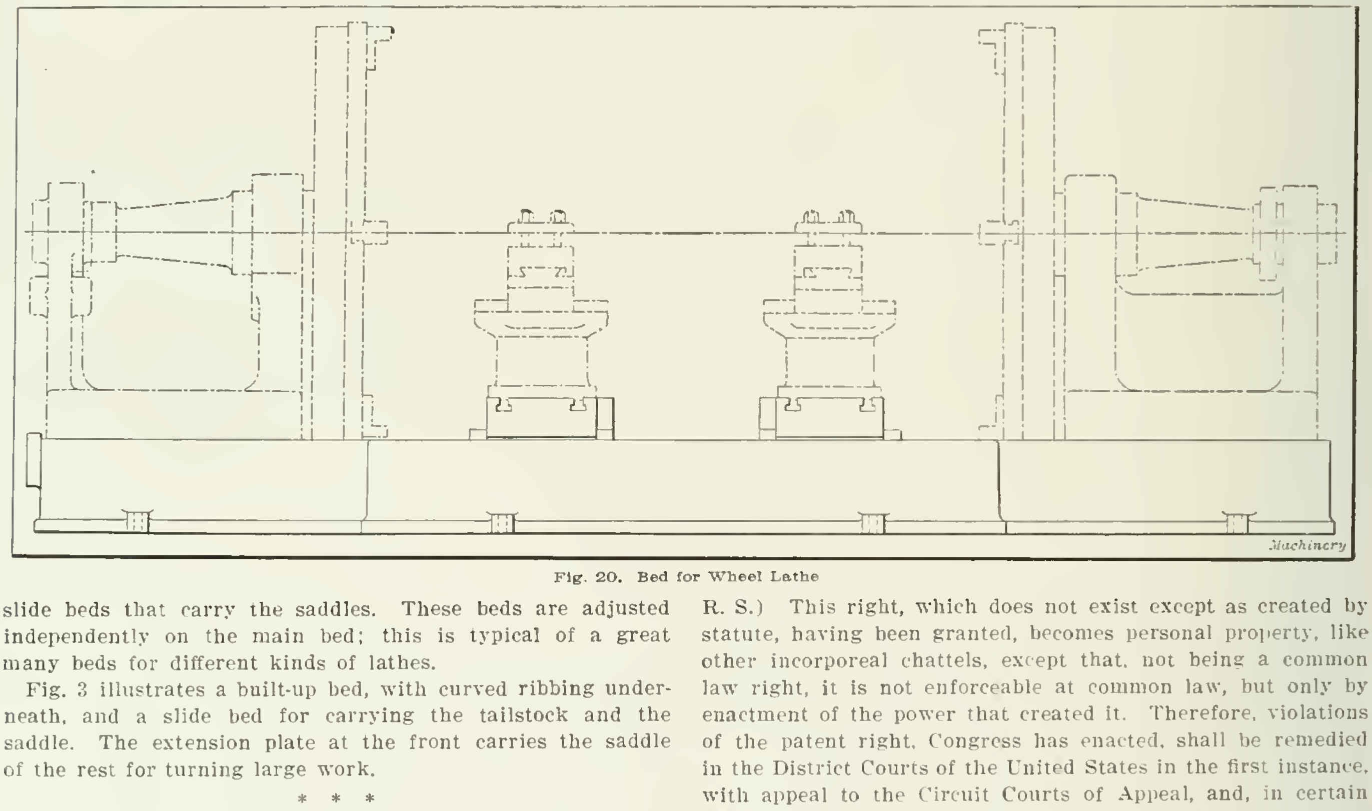

Fig. 20. Bed for Wheel Lathe

Fig. 3 illustrates a built-up bed, with curved ribbing underneath, and a slide bed for carrying the tailstock and the saddle. The extension plate at the front carries the saddle of the rest for turning large work.

* * *

The laws passed by the legislatures of several states prohibiting the use of common drinking cups have created a large demand for collapsible and other forms of individual cups. Paper cups coated with paraffine are dispensed by automatic vending machines, the common cost being one cent each. But in many places it is not feasible to charge, although necessary to provide the sanitary cups. In order to provide for free distribution the cups must be made very cheaply. Automatic machinery has been developed which forms cups from paper disks, crimping the sides and forming a curved edge and coating them with paraffine at the rate of sixty a minute. The cups are packed automatically in cartons and human hands do not touch them at any stage of the manufacture. These cups are sold in sealed boxes containing ten for family use, at five cents. They are sold much cheaper in quantities to theaters, hotels, clubs, hospitals, etc.

ACTUAL AND CONSTRUCTIVE PATENT INFRINGEMENT—1

By E. D. SEWALL

When entering upon the investigation of a subject at a point in its advanced development, there is a chance that one may reach erroneous conclusions by overlooking some fundamentals amid the intricacies of detail. It is well, therefore, to revert to the primer of patent law in seeking to discover what infringement of a patent is.

The Constitution authorizes Congress to secure for limited times to inventors the exclusive right to their discoveries. As ideas are not susceptible of exclusion from the apprehension of men who chance to perceive them, and as notions of natural justice do not admit of restraining the individual from putting the ideas he receives to innocent use, the exclusive right to a discovery can be secured only by affording inventors the aid of the public force to restrain all others over whom its authority extends from making practical use of the inventor's ideas.

This provision of the Constitution, Congress has sought to carry into effect by enacting that the patent right shall be conferred upon any person who has invented or discovered any new and useful art, machine, manufacture or composition of matter, under certain conditions, among others that he shall disclose clearly in writing the nature of his invention, and shall particularly point out and distinctly claim the part, improvement or combination which he claims as his invention or discovery; thereupon the government shall grant to him this right by an instrument under seal known as letters patent, for the term of seventeen years. (Sections 4886 and 4888, U. S. R. S.) This right, which does not exist except as created by statute, having been granted, becomes personal property, like other incorporeal chattels, except that, not being a common law right, it is not enforceable at common law, but only by enactment of the power that created it. Therefore, violations of the patent right, Congress has enacted, shall be remedied in the District Courts of the United States in the first instance, with appeal to the Circuit Courts of Appeal, and, in certain eventualities, in the Supreme Court of the United States, on *certiorari*. Damages for the infringement of any patent may be recovered by action on the case in the name of the owner of the patent; or injunctions may be had according to the course and principles of courts of equity, to prevent the violation of any right secured by a patent.

Nature of Patent Rights

The right secured by a patent, then, is an incorporeal right—a right of action in the U. S. courts to restrain others from making profitable use of the invention without the owner's consent, or for recovering damages for unauthorized use. It extends no further. All other rights in the property that may result from the invention remain to be adjudicated in the same manner as if this right created by Congress did not exist.

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Of the nature of a patent right, the Supreme Court of the United States has thus spoken:

> "Whenever this court has had occasion to speak, it has decided that an inventor receives from a patent the right to exclude others from its use for the time prescribed in the statute." (Marshall, C. J., Grant vs. Raymond, 6 Peters, 243.)
>
> "The franchise which the patent grants consists altogether in the right to exclude every one from making, using or vending the thing patented, without the permission of the patentee. This is all he obtains from the patent." (Taney, C. J., Bloomer vs. McQuewan, 14 How., 539.)
>
> "The right to sell [the patented manufacture] was not derived from the letters patent, but it existed and could have been exercised before they were issued, unless it was prohibited by valid local legislation. All which they primarily secure is the exclusive right in the discovery. That is an incorporeal right, or in the language of Lord Mansfield 'a property in a notion having no corporeal tangible existence.'" (Harlan, J., Patterson vs. Kentucky, 97 U. S., 501.)
>
> "Congress by its legislation made in pursuance of the Constitution has guaranteed to him [the patentee] an exclusive right to it [the invention] for a limited term; and the purpose of the patent is to protect him in this monopoly, not to give him a use which save for the patent he did not have before, but only to separate to him an exclusive use." (Brewer, J., U. S. vs. Bell Telephone Co., 167 U. S., 224.)

Thus Mr. Justice Miller before elevation to the Supreme Court:

> "It is to be observed that no constitutional or statutory provision of the United States was or ever has been necessary to the right of any person to make an invention, discovery, or machine, or to use it when made, or to sell it to some one else. Such right has always existed and would exist now if all patent laws were repealed. It is a right which may be called a natural right, and which so far as it may be regulated by law belongs to ordinary municipal legislation, and it is unaffected by anything in the Constitution or patent laws of the United States." (*In re* Brosnahan, 18 Fed. Rep., 62.)

Proper Tribunals for Cases Involving Patented Articles

Remedies for wrongs against patented property, then, may be had by the same procedure and in the same tribunals as remedies for wrongs against unpatented property; but wrongs against the "property in the notion," the right of exclusion, which is an artificial right created by Congress, may be remedied only in the way and by the tribunals designated by Congress. When one patents an invention, he has all the rights and remedies respecting the invention that he had before, and when these rights are invaded his remedy is at common law or equity; but when the government grants the patent, it undertakes, figuratively, to police the industrial territory reserved to him, by preventing others from making, selling and using the patented product without his consent. If no one else attempts to make, use or sell the patented product, the benefits derived from the invention are not augmented by reason of the patent, and wrongs to the property of the inventor may be redressed by the ordinary machinery of the law; but when others seek without authority to make, use and sell that product, thus encroaching upon the reserved territory, the government steps forward and, as it were, ejects them.

A patent right is inconsistent with the natural rights of individuals. It often denies to others the common right of utilizing the products of their independent inventions. Hence, as the patent law confers a privilege that is in derogation of natural right, it should be invoked only to enforce the right that it creates, namely, to restrain others from making, using, and vending without the patentee's consent that which the claim of the patent defines as the thing patented. "The taking away of rights is not favored by the law. Therefore, statutes in derogation of common right are in the construction kept within their express provisions." (Bishop on Written Laws, Sec. 19.)

There is therefore a distinct kind of property in the patent right, injuries to which will be remedied by the U. S. courts in a patent suit; and another distinct kind of property in the industrial process or product to which the patent right pertains, injuries to which will be remedied in the state or other courts wherein violations of rights relating to personal property generally are adjudicated. Each of these two kinds of property rights should be adjudicated in the particular tribunals provided and under the particular laws relating to them respectively, lest there be danger of confusing the two rights, and a failure of justice by reason of the application, to one right, of the law that was designed to have application solely to the other.

Infringement of Patents

Infringement, generally, is a violation of a legal right. Infringement, in the language of the patent law, is a violation of the patent right only, and the term is not appropriate, in speaking of patents, to an invasion of those rights which the patentee has aside from the patent. The only persons whose rights can be infringed under the patent law are the owners of the whole or a part of the patent; they are the patentees, and no one else may bring an action for infringement. The owner may be the inventor, or one or more persons to whom he has assigned the patent. A purchaser or lessee of a patented article, or one who has a permission to make, use and vend the patented thing, owns no interest in the patent, and has no power to sue for infringement.

Infringement of a patent right consists usually in making the thing patented without the consent of the patentee, and in selling or using a thing so made, or in so using a patented process. The thing patented is that which is defined in the claims. The claims measure the invention. "As the inventor is required to enumerate the elements of his claim, no one is an infringer unless he uses all the elements." (Cimriotti Unhairing Co. vs. American Fur Co., Day, J., 198 U. S., 399.) If one makes, uses or vends without permission the exact combination claimed in a valid patent, he infringes the patent; also, if without authority he makes, uses or vends that which contains as a part thereof the exact combination claimed; but if he takes only a part of that combination, he is not an infringer.

Contributory Infringement

There is, however, a wrong to patentees known in the patent law as contributory infringement. Prior to 1896 the text books and legal precedents taught that contributory infringement consisted in conspiring with another, or abetting or wilfully aiding another, to make, use or vend an instrument, or to use a process defined in the claims of a valid patent without permission from the patentee.

> "An infringement of a patent is a tort analogous to trespass or trespass on the case. From the earliest times all who take part in a trespass either by actual participation therein or by aiding and abetting it, have been held to be jointly and severally liable for the injury inflicted. There must be some sort of concert of action between him who does the injury and him who is charged with aiding and abetting, before the latter can be held liable. When that is present, however, the joint liability of both the principal and the accomplice has been invariably enforced." (Thomson-Houston Co. *vs.* Ohio, 80 F. R., 712, Taft, J.)

Necessarily, an act of contributory infringement presupposes an act of principal infringement by another. One may become liable for contributory infringement by assisting in constructing or renewing a patented combination, by furnishing to one who has no authority from the patentee some of the necessary parts with intent that they shall form a part of the infringing thing. These parts may be common, unpatentable things of general utility, or they may have no known use except in the patented combination. If the parts are of general utility, the person furnishing them must be proven to have had knowledge that they were to be used in constructing the patented thing, otherwise he is no infringer. (Snyder *vs.* Bunnell, 29 F. R., 47; Bliss *vs.* Merrill, 33 F. R., 39.) If they have no use except in the patented combination, the infringing purpose of the person furnishing them will be presumed, and he will be deemed a contributory infringer without other proof. (Wallace *vs.* Holmes, 9 Blatch., 65; Thomson-Houston Co. *vs.* Ohio, *supra;* Alabastine Co. *vs.* Payne, 27 F. R., 559; Leeds & Catlin Co. *vs.* Victor Talking Machine Co., 213 U. S., 318, McKenna, J.)

The law of contributory infringement, in substantially the circumstances noted above, must be deemed to be settled, since the U. S. Supreme Court has upheld it in the talking machine case above cited, wherein defendant, charged with making non-patented record disks of a kind particularly adapted to be used as a part of a patented combination comprising the record disk and a reproducing stylus in defined relation thereto, was held to be a contributory infringer. In the opinion it was said:

"A combination is a composition of elements . . . It is, however, the combination that is the invention, and is as much a unit in contemplation of law as a single or non-composite instrument. Whoever uses it without permission is an infringer of it. Whoever contributes to such use is an infringer of it . . . It can make no difference as to the infringement or non-infringement of a combination that one of its elements or all of its elements are unpatented."

Complicated Questions of Contributory Infringement

Although the law as above set forth is believed to be just, yet nice discrimination is often required to avoid stretching the law to restrict the common right of freedom of trade. Shall not only he who purposely makes and supplies the record disk to be assembled by an infringer with the motor and stylus to make a patented instrument, be liable as a contributor to the infringing act, but also he who furnishes the raw materials with knowledge that they are to be used to make such record disks?

Not only may infringement by a principal infringer be aided by one supplying necessary parts of the patented thing, but also by one providing an instrument with the purpose that it shall be used in practising a patented process without the consent of the patentee. Thus where a filter was furnished with the intent that it should be used in carrying out a patented process of filtering beer without the patentee's consent, and it was so used, the one furnishing the filter was held liable for contributory infringement of the process. (Loew Filter Co. *vs.* German-American Filter Co., 107 F. R., 949.) In such a case it must affirmatively appear that the one furnishing the instrument was knowingly a direct accomplice of the principal infringer, and the question is to be decided upon the particular facts of the case, for it cannot be deemed settled that the seller of a common mechanic's tool is guilty of infringement because he knows it is to be used in aiding to practise a patented process.

Case of the Commercial Acetylene Co. vs. Autolux Co.

One may also become liable as a contributor by supplying to a principal infringer an instrument adapted to aid in making a patented article. Here also the liability of him who supplies the instrument depends upon proof of intent to aid the principal in invading the patent right; and the circumstances that the instrument is a common one of general utility, or on the other hand of utility only in the manufacture of the patented product, may have effect one way or another on the liability of him charged as an accomplice. In the case of Commercial Acetylene Co., *et al., vs.* Autolux Co., 181 F. R., 387, the complainants were the owners of patents granted to Claude and Hess for a package containing acetylene gas. Among the claims of the patents is the following: "A gas package comprising a holder or tight vessel; a contained charge of acetone; a volume or body of gas dissolved by and compressed and contained within the solvent, and a reducing valve applied to an opening extending to the interior of the holder above the level of the solvent." The invention was one of great commercial value. It provided a solution of the problem of safely storing acetylene in large or small quantities in condition for use as desired. The patent was not for a special tank but for a package of gas held under pressure in solution. An exclusive license to make, use and sell this package in the United States had been accorded to the Prest-O-Lite Co.

According to the text of the decision, one of the original officers and stockholders of the Prest-O-Lite Co. severed his relation therewith for the purpose of establishing a plant for the manufacture of an infringing device, and also for recharging the tanks made by the Prest-O-Lite Co. when the gas had been consumed by the individual users. He was actively engaged in committing direct infringing acts until enjoined by an order of the court, on final hearing, from making the infringing device, which was known as the autogas tank, or committing any other infringing act. The party thus enjoined and his associates then organized a new corporation under the name of the Autolux Manufacturing Co. for the purpose of manufacturing an apparatus known as a high pressure generator, which, the court said, had been extensively used in recharging Prest-O-Lite gas packages and other gas tanks used on automobiles.

Now, the Claude and Hess patents contained claims for a receptacle containing gas dissolved in acetone. When the gas had been consumed the combination was destroyed, and whoever again assembled or conspired with another to assemble that combination without the patentee's consent made the patented article and infringed the patent. The receptacle alone was not patentable, but only the receptacle containing the gas in solution. The recharging of the package was as much a making of the patented article as would be the reconstructing of a patented sewing machine, which had been worn out, by taking the unpatentable table, drive wheel, and treadle, and assembling therewith new parts to make a new machine. Although the court made the statement that the generator supplied by defendants was extensively used in recharging Prest-O-Lite *and other gas tanks used on automobiles*, it must have satisfied itself that the maker of these generators intended them to be used in reconstructing Prest-O-Lite gas packages and was guilty as an accomplice of the person who actually procured the recharging of such tanks without the permission of the Prest-O-Lite Co., thus deriving profit by aiding others to do that which the patent reserved to the patentees and their assigns and licensees.

The fact, assumed to have been proven, that the defendant company actively and directly assisted others in reproducing a patented article, was one ground of the decision in the Prest-O-Lite case, and appears to be in accordance with the long established principles of contributory infringement. Another ground of the decision is based upon a more recent extension of the doctrine, to be referred to later.

Summary

It appears, therefore, to be settled that not only he who makes, uses and sells a patented thing without permission from the patentee infringes the patent and may be sued under the patent laws, but also he who actively and knowingly assists in the unauthorized making of a patented thing; and probably also that he who actively and knowingly assists another person in selling or using a patented thing that has come into the possession of that other person *against the permission of the patentee* may be likewise liable under the patent laws. The fact that not all acts that aid more or less directly or indirectly in infringement by another can be deemed to be acts of contributory infringement does not affect in any way the point under consideration, which is that such acts as invade the *patent right* only, raise any question under the patent law. If the allegations of fact are that the act complained of invades the monopoly—narrows the reserved market of the patentee by aiding in the unauthorized manufacture, sale and use of the thing patented, and which the patent reserved to him—the case made is one to be tried under the patent law, because the common law and laws of the states make no provision for property in a right to restrain others from making and dealing in useful commodities, but only the patent laws.

Thus far it has been sought to show, no doubt with some repetition, what right a patent confers, when it is infringed, and where the remedy for infringement lies. It has also been asserted that rights regarding patented property which do not bring into question the patent right to exclude others, have the same adequate remedies under general law as other property rights, and it has been intimated that the adjudication of the one kind of right in the courts provided for adjudicating the other, or the attempt so to do, may result in the inappropriate or inadequate remedy, or none at all.

The Questions to be Decided in a Patent Case

Very briefly may be discussed the tests that may be applied to determine whether an alleged injury to a patentee's rights is an infringement of the patent right. A charge of infringement of a patent puts in issue either (1) the title of the patentee; (2) the validity of the patent; or (3) the identity of the alleged infringing product or process with that claimed in the patent. One charged with infringement may defend by (1) denying the validity of the patent; (2) denying the title of the patentee; (3) denying the identity of the thing alleged to be made, sold or used by him with that defined in the claims of the patent. If, on the other hand, the alleged infringer concedes all these, but alleges an agreement with the patentee or his nominee whereby he was permitted to use the patented thing, a question of contract is raised out of the violation of which the wrong to the patentee, if any there be, proceeds, and which the ordinary law of contract is adapted to remedy. (Wilson *vs.* Sanford, above; Dale Tile Co. *vs.* Hyatt, 125 U. S., 46, Gray, J.)

If one surreptitiously destroys a patented still, because he deems the manufacturer of alcoholic liquor immoral, he does not thereby deny the title of the patentee, the validity of the patent, nor the identity of the still destroyed with that which is patented. The wrong complained of raises a question for the ordinary criminal law to deal with. So, if the patentee of a butter substitute seeks to sell it in a state the laws of which make the sale of a butter substitute of that character a penal offense, the action of the state in preventing the sale thereof is not a denial of the title of the patentee, the validity of the patent, nor the identity of the substance sold with the patented substance, but is a criminal prosecution and one in which the validity of the laws of the state may be put in issue. (*In re* Brosnahan, above; Patterson *vs.* Kentucky, above; Webber *vs.* Virginia, 103 U. S., 344, Field, J.)

If a patentee makes a shipment of patented articles and they become damaged *en route* by the fault of the common carrier or his agents, no question of title, validity of the patent, or identity arises, the injury being a simple tort cognizable in the state courts, or in the federal courts solely on the ground of amount involved, diversity of citizenship, or interstate commerce. If a patentee of a useful article makes a contract with a manufacturer of an inferior article having a similar use, whereby the patentee agrees for a money consideration not to place his article on the market, or license others so to do within the state wherein the manufacturer of the inferior article is situated, no question affecting the validity, ownership or scope of the patent is raised, and the patent law has no dominating influence such as would prevent the courts of the state holding the contract to be one in restraint of trade, and imposing penalties accordingly. (Blount Mfg. Co., *vs.* Yale-Towne Mfg. Co., 166 F. R., 555.)

[The Supreme Court of the United States handed down a decision March 11 which apparently will have far-reaching consequences in furthering monopolistic control of patented apparatus by the makers. By a decision of four to three it was held that the maker of the Dick patented rotary mimeograph machine has the right to restrict the use of the machine to the supplies furnished by the maker. Chief Justice White in the dissenting opinion pointed out how dangerous the decision may be:

> "My reluctance to dissent, is overcome in this case: First, because the ruling now made has a much wider scope than the mere parties to this record, since, in my opinion, the effect of the ruling is to destroy in a very large measure the judicial authority of the states by unwarrantedly extending the Federal judicial power.
>
> "Second, because the result just stated, by the inevitable development of the principle announced, may not be confined to sporadic or isolated cases, but will be as broad as society itself, affecting a multitude of people and capable of operation upon every conceivable subject of human contract, interest, or activity, however intensely local or exclusively within state authority they otherwise might be.
>
> "Third, because the gravity of these consequences which would ordinarily arise from such a result would be greatly aggravated by the ruling now made, since the ruling not only vastly extends the Federal judicial power as above stated, but as to all the innumerable subjects to which the ruling may be made to apply, makes it the duty of the courts of the United States to test the rights and obligations of the parties not by the general law of the land, in accord with the conformity act, but by the provisions of the patent law, even although the subject considered may not be within the embrace of that law, thus disregarding the state law, overthrowing, it may be, the settled public policy of the state and injuriously affecting a multitude of persons."

In view of the gravity of the decision which was made by four out of seven judges, whereas a full court consists of nine judges, the effort probably will be made to have a rehearing of the case before a full bench. It is generally conceded that the decision may lead to the creation of monopolies of the most oppressive sort.—Editor.]

* * *

To furnish good lockers is the duty of the institution—to take good care of them is the duty of the men using them.

BRASS ENGRAVING BY MACHINERY

By CHESTER L. LUCAS*

Among the many operations now being done by machinery instead of by hand, the engraving of brass signs and plates is of more than passing interest. The old way of making brass signs was to chip out the letters by hand, the quality of the work depending wholly upon the skill of the workman. Naturally the progress was very slow. At the present time many brass signs are etched, and a considerable number are cut by machinery. Another large field for brass engraving by machinery is in the making of printing plates for printing wooden box-sides. Not only has the introduction of engraving machinery resulted in faster work, but it has made it possible to do this work without the employment of skilled engravers.

Fig. 2 shows a Wesel routing machine in use at the Schwerdtle Stamp Co., in Bridgeport, Conn. The machine is shown at work on a brass sign, the work being more clearly shown in Fig. 3. The most essential features of a machine of this kind are that straight cuts can be quickly made either vertically or horizontally; that the cutter spindle rotates at a high speed without vibration; and that the cutter can be easily moved to any part of the work, there still being no play between the connecting joints. In this machine, a pulley on the vertical driving shaft transmits motion to the two-step cone pulley *A*. This pulley is mounted upon the swinging arm *B*, and its position is adjustable to allow for slight variations in belt lengths. From the adjustable slide *C* a second arm extends at right angles to arm *B*; this second arm is free to swing in the same plane as the first arm, and at its extreme end the cutter spindle is mounted.

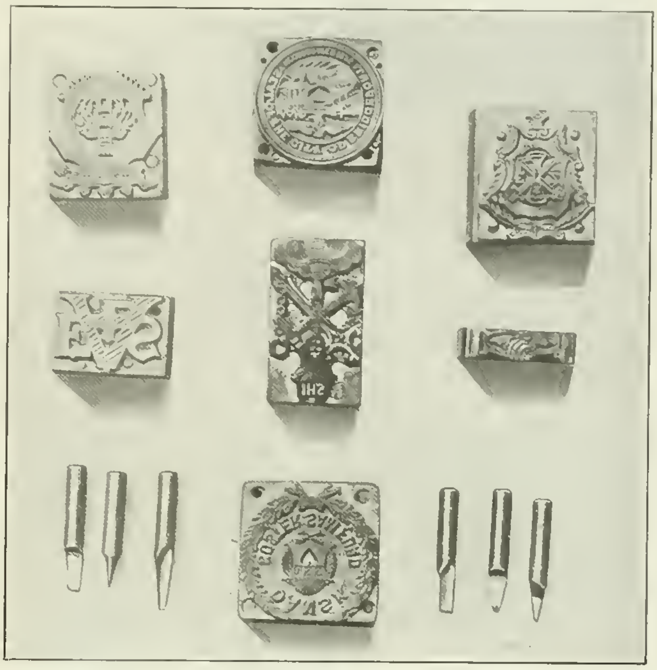

Fig. 1. Brass Dies for Bookbinders' Use and Cutters used for Engraving

The cutter spindle and adjacent parts are shown on a larger scale in Fig. 3. The cutter spindle (*D* in Fig. 3) receives its motion from the belt that passes over pulley *E*. This pulley is located at the center of the cutter spindle, thus equalizing the pull on the bearings. As the spindle revolves at the rate of 16,000 R. P. M., it is essential that the bearings should be good. The cutter *F*, or "bit," as it is called, is held in the end of the spindle. Just above it is a small aluminum fan *G* that blows the chips away from the cutter, leaving the lines to be followed in plain sight.

It will be noticed that the cutter spindle is mounted in a slide *H* that may be raised or lowered to accommodate thick or thin plates, or long or short cutters. This slide is operated by means of screw *I*. To supply artificial light, when needed, the two incandescent lights are provided; the use of two lights, on opposite sides of the cutter, eliminates the shadows. The cutter-head is supported by means of a bar *K*, resting upon a small grooved roll on rail *L*, Fig. 2. By means of hand-rod *M*, the cutter is moved to and from the operator to make the perpendicular lines of the letters, and by moving bar *K* along the rail, the horizontal cuts are made. A bracket that is hidden by pulley *A* guides the horizontal movements of the cutter. Handwheel *N* is tightened only when the routing machine is used as a radial arm machine, in which case cuts may be made in any direction.

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* Associate Editor of Machinery.

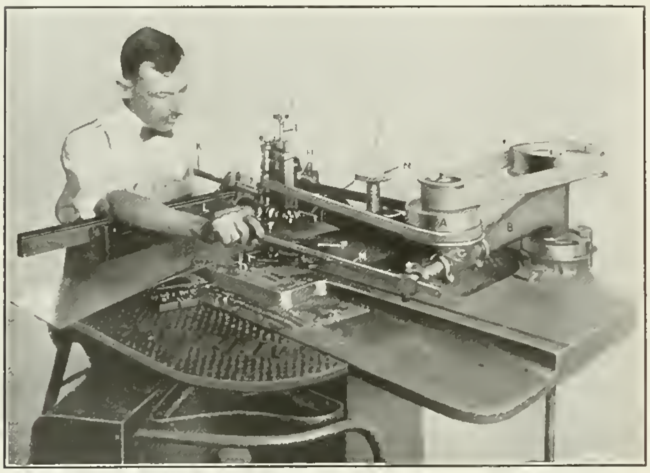

Fig. 2. Wessel Routing Machine at Work on a Brass Sign

The cutter-head is raised by a foot treadle when necessary to jump from one letter to another, and the machine is started and stopped by another foot treadle. The work is held in place by clamping jaws, one of which is shown at *O*. This jaw is movable, and is tightened against the edge of the plate by handwheel *P*.

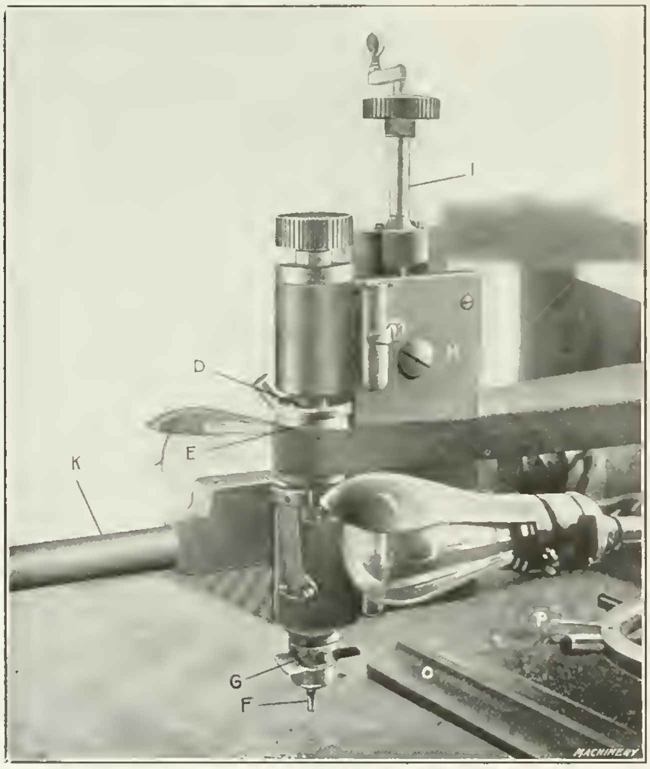

Fig. 3. Cutter-head at Close Range

The work of an engraving machine is not confined to large signs and plates, but is also utilized in getting out brass dies for bookbinders' use, similar to those shown in Fig. 1. It is impossible to finish completely such work as these dies on the machine, but the bulk of the metal in and around the design may be removed to good advantage. Some of the cutters used on this class of work are also shown in this illustration, most of them being of the one-lip variety, as this style of cutter is strong and has plenty of chip-room.

On work of this nature, the skilled engraver is still required to finish up the work, truing up the lines and cutting the parts that it is impossible to finish on the machine. Engravers' tools of various shapes are used for this part of the work. Fig. 4 shows an engraver, Mr. Louis F. Schwerdtle, finishing up brass dies. The work is held in a ball vise, made especially for engravers' use. Two jaws *B*, which swivel, are mounted upon the secondary jaws *C*. The jaws *B* contain numerous small holes in which pins may be placed to grip the work. These pins are usually shaped so as to grip the work without marring it. The secondary jaws *C* are located and held in place by large dowel pins upon the primary jaws *D*, which latter are operated by the right- and left-hand screw *E*, working in base *F*. It will be seen that this vise is doubly useful, for when not in use on small work, as shown, the vise may be utilized on large die work, by simply pulling off the secondary jaws *C*, which allows the primary jaws *D* to be used independently.

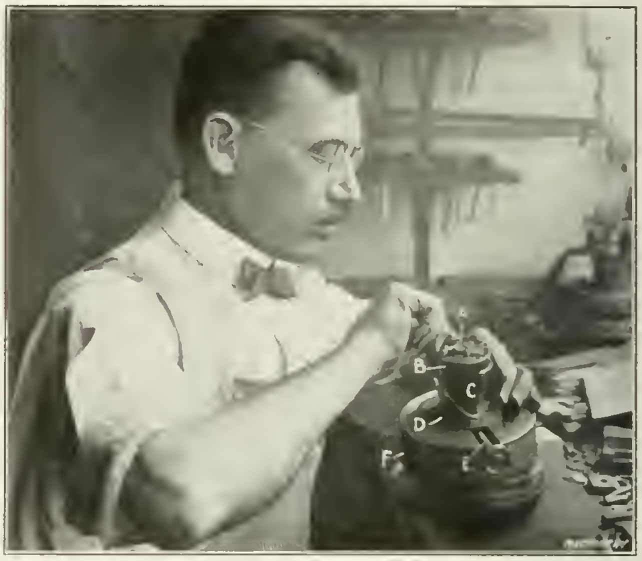

Fig. 4. Finish-engraving Small Dies

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BOILING POINT OF METALS

In a paper presented at a meeting of the Faraday Society, London, England, Mr. H. Greenwood gave the boiling point of various metals at atmospheric pressure, as follows:

	Degrees F.
Antimony	2625
Bismuth	2550
Copper	4200
Lead	2775
Magnesium	2050
Silver	3500
Tin	4125
Aluminum	3250
Chromium	4000
Iron	4450
Manganese	3450

* * *

ARMOR PLATE VS. PROJECTILES

The competition between increased thickness and quality of armor plate versus big guns has come to a point where it is very evident that the big gun is victorious. The armor carried by battleships of the Dreadnaught type cannot prevail against the latest guns carried by the same ships. The latest guns made by the British navy and used on the *Orion* and the *Lion* fire a 1250-pound projectile. When it is remembered that an 850-pound projectile will pierce 17 inches of the best Krupp steel, it is evident that only an excessively thick armor would insure a vessel against the attacks of these new heavy guns. It, therefore, seems likely that the man-of-war of the future will carry less heavy armor, protection being obtained instead by high speed. This idea, in fact, has been carried out in the British navy in the battle-cruiser *Lion*, in which high speed, heavy guns and light armament has been consistently adhered to throughout the design.

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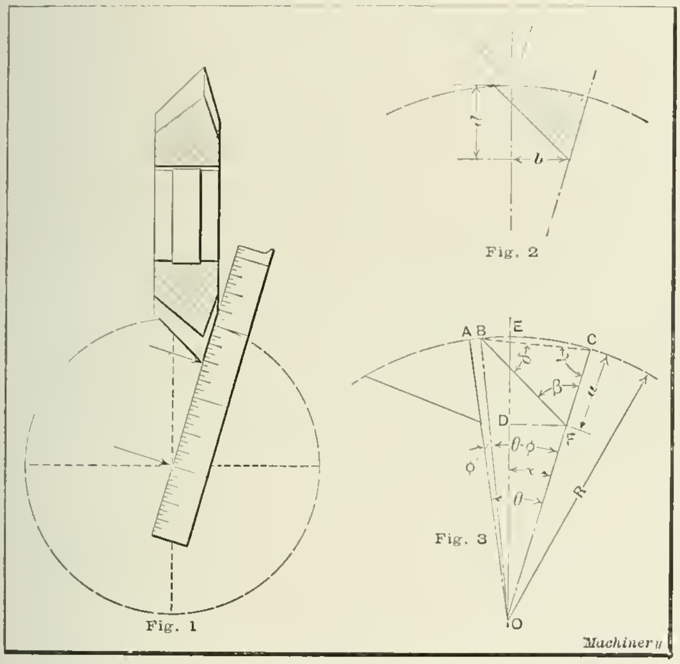
* For a complete description of the engraver's vise see MACHINERY, June, 1909, "Making an Engraving Block."

SETTING DOUBLE-ANGLE FLUTING CUTTERS*†

By GEORGE W. BURLEY‡

The ordinary method of setting double-angle milling cutters when fluting spiral mills and reamers is only an approximate one, and depends entirely upon the skill of the milling machine operator for its success. This method is indicated in Fig. 1. As will be seen from this illustration, two operations have to be performed simultaneously: the cutter has to be so arranged with respect to the center or axis of the blank that the edge of the scale or rule laid alongside the cutter, as shown, passes through the blank-axis, and that the distance from the center to the point of the cutter is a definite amount. This definite amount is a predetermined quantity, and is equal to the difference between the radius of the cutter or reamer to be fluted and the depth of the flute, which, of course, are elements in the design of the cutter or reamer.

It is fairly obvious that errors can readily be made; and it is not inconceivable that angular errors up to 1 degree and linear measurement errors up to 1-64 inch, or even greater, are being continually made. When this is the case, the finished cutters or reamers are not the same as those originally designed. By the method to be described in the following, however, it is possible to set the fluting mill with respect to the cutter blank without recourse to the use of a rule, either for the purpose of making linear measurements or obtaining correct angularity. The method involves the setting of the cutter central (that is, with the angular point of the cutter exactly over the axis of the blank) and at a distance from the axis equal to the radius of the blank, as is indicated by the dotted lines in Fig. 2. This is done in the usual way. To get the off-set, the table is moved transversely an amount equal to b (Fig. 2), and raised an amount equal to d. These distances vary considerably, the exact values depending upon the radius of the blank, the number of flutes to be cut in it, the width of land, and the angles of the fluting cutter; but, whatever these distances are, they can be obtained on the machine directly from the micrometer dials on the feed-screws. The values of d and b for any particular case can be calculated in the manner indicated below, or taken directly from the accompanying Data Sheet Supplement.



Figs. 1 to 3. Finding Formulas for Determining Setting of Double-angle Fluting Cutters

Let R = the radius of the cutter to be fluted.

N = the number of teeth to be cut in it.

W = the width of the land of the tooth.

θ = the angle subtended at the center of the cutter by any one tooth.

a = the depth of each tooth measured radially.

α = the small side-angle.

β = the included or total angle of the angular fluting cutter.

R is the radius of the finished cutter, and as the blank is invariably left a little large, corrections, as will be indicated later, may have to be made for d, but not for b; usually, it will be found that the correction is a very slight one.

$$\theta = \frac{360}{N} = AOC \text{ (Fig. 3)};\ EOC = \alpha, \text{ and } BFC = \beta.$$

The width of the tooth-land, as usually defined, is measured on the face formed at the back of the cutting edge by the grinding wheel, and it is, therefore, a straight-line quantity, whether the land is formed by a cup-wheel (forming a flat land) or a disk wheel (forming a concave land). This is, therefore, not exactly the quantity AB (Fig. 3), measured as an arc of the circle, but the difference between the two is usually so slight as not to be worth consideration from a practical point of view. As a matter of fact, the writer has found that the difference in the most extreme cases amounts to only three or four thousandths inch, an amount which, under the circumstances, is negligible. Hence, in what follows, we shall assume that the actual width of the land and the arc AB are equal. Let the width of the land and, therefore, the length of the arc AB be equal to W. Then angle ϕ is the angle subtended by arc W at the center of the circle, and can, therefore, be determined by first calculating the angle in radians or fractions of a radian, and then consulting a table of angles for the equivalent angle in degrees. If no such table is handy or immediately procurable, the angle in degrees can be obtained as follows:

$$\phi \text{ (in degrees)} = \frac{W}{R} \times 57.296 \qquad (1)$$

From this angle and the angle θ, the angle $(\theta - \phi)$ can be obtained. This angle is the one which is subtended at the center of the circle by the chord BC; therefore,

$$\text{Angle } BCO = \gamma = \left(90 - \frac{\theta - \phi}{2}\right)$$ The angle CBO is also equal to this. Hence,

$$\text{Angle } CBF = \delta = 180 - (\beta + \gamma) = 180 - \left(\beta + 90 - \frac{\theta - \phi}{2}\right)$$

$$= 90 - \left(\beta - \frac{\theta - \phi}{2}\right)$$

Let the length of the chord $BC = cR$, c being the length of the chord of a unit-radius circle which subtends the angle $(\theta - \phi)$ at the center. Then,

$$\frac{cR}{\sin\beta} = \frac{a}{\sin\delta}; \text{ therefore,}$$

$$a = \frac{cR\sin\delta}{\sin\beta} = \frac{cR\sin\left(90 - \beta + \frac{\theta - \phi}{2}\right)}{\sin\beta}$$

$$= \frac{cR\cos\left(\beta - \frac{\theta - \phi}{2}\right)}{\sin\beta} \qquad (2)$$

From this expression, assuming any given data, the actual depth a of the flutes to be milled in the cutter blank can be calculated.

$$OF = (R - a)$$

$$= R - \frac{cR\cos\left(\beta - \frac{\theta - \phi}{2}\right)}{\sin\beta} = R\left\{1 - \frac{c\cos\left(\beta - \frac{\theta - \phi}{2}\right)}{\sin\beta}\right\}$$

Now, d (Fig. 2) = ED (Fig. 3) = $R - OD = R - OF\cos\alpha$

$$= R - R\left\{1 - \frac{c\cos\left(\beta - \frac{\theta - \phi}{2}\right)}{\sin\beta}\right\}\cos\alpha \qquad (3)$$

Usually the radius of the cutter or reamer blank is made a little larger (a few thousandths inch) than the finished cutter. Therefore, in actual practice,

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* With Data Sheet Supplement.

† For information on allied subjects, see "Milling Axial Teeth in Cutter and Reamer Blanks," March, 1912, and articles there referred to.

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$$d = R_1 - R\left\{1 - \frac{c\cos\left(\beta - \frac{\theta-\phi}{2}\right)}{\sin\beta}\right\}\cos\alpha \qquad (4)$$

where R_1 = the radius of the blank.

For any given values of $\frac{W}{R}$, N, α and β, the expression:

$$\left\{1 - \frac{c\cos\left(\beta - \frac{\theta-\phi}{2}\right)}{\sin\beta}\right\}\cos\alpha \text{ is a constant.}$$

Let this constant be represented by x; then,

$$d = R_1 - x\,R. \qquad (5)$$

This is the "elevation" formula, the values of x for a large number of combinations of $\frac{W}{R}$, N, α, and β, occurring in practice being given in the tables in the accompanying Data Sheet. The values of x for any combination not included in the tables can be determined as indicated above, or obtained by interpolation.

Further, b (Fig. 2) $= D\,F$ (Fig. 3) = the cross-movement required $= O\,F\sin\alpha = (R - a)\sin\alpha =$

$$R\left\{1 - \frac{c\cos\left(\beta - \frac{\theta-\phi}{2}\right)}{\sin\beta}\right\}\sin\alpha \qquad (6)$$

Again, for any given combination of $\frac{W}{R}$, N, α, and β, the expression:

$$\left\{1 - \frac{c\cos\left(\beta - \frac{\theta-\phi}{2}\right)}{\sin\beta}\right\}\sin\alpha \text{ is a constant.}$$

Let it be called y. Then $b = y\,R$. (7)

This is the "cross-movement" formula, the values of y for a large number of combinations being given in the accompanying Data Sheet beside those of x for the same combinations.

In regard to the values of $\frac{W}{R}$ which have been selected, the lower values are those usually chosen for milling cutters of medium and large sizes, the higher values being usually chosen for small cutters and reamers. If the value adopted in any particular design is not found in the tables, a simple calculation is all that is necessary for the determination of the corresponding values of x and y. By way of an illustration, let us suppose that 0.030 has been adopted as the value of $\frac{W}{R}$, and that $N = 20$ teeth, $\alpha = 12$ degrees, and $\beta = 60$ degrees. Then, upon consulting the accompanying tables, we find that when $W \div R = 0.020$, $x = 0.7750$, and $y = 0.1643$, and that when $W \div R = 0.040$, $x = 0.7908$, and $y = 0.1677$. By simple proportion, which in this case is sufficiently accurate, when $W \div R = 0.030$, $x = 0.7829$, and $y = 0.1660$. Therefore for the combination chosen,

$$d = R_1 - 0.7829\,R \text{ and } b = 0.1660\,R.$$

Dealing further with this case, let us assume that $R = 2.5$ inches, and that $R_1 = 2.503$ inches. Then,

$d = 2.503 - (0.7829 \times 2.5) = 2.503 - 1.9572 = 0.5458$ inch, and $b = 2.5 \times 0.1660 = 0.4150$ inch.

If this method of interpolating is not deemed sufficiently accurate, then the values of θ, ϕ, a, β and c can be determined for any particular case and introduced into Formulas (4) and (6). This method is, however, sufficiently accurate for all the ordinary cases that occur in everyday practice.

* * *

Solder which has been exposed to damp air for some time and has become more or less oxidized on the surface will not give as good results as fresh solder.

ROLL PRESSURE AND POWER REQUIRED FOR ROLLING MILLS

In a recent issue of *Stahl und Eisen*, Prof. M. Hermann gives some formulas for obtaining the roll pressure and power required for rolling mills. The *Engineering Digest* gives a summary of these formulas, which apply to the rolling of rectangular sections.

Let A = reduction of sectional areas per pass, in square inches,
k = limiting stress of lateral extension of metal, in pounds per square inch,
t = reduction of thickness of billet per pass, in inches,
D = roll diameter, in inches,
v = velocity of bar leaving rolls, in feet per second,
a = arc of contact of billet with the roll, in degrees.

Then $\cos a = 1 - (t \div D)$, from which $\sin a$ may be found.

Force required to draw billet through the rolls: $F = 2k\,A$.

Roll pressure in pounds: $$P = \frac{k\,A\left(1 + \frac{1-\cos a}{2}\right)}{\sin a}$$

H.P. (exclusive of power required to run rolls empty)

$$= \frac{F\,v\left(1.1 + 0.12\,\frac{P}{F}\right)}{550}$$

The value of k is difficult to determine; it increases with the number of passes, and decreases with increasing temperatures. Prof. Hermann gives a table taken from Puppe's experiments in which k (average) for the fifth to eighth passes ranges from 6940 pounds per square inch at 2237 degrees F., to 10,042 pounds per square inch at 2091 degrees F.; and for the ninth to seventeenth passes from 7965 pounds at 2237 degrees F., to 11,547 pounds at 2091 degrees F.; or the mean value of k for the 12 passes ranges from 7609 pounds at 2237 degrees to 11,265 pounds at 2091 degrees.

Example.—Let $A = 4$ square inches; $k = 8000$ pounds per square inch; $t = 0.75$ inch; $D = 20$ inches; $v = 6$ feet per second.

Then, $\cos a = 1 - (0.75 \div 20) = 0.9625$. Hence $\sin a = 0.2712$.
$F = 2 \times 8000 \times 4 = 64{,}000$ pounds.

$$P = \frac{4 \times 8000\left(1 + \frac{1 - 0.9625}{2}\right)}{0.2712} = 120{,}000 \text{ pounds, approximately.}$$

$$\frac{P}{F} = 1.88$$

$$\text{H.P.} = \frac{64{,}000 \times 6\,(1.1 + 0.12 \times 1.88)}{550} = 925\text{, approximately.}$$

* * *

It has been said of great scientists and engineers that they take nothing for granted and accept nothing as final simply because it has been done in a certain way since time immemorial. The really great engineer sees things as they ought to be rather than as they are, and that is the keynote of his preeminence in his chosen field. John Ericsson was one of those mechanical seers who are constantly at war with the mechanical superstition of their day. No better example could be cited to illustrate the fact that he would take nothing for granted, than a humorous incident from the days of his early childhood. When he was learning his alphabet, the shape of the letters did not suit his fancy and he had very decided opinions of his own about how they ought to be formed. He quickly perceived that the letters were symbols of sounds, and hence of arbitrary origin, and he forthwith proceeded to construct letters of his own design that to his mind possessed certain advantages of simplicity that were lacking in those of the time-honored Latin alphabet.

* * *

The estimate of Portland cement production in 1911, made by the United States Geological Survey, is 77,877,236 barrels. The production in 1910 was 76,549,951 barrels. The average factory price per barrel in 1910 was \$0.891, and \$0.867 in 1911.

THE TESTING OF SPIRIT LEVELS

By EQUA

In order to be able to produce accurate work on machine tools, it is necessary that they be set up level. Frequently there are complaints of the working of lathes and planers and the manufacturer is blamed for sending out a poor machine, when the real trouble is that certain parts of the machine are under a strain because of not having been set up level. Hence the spirit level is an important part of the equipment used by the machinist when erecting machinery.

The spirit level consists of a glass tube or cylinder, the inside of which is ground to a barrel shape. This tube is nearly filled with spirits of wine, ether, or some similar fluid, and hermetically sealed at each end. It is ordinarily spoken of in the shop as the "bubble," and is mounted in a brass tube having an opening at the top so as to make it possible to see the air space in the bubble or level. The brass tube is fixed to a block of brass or iron with suitable screws, so that it can be adjusted to be parallel to the base surface of this block.

It is readily understood that the chief part of the complete level is the glass tube, and the accuracy of the instrument depends entirely upon the curvature to which the inside of the tube has been ground. The makers of spirit levels use a device called a "level tester" for determining the accuracy of the bubble. A device of this kind is shown in the accompanying engraving, Fig. 1, the principle of the device being simply that upon turning the adjusting screw at one end of the bar or plate, this end is raised or lowered, so that the air space in the level will run from end to end. By means of this testing device it is possible to ascertain the curvature of the interior of the glass tube. The accuracy of a level is defined by saying that so many seconds of arc are equal to one-tenth or one-twentieth inch, etc. It will be seen in Fig. 1 that by turning the screw carrying the graduated disk we raise or lower the bar about the points *A* as pivots. The action of the screw is not the same as if the bar had worm teeth cut in it and the screw were a worm, but as the screw only has to move the bar through an arc of about two or three degrees, the error resulting from considering the action as that of a true worm and worm-wheel, is negligible. The adjusting screw on the testing device has 100 threads per inch and the graduated disk has 120 divisions. Each division should be equal to an angular movement of the bar about points *A* of one second. From this the distance from *A* to *B* can be determined. As the disk has 120 divisions and each division is equivalent to one second, one revolution of the screw will equal a movement of two minutes of the bar. The movement of the bar, however, is also equal to 0.01 inch for one revolution of the screw, and as there are 21,600 minutes in a complete circle, the total circumference of the circle having point *A* for a center and the distance *AB* for radius must be 10,800 × 0.01 = 108 inches. This circumference corresponds to a diameter of 34.377 inches and a radius of 17.188 inches, which is then the distance between *A* and *B*. It will be seen that for the accuracy of the device it is highly important that this distance be exact.

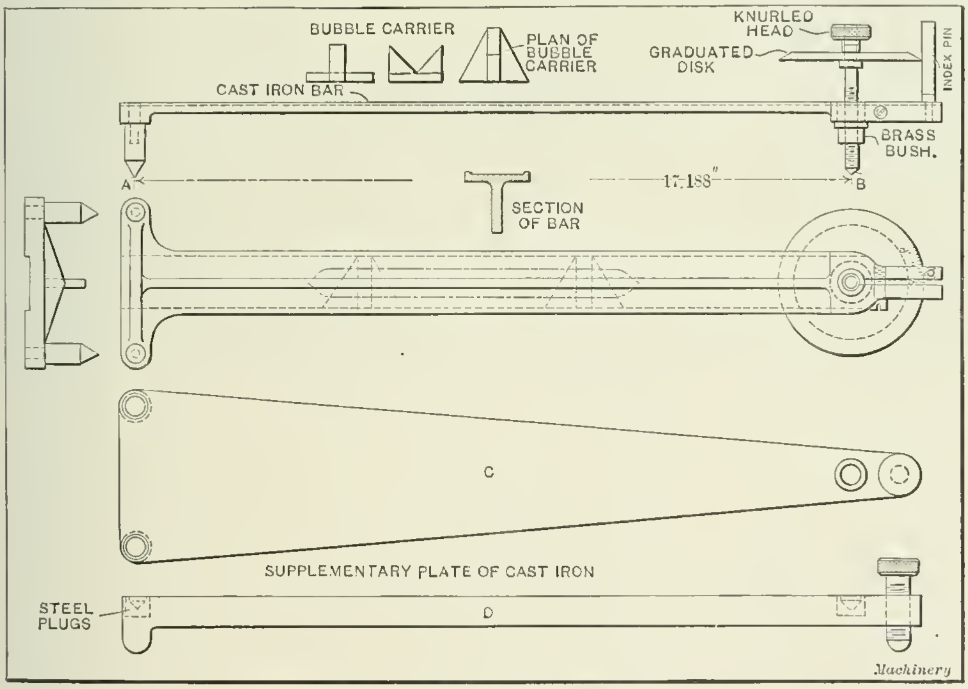

Fig. 1. Device for Testing Spirit Levels

With a first-class testing device a supplementary plate having a screw of coarser pitch than that already mentioned is also provided. This supplementary plate is shown at *C* and *D* in Fig. 1. One of the purposes of this plate is to enable the testing device to be quickly adjusted, and another object in view is to test the accuracy of the fine pitch screw. Suppose, for example, that we wish to test the screw. We place a level on the test-bar, set the graduated disk at zero, place the testing device on the supplementary plate, and by means of the coarse screw we bring the air space near the center, carefully noting its location. Then we turn the fine screw half a revolution or 60 divisions and find that the air space has moved, say, 12 divisions. Then by means of the coarse screw we bring the air space carefully back to its first place, and then turn the fine screw another half a revolution or 60 divisions in the same direction and note how much the air space has moved. Should it have moved only 11½ divisions, for example, we know that the lead of the screw or its point is slightly out of true. This test should be carried out over various parts of the screw, and if it is found that one half of a revolution is slightly finer than the other half, there is nothing to do but to take the average of the error and proceed with the calculations on this basis. Of course it is still better to get a new screw, if one that is perfectly correct can be obtained.

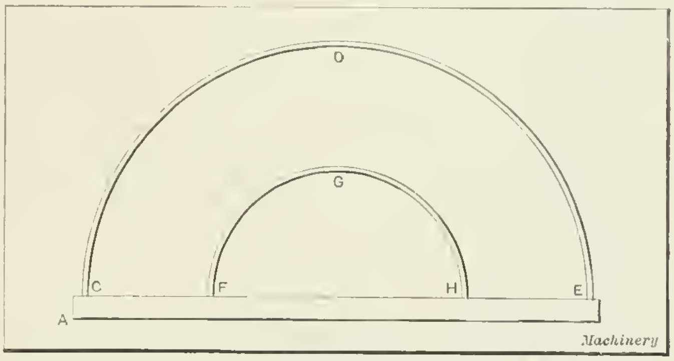

Fig. 2. Diagram illustrating Effect of Curvature on Sensitiveness of Level

When using the testing device it must be placed on a very firm foundation, free from vibration. The level to be tested is placed on the bubble carriers and allowed to come to rest. Should the bubble have been held in the hands just before putting it on the testing device, a few minutes must be allowed for the cooling of the tube and its contents.

The method of testing will be best understood by referring to an actual example. Suppose that the level to be tested is 6 inches long, and that it is divided into tenths of an inch. The three or four last divisions at each end may be ignored, as the level is rarely sealed up without disturbing these divisions. Of the sixty divisions on the level in question, however, fifty-four will be assumed to be serviceable. Assume further that the air space takes up twenty divisions.

The method of testing varies somewhat. Some testers will test every division, while others take the average of four or five divisions. In this example we will take the average of every five divisions. The air space, at the beginning, is nearly at one end, and we note the lines between which it is located. Now the knurled head of the adjusting screw is carefully turned and the number of divisions on the graduated disk that are required to move the air space five divisions is noted. We find that it takes 60 divisions on the disk for the first five divisions on the level, and 63, 65, 65, 63, 61, 60 and 59 divisions, respectively, for the remaining sets of five divisions each. The average of this is 62 divisions on the graduated disk; therefore each division on the level is equivalent to $62 \div 5 = 12.4$ seconds of arc.

A level that varies more than 5 per cent from the average is spoken of as fair, one that varies 2½ per cent is termed good, and one that varies only ½ per cent is known as first-class. Hence the level tested in this case would be classed as a fair specimen. In making these tests, the temperature plays a considerable part. Nevertheless, a good level should show very little variation in its sensitiveness with a difference in temperature not exceeding 40 to 50 degrees F., although, of course, the air space will vary in length with this difference.

In order to understand how the curvature of the level affects its sensitiveness, it is perhaps best to take an extreme example. In Fig. 2 are shown two glass tubes *CDE* and *FGH*, bent to a semi-circular shape. One has a diameter of 12 feet and the other a diameter of 6 feet. As these tubes represent exactly half a circle, we will have 648,000 seconds of arc. The linear length of the larger tube, in inches, will be $(12 \times 12 \times 3.1416) \div 2 = 226.1952$, and of the smaller, 113.0976. Suppose that we have a girder 13 feet long and capable of being turned about *A* through an angle of 90 degrees. Now place the tubes on the girder, taking care to keep them in an upright position. The air space will be at *D* and *G*. Turn the girder through an angle of 90 degrees and the air space will have run to *E* and *H*, respectively. Now the air spaces in both tubes have run through 90 degrees, but the one in the larger tube has moved 113.0976 inches and that in the smaller tube 56.5488 inches. Thus we would say that the larger tube is twice as sensitive as the smaller, for it will be seen that to move the air space one inch in the larger tube, we need only to turn the tube through one-half the number of degrees required for the smaller tube. Of course in actual practice we never have to deal with tubes of this shape, but the principle is the same.

In all modern work the levels are divided on the outer surface to tenths and twentieths of an inch, except when they are divided according to the metric system. The following table gives the curvature of levels of various sensitiveness, the divisions on the level being in tenths of an inch:

Division of Arc of Circle to Each Graduation	Corresponding Diameter of Curvature of Level in Feet
1 second	3437.73
2 seconds	1718.86
5 seconds	687.54
10 seconds	343.77
20 seconds	171.88
30 seconds	114.59
1 minute	57.29
1 degree	0.954

All levels should be ground, although it often happens in cheaper ones that the glass tube is just bent to the approximate curve. These latter levels are not to be recommended except for work which does not require any particular accuracy.

The value of a division of a level may be found roughly by using a piece of metal about 12½ inches long and wide enough to support the level. Take, for instance, a piece of brass 12½ inches long and file away the lower surface so that it bears on two points exactly 12 inches apart. Put the level to be tried on it, bringing the air space near the center by putting packing under one of the bearing points. Note carefully where the air space is, and then put a feeler gage of 0.002 inch thickness under one of the bearing points of the brass bar. If then the air space runs say 0.1 inch, what is the value in seconds of arc of one division of the level, and what is the curvature to which the level has been ground?

The distance from the bearing point to the feeler gage is 12 inches; this is the radius of a circle whose circumference is 75.3984; hence 75.3984 inch is equivalent to 1,296,000 seconds of arc, and from this we find that 0.002 inch equals 34.3 seconds of arc; or in other words, each 0.1 inch on the level equals 34.3 seconds of arc. To find the curvature, we know that 34.3 is to 1,296,000 as 0.1 is to the total circumference of the curvature circle. Hence:

$$\frac{0.1 \times 1,296,000}{34.3} = 3749.27 \text{ inches,}$$

which is the circumference of the curvature circle of the level, the diameter being 99.1 feet. This calculation indicates the simplicity of finding the sensitiveness of the level, and further if the user of a level does not know the value of a division on the level, he can by this means ascertain more easily how much out of level a piece of work is that he is setting up.

A good level is one of the most sensitive instruments made, and the utmost care should be exercised when using it. Levels are generally fixed in the brass tubes with plaster of paris. This method is satisfactory for all levels of an accuracy of about 5 seconds to 0.1 inch. For finer levels it will be found best to fix one end only with plaster of paris and the other end with cork, for if the level be fixed rigidly with plaster of paris at both ends, there will be a strain on the level at the extremes of temperatures at which it may be used, and as the coefficients of expansion of glass and brass are different, an inaccuracy is liable to occur. For fine levels it is also best to have an extra glass tube around them in order to prevent the heat of the hand from affecting them. In general practice, the length of the air space is from one-quarter to one-third of the length of the level. A level of 1 minute to 0.1 inch is most serviceable for general use. One having an accuracy of 30 seconds to 0.1 inch must be used on a floor free from vibration, and still finer levels are used mostly on surveying and astronomical instruments.

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POSTAGE FOR FOREIGN COUNTRIES

By FINK

As an employe of a European firm which has an extensive correspondence with American manufacturers, the writer has observed that a great many letters from the United States are prepaid with only two cents instead of five cents, which is the regular foreign postage. It is true that letters from the United States to England or Germany need but two cents postage, but for every other European country the postage is five cents. Of course everyone who receives American letters insufficiently prepaid knows that the trouble is due to errors on the part of the clerks having charge of the mailing, but nevertheless, it is not exactly pleasing for the European business man to have to pay for the carelessness of the employes of an American firm, especially as this extra expense in a large house may amount to quite a considerable sum during the year, and this expense, with some attention, could be easily avoided.

The postage required to be paid on the European side is double that which is lacking, so that six cents has to be paid for every letter which is provided with a two-cent instead of a five-cent stamp. The writer feels sure that American manufacturers would regret the condition even more than the receivers of the letters, if they knew that their European customers sometimes pay six cents extra postage for practically every letter sent them. On the other hand, it is true that some firms always prepay the full postage on their letters.

Now I do not doubt that American manufacturers may have had this called to their attention in the past, but it is a matter that is easily overlooked. As a rather amusing incident in this connection, I might mention that I sent a letter similar to this to another highly esteemed mechanical journal in the United States, but my contribution was returned with an explanation that my remarks would not be of interest to the readers of that periodical. However, in spite of the fact that this journal considered my remarks too trivial to be worthy of publication, and that they contained nothing of interest to American manufacturers, the very letter in which my manuscript was returned was prepaid with only two cents instead of five cents, so that I had to pay the extra postage of six cents. I believe that this clearly shows that the matter to which I have called attention is one which American firms in general would do well to give some attention.

FEATURES OF APPRENTICESHIP SYSTEM AT THE G. E. CO.'S LYNN WORKS

By CHESTER L. LUCAS

The apprenticeship system in vogue at the Lynn Works of the General Electric Co. was described in MACHINERY, in the April and September, 1906, numbers. As the apprentice department has recently moved into a large new building, and as some of the work being done at the present time is especially interesting from a mechanical standpoint, a description of the new quarters, and an outline of some of the work of the apprentices, may, perhaps, prove of interest.

The apprenticeship system, which is under the general supervision of Mr. Magnus W. Alexander, was started in February, 1902, with twelve boys. At the present time there are enrolled over three hundred boys, who have come from all parts of the United States, and even from Canada, to learn to be machinists and toolmakers, patternmakers, iron or brass molders, steam-fitters, etc. Although applicants for this course must be well qualified, educationally as well as physically, and come well recommended, and although the requirements as to home study and class standing are rigorous, there is always a long waiting list of young men who are looking for opportunities to take the course. This condition is due to the fact that it has become well known in mechanical circles that graduates of these courses are qualified to take responsible positions as skilled mechanics or as assistant foremen, and later as foremen and superintendents.

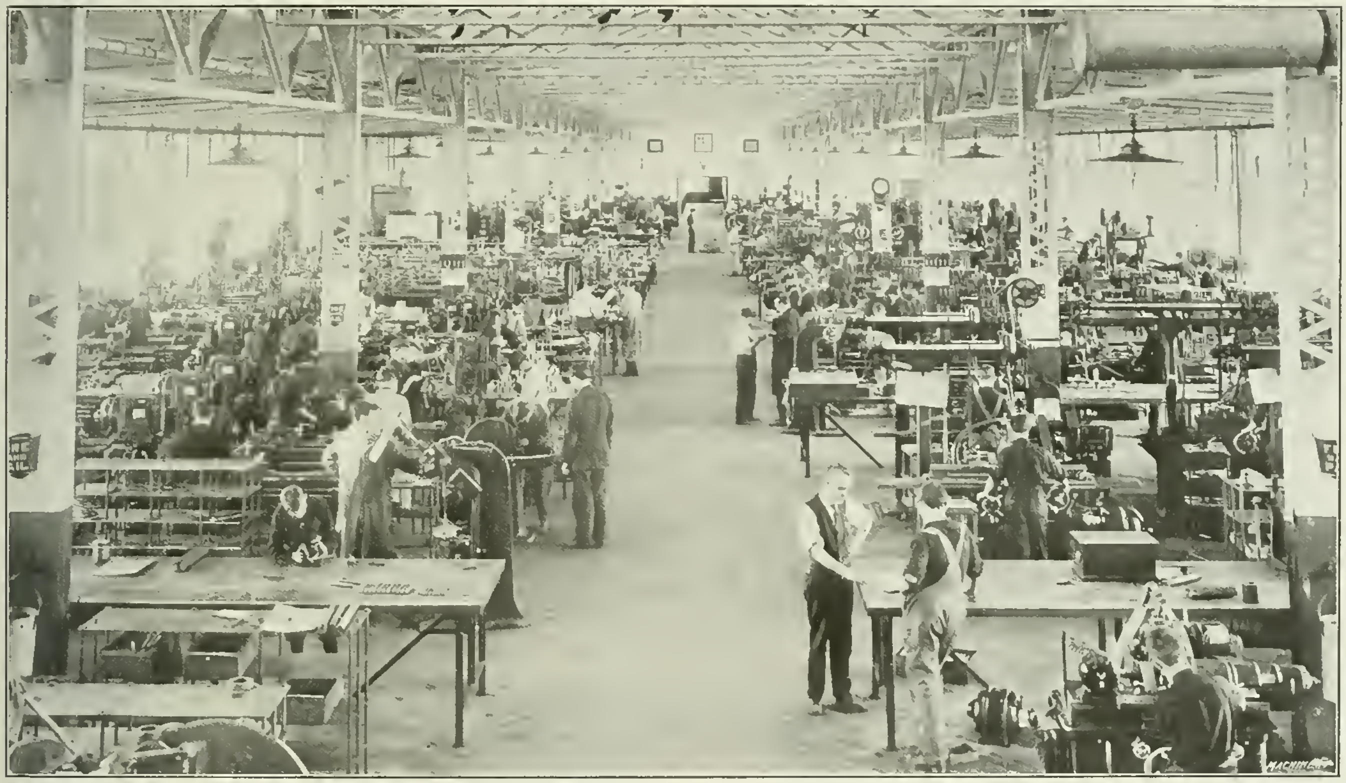

Fig. 1. A View in the New Training-room of the Apprentice Department

During the past year the apprentice department has moved into a large new building, designated as building No. 40 of the Lynn Works, where a well-lighted and ventilated training room for machinist and toolmaker apprentices is located. This room has over one hundred machine tools. The building also has large and well appointed class-rooms in which instruction is given in arithmetic, algebra, geometry, plane trigonometry, physics, mechanical drawing and tool-design, as well as in English and industrial history. This department occupies a space of 80 by 450 feet. A smaller, but equally well equipped training room for patternmakers is located in the wood-working building. A view of the machine shop is shown in Fig. 1, from which it will be seen that the shop is well appointed, of modern construction, and equipped with the best of machine tools. The General Electric Co. does not believe that "anything is good enough" for an apprentice, and the lathes, shapers and other machine tools are modern in every respect. It is also interesting to note that all machines are motor driven, so that no overhead belts are required.

A trial period of two months must be served by all applicants for positions on the course, after which time, if the applicant is found to be satisfactory and adapted for learning the chosen trade, he is permitted to sign the apprentice agreement. Compensation is paid, even during the trial period, at the rate of eight cents per hour for the first half-year, ten cents for the second half-year, twelve cents for the second year, fourteen cents for the third year, and sixteen and one-half cents for the fourth year. If the four years' work has been satisfactorily completed in every respect, a cash bonus of one hundred dollars is given to the graduate. The courses for molders and steam-fitters, however, are completed at the end of two years, and the rate of compensation is ten cents per hour for the first half-year, twelve cents for the second half-year, and fourteen cents for the second year, and graduates receive a bonus of fifty dollars at the completion of the course.

The company also maintains apprenticeship courses for high-school graduates who, during a three-year period, desire to fit themselves for efficient service as draftsmen, designers, engineers, electrical testers, erection and installation men, or salesmen. Their initial training consists of well supervised machine work in the apprentice training-room. These apprentices receive ten cents per hour for the first half-year, twelve cents for the second half-year, fifteen cents for the second year, and twenty cents for the third year. A bonus of seventy-five dollars is also paid upon completion of the course. The class-room work is of a high order, and a high standard of work is maintained in the shops and testing departments.

Mr. Charles K. Tripp is the superintendent of apprentices and is in charge of all work. The educational feature of the course is a strong attraction to all, and a great deal of attention is given to this side of the work. The educational work is under the direction of Major A. W. Lowe, and a corps of instructors instructs the boys in those subjects that are closely allied to their work. Fig. 2 shows the interior of a class-room. Mr. Tripp is here instructing a class of apprentices in the proper methods of sharpening lathe tools, illustrating on the black-board methods which are right as contrasted with those which are wrong. As will be noticed, the apprentices are provided with pencils and paper in order that they

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* Associate Editor of MACHINERY.

may take notes, for they are expected to remember the points brought out in these lectures when the time comes for their practical application in the shop.

The chief aim of the educational side of this course is to develop proper thinking on the part of the boys, and to familiarize the apprentices with such problems as are apt to come up in their everyday work. Practical examples are always selected to impress upon their mind the value of the information they get. Many boys are dropped from the course on account of their inability to keep up with the class work, this inability being due either to natural dullness or to indifference.

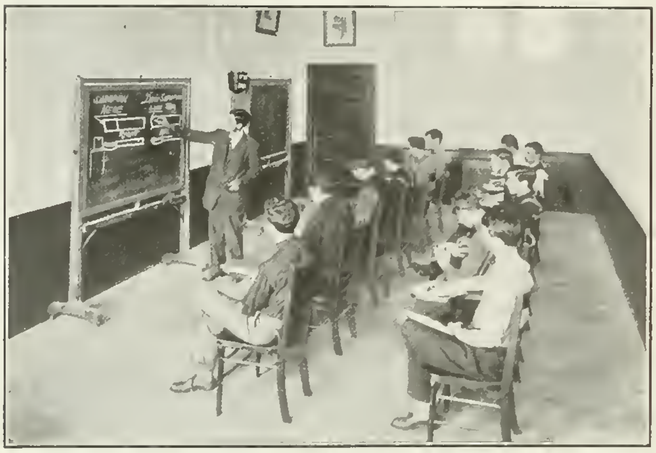

Fig. 2. Another of the Class-rooms with the General Foreman showing Methods of Tool-sharpening

Work done by Apprentices

The following examples are given to convey an idea of the class of work that the apprentices perform in the training-room, before being placed in the various departments of the plant. All of the work described, as well as many of the tools used for doing the work, has been done by apprentices more or less advanced in the course.

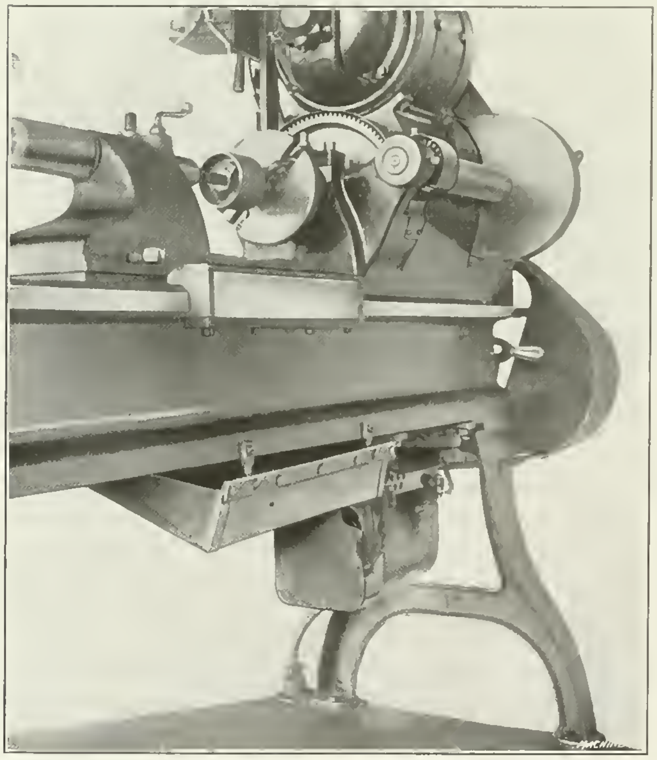

Fig. 4. Chip-pan and Method of attaching to Lathe

T-slotting in the lathe, as shown in Fig. 3, is an unusual operation, but in the apprentice department it is employed to good advantage on turbine work. The piece of work—a turbine valve shown at *A*—is held in a block *B*, bolted directly to the carriage of an old lathe. The cutter *C* is then held in the universal chuck, and a straight slot milled by feeding the cross-slide on to the cutter to the required distance. This operation is followed by inserting T-slotting cutter *D* in the chuck. This cutter mills the bottom of the slot to the proper size and shape. This method has the advantage of cheapness, as it requires only an old lathe instead of a first-class milling machine, and it certainly produces a very good job.

The simple little contrivance shown in Figs. 4 and 5 helps to keep the floors beneath the lathes clear of oil and chips. Fig. 4 shows the pan in position. In cleaning out the pan, it is simply unlatched at the front and allowed to drop, and the chips and oil are caught in a regular dirt pan, as shown in Fig. 5.

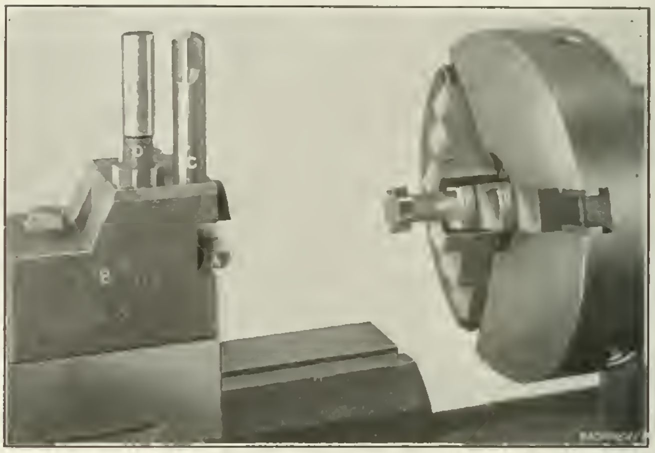

Fig. 3. Using a Lathe for T slotting

A little kink that often proves useful in shops where comparatively little cutting-off is done, is the method of cutting-off short duplicate lengths of round stock on the lathe, as shown in Fig. 6. The solid chuck grips the work, while the other end is supported by the tail-center. The cutting-off, of course, is done with the usual cutting-off tool, and the distance the bar enters the chuck governs the length of the pieces.

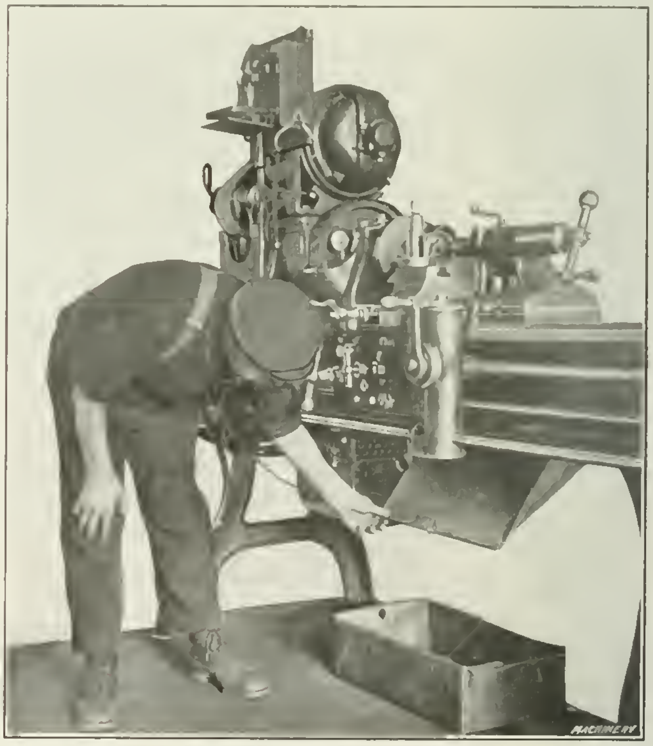

Fig. 5. Removing the Chips and Oil

Valve-seats, a group of which is shown finished in Fig. 7, present some unusually interesting machining methods. At *A*, Fig 7, is shown a rough casting from which the valve-seats are turned, and in Fig. 8, is shown a line-engraving of the valve-seat. It is important that these castings be internally gripped and held central on the arbor by the three points *M*, shown in Fig. 8. For this purpose the special arbor shown at *B*, Fig. 7, is employed. This special arbor consists of a steel core *C*, on which is slidably mounted a sleeve *D*, one end of which terminates in a tapered flange. At the opposite end of this core is permanently located a collar *E* in which three pins are equidistantly placed about the flange. These pins are so supported that when the sleeve *D* is moved toward the collar *E*, the pins are forced outward due to the action of a taper bearing under the pins.

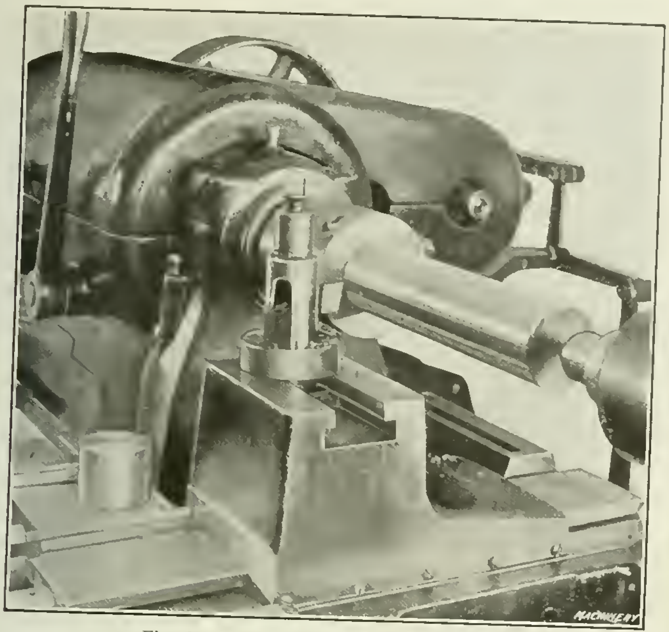

Fig. 6. Cutting-off Short Pieces of Stock

In operation, the casting is slipped over the arbor, care being taken to locate the three internal spots *M* over the pins that extend from the arbor. Sleeve *D* is then inserted and nut *G* tightened. This operation forces the three pins to grip the casting internally, while the tapered flange on the sleeve centers the other end of the casting. In this position the outside of the casting is turned. Next, the casting is removed from this arbor, and one end is held in a chuck while the body of the valve-seat is supported by a steady-rest, thus leaving the interior clear for machining. After being rough-bored, reamer *H* is run through, after which the succeeding counterboring tools, *I*, *J*, and *K* are used. Each of these tools is held in the tail-center of the lathe and each counterbores some particular part of the valve-seat. The interior of the valve-seat being thus finished, it is finally slipped on the arbor *L* and the exterior of the work polished with emery cloth.

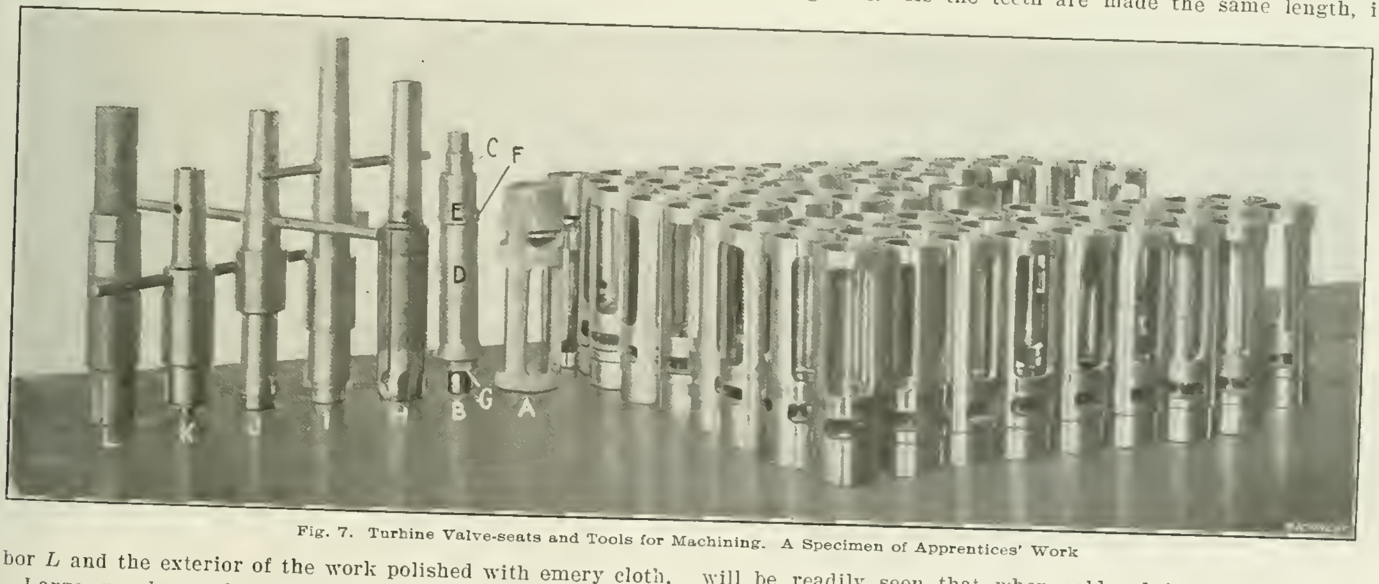

Fig. 7. Turbine Valve-seats and Tools for Machining. A Specimen of Apprentices' Work

Large numbers of cast-iron pulleys are turned in this department, this work being one of the first jobs that the prospective machinist receives. In finishing these pulleys considerable filing must be done, and with the ordinary faceplate and dog, there are plenty of chances for a novice to have his jumper-sleeve caught, with possible injury to himself. To overcome this danger, the lathes in the apprentice department are fitted with faceplate guards, consisting of a piece of sheet metal bent into circular form and fastened to the edge of the faceplate with small screws. The guard (see Fig. 9) extends over the dog, and there is no possible chance for any part of the workman's sleeve or arm coming in contact with the dog.

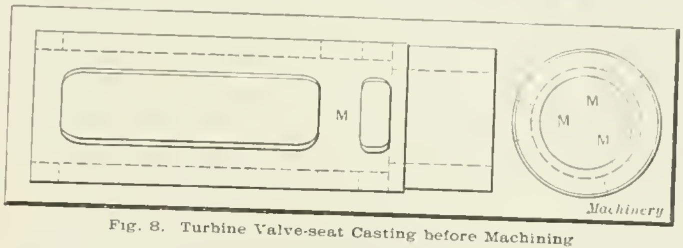

Fig. 8. Turbine Valve-seat Casting before Machining

In connection with the pulley work there is a splining operation, which is interesting on account of the method by which the splining bars are made. The bar is mounted on the table of a vertical milling machine, with one end slightly raised. The holes for the teeth are then milled to the same depth, measured from the surface of the table. This, of course, results in each hole being slightly shallower than the preceding hole. As the teeth are made the same length, it will be readily seen that when soldered in place, they will project from the bar with regularly increasing amounts.

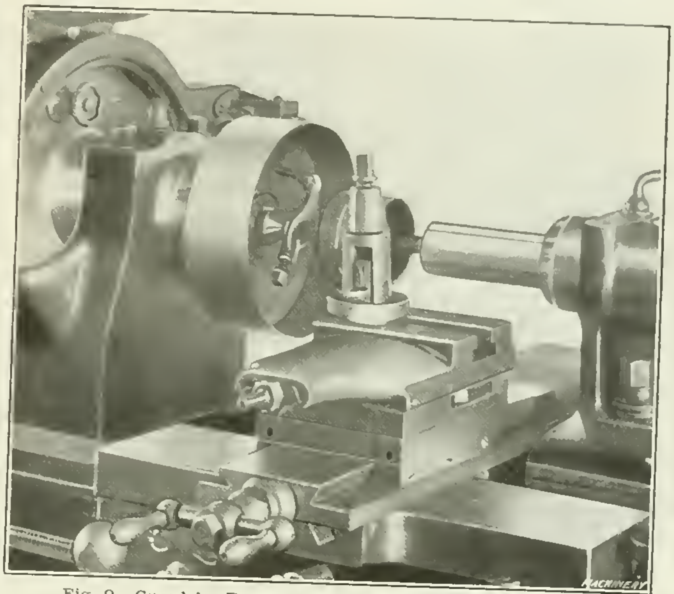

Fig. 9. Guard for Faceplate and Dog when filing in the Lathe

Fig. 10 illustrates the way in which the apprentices are taught to run the various machines, the example illustrated being a grinding machine. The apprentice who is to learn to run the machine is instructed by an older apprentice who has already performed work on this machine in a satisfactory manner. The younger apprentice operates the machine under the guidance of the more experienced boy, and the two work together until the younger apprentice is proficient in handling the work alone. This illustration shows the operation of grinding shafts, of which a great many are used by the General Electric Co., in building small motors. As soon as the younger boy becomes experienced in handling this machine, the older apprentice is taken off and started at work on some other job, and, in due time, the younger boy proceeds to instruct a new recruit. All of this work, of course, is under the supervision of the foreman and his assistants.

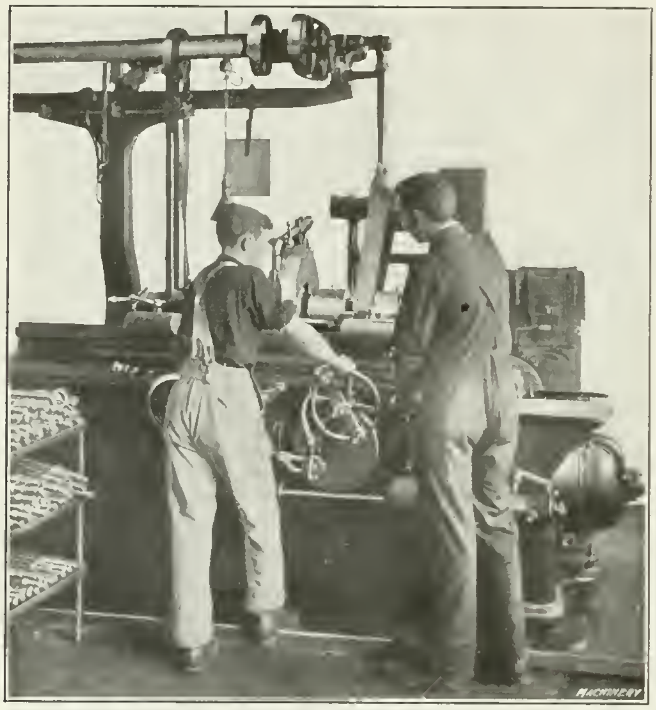

Fig. 10. How One Apprentice instructs Another to operate a Grinding Machine

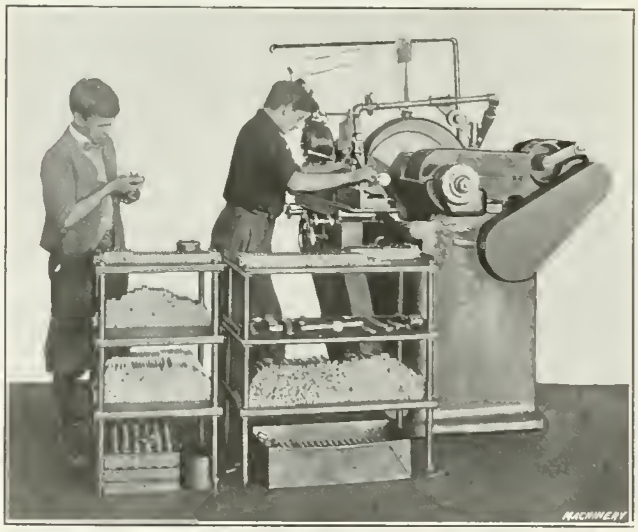

Fig. 11. Grinding Small Motor Shafts. Grinding Machine made by Apprentices

In Fig. 11, one apprentice is shown running the machine while the other, who is more experienced in the work, is measuring the finished motor shafts with micrometers. This work, being regular production work, is extremely good practice for apprentices to work upon, as the limits of accuracy are held to within 0.0005 inch. The grinding machine here shown was built by apprentices. The illustration also shows a simple type of homemade shop-stand, built up of iron plates and short lengths of pipe, the whole being held together by long bolts with nuts at the top.

Fig. 13 shows an extremely convenient type of dog used for driving work on the grinding machine. The tail of the dog, which comes in contact with the driving pin, is hinged in the frame of the dog. The hinged end is made cam-shaped so that the slightest pressure upon the tail causes the cam to grip the work, and as the pressure increases, the cam grips the work still harder. The eccentric is kept normally on the work by a spring *A*. This dog is the design of Mr. Tripp and is used exclusively for small grinding work in the apprentice department.

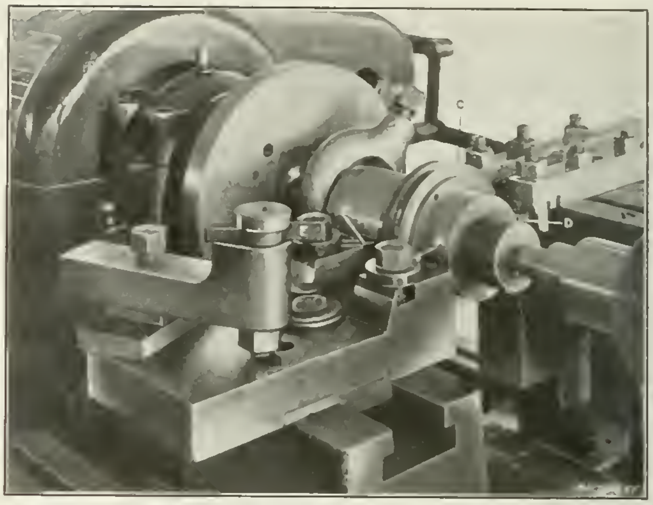

Fig. 12. Multiple-turning an Oil Deflector

In Fig. 12 is shown an interesting example of turning. The piece of work is a bronze oil deflector, approximately six inches in diameter, made from large bronze tubing cut to lengths slightly longer than the finished pieces. It is necessary that the inside of this piece be perfectly smooth and accurately sized within 0.0005 inch. This sizing is done by forcing a perfectly smooth arbor through the hole after it has been brought approximately to the required internal diameter. This operation is practically a planishing operation, in that it leaves the metal with a fine finish—far better than could be produced by reaming. Another important reason for using this method in preference to reaming, is the fact that reamers dull very quickly in cutting this hard bronze.

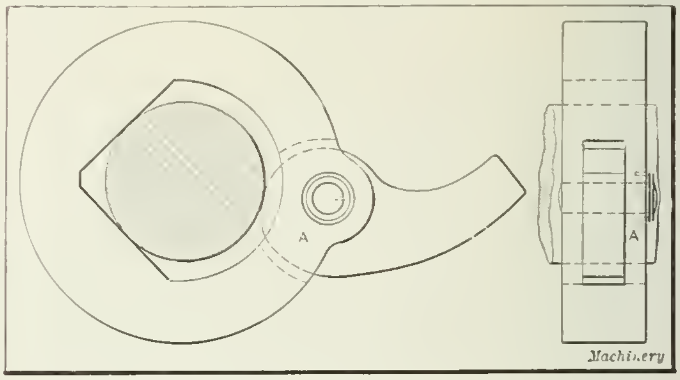

Fig. 13. Dog with Cam-grip; used in Driving Work for Grinding

The method of doing the lathe work on this piece is interesting, because it involves multiple-turning. After the interior of the piece has been finished, it is held upon an arbor and placed between the centers of the lathe. Tools *A* and *B* are used for facing the sides of the work, at the same time sizing the piece. These tools are, of course, operated by running in the cross-feed of the carriage-slide. As soon as this operation has been completed, the cross-slide is withdrawn, bringing tools *C* and *D* into contact with the surface of the work. These tools each cut away certain parts of the metal, after which tool *E* is set to cut the grooved section near the center of the oil deflector. In this manner the pieces are finished very quickly and accurately.

In Fig. 14 is shown an example that aptly illustrates the work of the apprentices in fixture making. The operation being done is that of milling a turbine detail, and not only is the work done by apprentices, but the fixture used has also been made by them. The method of doing this milling, in common with many of the other jobs that have been previously described in this article, originated with Mr.

Tripp, who is constantly working out new ideas to be carried out by the apprentices. Referring to the illustration, the work *A* is clamped on the faceplate *B*, of a fixture *C*. It is located at the bottom by set-screw *D*, and at the top by latch *E*, which engages in the longitudinal slot in the work. The seats for the work are V-blocks *F*. The faceplate *B* is removable from the body of the fixture; it is located accurately by two removable dowel pins *G*, and held in place by four swing-bolts *H*.

It will be noticed that one section of the cut is slightly deeper than the other part, a condition that is met by using cutters of different diameters. As soon as one cut has been made in the work, the top half of the fixture is loosened and reversed, and the second cut is made at the other end of the turbine part. While this cut is being taken, the apprentice clamps a new part in a duplicate faceplate, and at the completion of the cut, he simply removes the top half or faceplate of the fixture, replacing it with the duplicate faceplate that has a new piece in it, and is ready for milling. In this manner the machine is kept at work all the time.

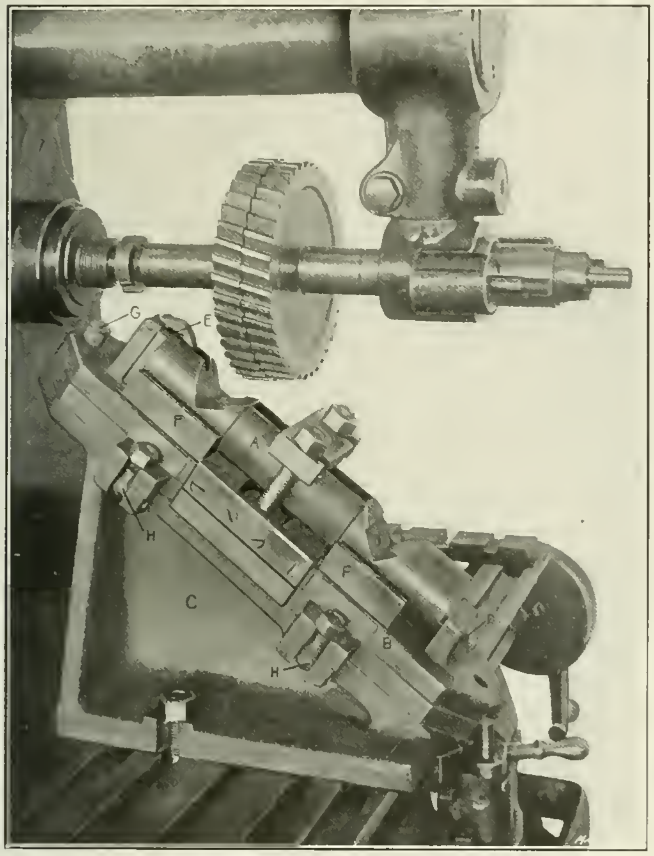

Fig. 14. Fixture employed in milling Turbine Parts

There are many other jobs done by the General Electric apprentices that are worthy of description. Screw-cutting bench lathes and other machines have been built complete in this department, and some unusually good punch and die work and general toolmaking has been done, but enough has been said to make it plain that the apprentices on this course get "real work" to do.

* * *

During the last thirty-six years the fire losses in the United States, according to an article by Mr. S. G. Koon in the *Engineering Record*, have amounted to more than $5,000,000,000. This is more than seven per cent of the average estimated national wealth during this period. The fire loss per capita is considerably over two dollars a year, which is about six times the fire loss per capita in some of the leading European countries. When it is known that over ninety-five per cent of all fires in buildings equipped with automatic sprinklers are either completely extinguished by the sprinklers or held in check so as to be easily handled by the firemen, it is evident that these enormous fire losses are not necessary. A department store with a sprinkler system stopped the progress of the Baltimore fire. Had the building in which this fire started been properly protected in this manner, there would have been no conflagration to stop.

DAD'S BOY

By A. P. PRESS

We had a new man come in lately. This is not, in itself, an unusual thing, for new men come in every day. In fact this one came in with a "bunch" of five; but he "stuck out" from the rest, although he did not put himself forward—he just stuck out, anyway. He had on a blue woolen shirt, but it was clean; and he had blue eyes—and they were clean too. He did not have much of a kit none of the boys do nowadays. A kit is in the way on the bench if kept in a chest, and on the set-up job it is not needed anyhow; but what tools this new man had were first-class.

He started in just the same as the rest of the men, and no favors were shown him, but one thing we noticed was that he "peeled off" before he started, the same as the molders do, and put on some rough clothes.

The floor boss came along past the desk, that noon, just as we were eating lunch, and said:

"Say, but that new man is all right." (He didn't say which new man, but we all knew who he meant.) "He showed me how to get the angle on that big brace without a protractor and it came out right, just as the drawing called for. You can't get a protractor on it very well anyhow—there is no planed surface to work from."

"A good man, is he?"

"He sure is," was the reply, and the matter was dropped.

About a week after that we wanted a nice lathe job done. It was a kind of a government job. It happened this way. We broke down one of the big cranes, and it was due to carelessness, so we hated to ask the office for an order to fix it, as that would mean a lot of explanations as to how it was done. It only needed a new bushing with a taper hole in it to make it as good as new, so we asked the floor boss if he had a good lathe hand in the gang.

"Sure and I do not think of one, sir; but wait a minute and I'll ask that new man and see what he knows."

Back he came in five minutes. "Yes, sir, the new man says he can do anything in the way of a lathe job; and that is not all—he has a pair of 'mikes' and a pair of vernier calipers in his coat pocket, both in little cases."

We got the use of a good lathe in the experimental room and sent the new man in there with a sketch showing what was wanted, and a solid casting to cut it from. Along in the afternoon he came out with the job and fitted it into the crane—it *was* a fit, too—and went back to his floor work, and said nothing.

A week after this the man on the big planer was taken sick, and word came from the planing job to ask if we had a man who could take his place for a week, as the planer had all it could do every hour of the day. We called in Mike, the floor boss, and put it up to him.

"Sure, and that new man does have a machinery paper, and he is reading most every noon; I will ask him." Back he came and said, "Yes, he says he has run big planers and is not afraid to take hold of this one—in fact, he is very willing to do it." So on the planer he went and he made good, and stayed there until the regular man got back again; and then he went back to the floor.

A month went by, and one morning we got a telephone message from Mike. "Sure," said he, "and I was going upstairs with a hod of coal, and I fell and hurted my ankle. The doctor says that it will be a week before I can get in." Well, we were stuck, for that meant that we either had to find a piece of stock on the floor that we could hammer a floor boss out of, or be boss ourselves. The new man was the first one that came into our mind, so we went gunning for him at once.

"Did you ever handle any men?"

"Yes, sir, on several jobs, sir," was the reply.

"How many?"

"Oh, anywhere from five to fifty," was the quiet reply.

"Can you take hold of this gang and run it until Mike gets back?"

"I can try," he answered.

"Go ahead."

And "go ahead" he did; and although Mike's one week with his injured leg, stretched out into three, things ran so smoothly that we should never have known he was out—as far as the work was concerned. Mike came back at last, and then our curiosity got the best of us, and we called the new man into the office.

"See here, now, what are you doing here? You have been here four months and you have shown that you are an expert lathe hand, a good planer hand, and also a good floor boss—and still you are working for a journeyman's pay. We know drinking is not the trouble."

"Well, boss, you see it is like this: Dad is superintendent of the Smith Co. (naming one of the largest concerns in the country) and it has always been his brag that he was a self-made man and came up from the ranks. He said that any boy of his had got to do the same—and that is just what I am doing now. I started in three years ago in the lumber mills of Vancouver, worked my way along to Seattle, put in a year in 'Frisco, and then worked my way through the gulf shops to New York. I put in nine months in a big garage there before I came here—and I would like to respectfully give you notice that I wish to leave next Saturday night. I am going across to the old country for a year in France and on the Continent. Then I am going home to Dad."

Now, we have not the pleasure of the acquaintance of "Dad," but we certainly have the highest respect for him and his method of bringing up the boy—and we should like to be in Dad's shoes when the kid gets home.

* * *

TABLE OF ALLOWANCES AND LIMITS

FOR DRIVING, PULLEY, RUNNING, SHRINK AND SLIDING FITS

By H. M. NICHOLS*

In manufacturing machinery where the parts must be interchangeable, it is necessary to have some standard of allowances and limits in order that parts made at different times will go together without fitting. The accompanying table gives the allowances and limits for sizes from zero up to 8 inches for driving, pulley, running, shrink and sliding fits. The allowances are in all cases added to the even dimensions to determine the dimension that is put on the drawing for the mechanic to work to. The limits are given after the important dimensions on the drawing, and all pieces must be made to the degree of accuracy called for by these limits; that is to say, if the limits for a particular piece are +0.001 and —0.000, it must at least caliper to the size and must not be more than 0.001 inch over to pass the inspector.

TABLE OF ALLOWANCES AND LIMITS

Diameter in Inches	Driving Fit			Pulley Fit		Running Fit			Shrink Fit			Sliding Fit		
	Bore, No Allowance	Shaft		Bore, No Allowance	Shaft, No Allowance	Bore		Shaft, No Allowance	Bore, No Allowance	Shaft		Bore		Shaft, No Allowance
	Limits, Inches	Allowance, Inches	Limits, Inches	Limits, Inches	Limits, Inches	Allowance, Inches	Limits, Inches	Limits, Inches	Limits, Inches	Allowance, Inches	Limits, Inches	Allowance, Inches	Limits, Inches	Limits, Inches
0 to ¼	+0.000 −0.00025	0.000	+0.00025 −0.000	+0.00025 −0.000	+0.00025 −0.000	0.001	+0.000 −0.00025	+0.000 −0.0005	−0.000 −0.0005	0.0005	0.00025 −0.000	0.0005	+0.000 −0.00025	0.000 −0.0005
¼ to ½	+0.000 −0.00025	0.000	+0.0005 −0.000	+0.0005 −0.000	+0.0005 −0.000	0.001	+0.000 −0.0005	+0.000 −0.0005	+0.000 −0.0005	0.00075	0.0005 −0.000	0.0005	+0.000 −0.00025	0.000 −0.0005
½ to 1	+0.000 −0.00025	0.0005	+0.0005 −0.000	+0.0005 −0.000	+0.0005 −0.000	0.001	+0.000 −0.0005	+0.000 −0.0005	0.000 −0.0005	0.0015	0.0005 −0.000	0.00075	+0.000 −0.00025	0.000 −0.0005
1 to 1½	+0.000 −0.0005	0.00075	+0.0005 −0.000	+0.0005 −0.000	+0.0005 −0.000	0.0015	+0.000 −0.0005	0.000 −0.0005	0.000 −0.0005	0.002	0.0005 −0.000	0.001	+0.000 −0.00025	0.000 −0.0005
1½ to 2	+0.000 −0.0005	0.001	+0.0005 −0.000	+0.001 −0.000	+0.0005 −0.000	0.0015	+0.000 −0.0005	+0.000 −0.001	+0.000 −0.0005	0.0025	+0.0005 −0.000	0.0015	+0.000 −0.00025	0.000 −0.0005
2 to 3	+0.000 −0.0005	0.0015	+0.0005 −0.000	+0.001 −0.000	+0.0005 −0.000	0.002	+0.000 −0.0005	+0.000 −0.001	+0.000 −0.0005	0.003	+0.0005 −0.000	0.002	+0.000 −0.00025	+0.000 −0.0005
3 to 4	+0.000 −0.0005	0.0015	+0.001 −0.000	+0.001 −0.000	+0.001 −0.000	0.002	+0.000 −0.001	+0.000 −0.001	0.000 −0.001	0.004	+0.001 −0.000	0.002	+0.000 0.00025	0.000 −0.001
4 to 5	+0.000 −0.0005	0.00175	+0.001 −0.000	+0.001 −0.000	+0.001 −0.000	0.003	+0.000 −0.001	0.000 −0.001	+0.000 −0.001	0.0045	0.001 −0.000	0.0025	+0.000 −0.0005	0.000 −0.001
5 to 6	+0.000 −0.0005	0.00175	+0.001 −0.000	0.001 −0.000	+0.001 −0.000	0.003	+0.000 −0.001	+0.000 −0.001	+0.000 −0.001	0.005	+0.001 −0.000	0.003	+0.000 −0.0005	0.000 −0.001
6 to 7	+0.000 −0.0005	0.002	+0.001 −0.000	+0.001 −0.000	+0.001 −0.000	0.004	+0.000 −0.001	+0.000 −0.001	+0.000 −0.001	0.0055	+0.001 −0.000	0.004	+0.000 −0.0005	0.000 −0.001
7 to 8	+0.000 −0.0005	0.002	+0.001 −0.000	+0.001 −0.000	+0.001 −0.000	0.005	+0.000 −0.001	+0.000 −0.0015	+0.000 −0.001	0.006	+0.001 −0.000	0.004	+0.000 −0.0005	+0.000 −0.001

As an example, suppose we have a 3-inch shaft and a collar to be shrunk onto it. Referring to the accompanying table we find that there is no allowance for the bore, and consequently the dimensions for the bore of the collar would be written $3.000 \frac{+0.000}{-0.0005}$. The allowance for the shaft is 0.003 inch, so that the dimensions for the shaft would be written $3.003 \frac{+0.0005}{-0.000}$.

It is customary to write dimensions that have to be accurate to the thousandth part of an inch in the form of a decimal, annexing ciphers in case a particular dimension happens to come out an even figure. All other dimensions are written in sixteenths or multiples of sixteenths. This enables the workman to pick out all dimensions requiring accurate work. The limits are usually given in small figures immediately following the main dimensions and a little above the main dimensions. Some concerns have letters to represent their standard limits which they add to the general dimensions requiring limits.

[While the values given in the table for shrinkage and force fits are all right for average conditions, they cannot be used in all cases, the allowance to be made depending on the length of the work, diameter of the hub, character of the bore, and numerous other conditions. For a more extended treatment of the subject, reference should be made to the article on "Shrinkage and Force Fits in the Bradford Shops," which appeared in the August, 1911, number of MACHINERY, engineering edition, and also to the two articles by William Ledyard Cathcart, entitled "Shrinkage and Force Fits," in the April and May numbers of MACHINERY, engineering edition.—EDITOR.]

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* Address: Kenyon, R. I.

MAKING PISTON RINGS*

By C. A. ROGERS†

The subject of making piston rings has been discussed before, but as this is an interesting problem in machine shop practice, the writer feels that there is still more to be said. A great many mechanics insist that piston rings must be ground, yet I have seen very few ground rings that were parallel sideways, and consequently they would not have a perfect bearing when placed in the cylinder. The piston ring, the manufacture of which is to be described in the following, is for a 4-inch cylinder and is shown in Fig. 1. Fig. 2 shows the casting from which the piston rings are made, while Fig. 3 is a fixture fitted to the lathe spindle for holding the casting shown in Fig. 2.

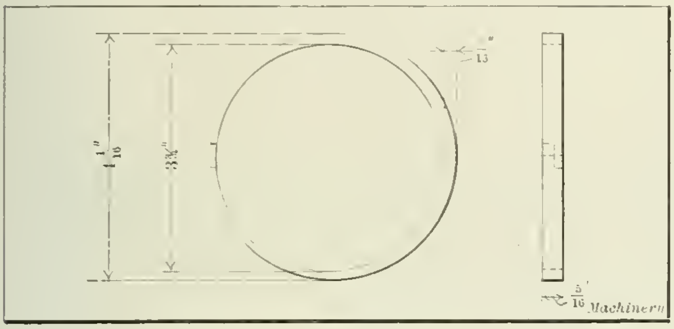

Fig. 1. Piston Ring for a 4-inch Cylinder

The fixture shown in Fig. 3 consists of a casting *A*, fitted to the nose of the spindle and which is machined out on the front end to receive a block *B*. This block is counterbored to fit the external diameter of the casting shown in Fig. 2, the latter being reduced on one end to 4 1/8 inches. The casting is held in the block *B* by a binding screw which securely holds the casting while it is being turned, bored, faced, and the rings cut off. The block *B* is provided with a pin *C*, which locates it in two positions so that the castings for the rings can be turned eccentric. The block when located in the desired position, is held by cap-screws as shown.

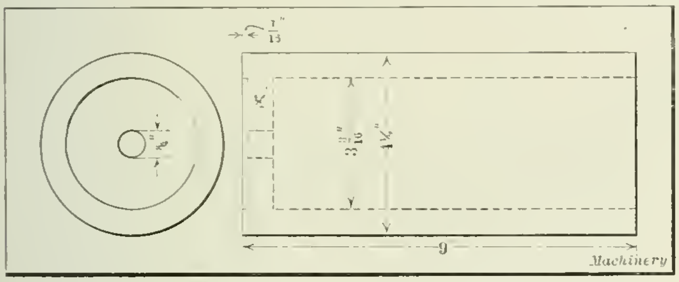

Fig. 2. Casting from which the Piston Rings are cut

The casting is turned, faced and cut up into rings by means of tools held in the turret toolpost, shown in Fig. 4, which comprises three blocks of machine steel. The turning tool *A* is used for rough turning; tool *B* for finishing; *C* for cutting off; and *E* and *F* for side facing. The first operation after placing the casting in the fixture, Fig. 3, is to rough down the external diameter with the tool *A*, Fig. 4, at a feed of 1/16 inch per revolution, and a surface speed of 80 feet per minute, leaving 1/32 inch for the finishing tool *B* to remove. Finishing tool *B* is operated at the same speed as tool *A*, and finishes the casting to the required diameter.

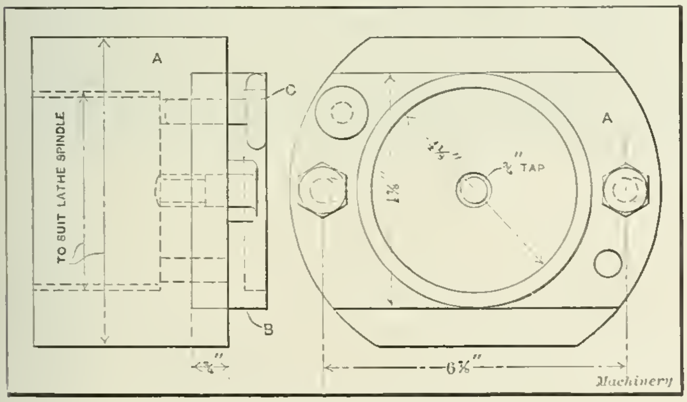

Fig. 3. Fixture for Holding Casting when turning, facing and cutting-off Piston Rings

Cut-off tool *C* is then brought into position, and is used to face off the outer end of the casting. The carriage is then moved 5/16 + 0.020 inch, and the cut-off tool put in to within 1/64 inch of cutting the ring off. The carriage is again moved 5/16 + 0.020 inch, and while the groove is being cut to form the second ring, the two side facing tools *E* and *F* face the first ring and cut it off. This order of operation is repeated until the casting is cut up into rings.

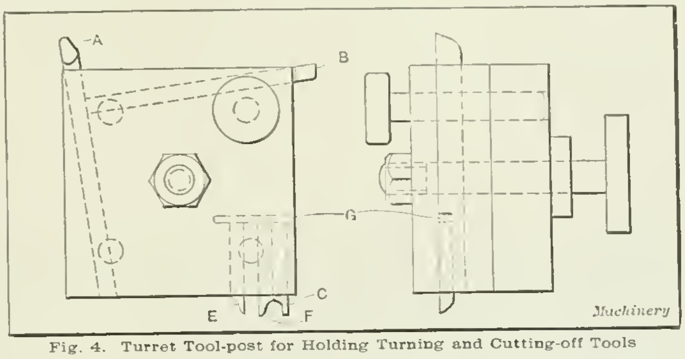

Fig. 4. Turret Tool-post for Holding Turning and Cutting-off Tools

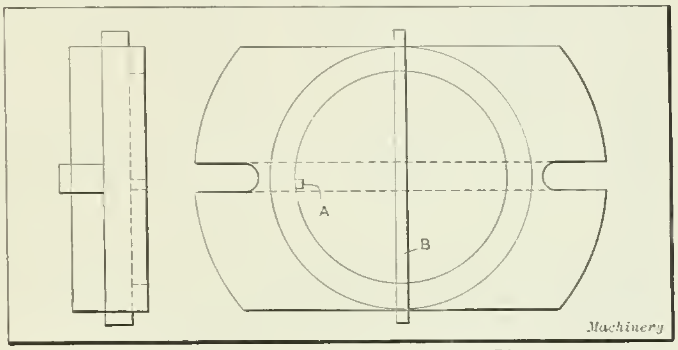

Fig. 5. Fixture used in Splitting Piston Rings

After the rings are turned externally and cut off, they are taken to the milling machine and placed in the fixture shown in Fig. 5. This is a fixture for holding the rings while the slot is milled, a cutter 0.197 inch wide being used. The fixture is set off center, an amount equal to half the thickness of the cutter—0.0985—and all the rings are milled on one side. Then the piece *A* is slipped into position to fit the slot already cut, when the rings are milled on the other side.

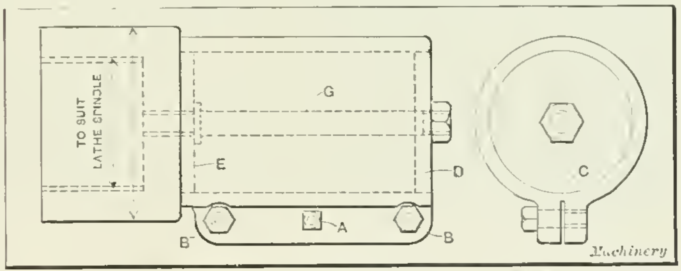

Fig. 6. Fixture for Holding and Clamping Piston Rings when taking the Finishing Cut

Following the milling of the rings they are taken back to the lathe and placed in the fixture shown in Fig. 6. This consists of a clamping sleeve which will hold as many rings as are cut off from the casting. To make the sleeve ready for holding the rings, the set-screw *A* is backed out and the binding screws *B* tightened, so that the sleeve is cracked open at *C*; then the fixture is filled up with rings, leaving sufficient room for the washers *D* and the projection *E* on the fixture. The retaining sleeve holding the rings is now slipped over the stud *G*, the washer *D* put on and the nut tightened. The binding screws *B* are now loosened, and the set-screw *A* tightened slightly, when the sleeve can be easily removed. A center is provided in the end of stud *G* so that it can be supported with the tailstock center when taking the finishing cut. The finishing tool *B* shown in Fig. 4 is used for this last operation.

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* For additional information on this and kindred subjects, see "Automatic Piston Ring Peening Machine," August, 1911; "Fixtures for Machining Eccentric Piston Rings," April, 1910, and articles there referred to: "Turning Gas Engine Pistons in a Turret Lathe," April, 1910; "Making Accurate Automobile Engine Pistons," January, 1910; "Automobile Factory Practice," January, 1910, engineering edition; "Automobile Factory Practice," October, 1909, and other articles there referred to.

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As the sleeve is bored the same size as the cylinder (plus 1/32 inch to allow for turning), and as the rings are closed together when they are placed in it, they are thus turned when in their compressed condition so that they fit the cylinder of the engine snugly. The total time required to make these rings is five minutes each, and when made on a good engine lathe equipped with fixtures as illustrated, a very good job will be the result.

Referring to Fig. 5, the strip *B* is used for pulling the rings from the fixture. They require no holding in this fixture, as the cutter should be fed down from the inside, and any tendency for the rings to fly up on the opposite side is easily overcome by holding them down by the fingers. If the rings were clamped down, the time required for clamping would be nearly as long as that required for milling. The strip *G*, Fig. 4, is set in a milled slot to prevent the cut-off and side facing tools from slipping back. The two side facing tools should be packed apart with tin foil so that they can be adjusted for wear, as the rings should be a very close fit in the grooves of the piston.

* * *

SPECIAL ACME-THREAD MACHINE TAPS

By FRANK LANG*

Having had considerable trouble in making machine taps with Acme threads due to the change of the lead in hardening, the writer designed the type of tap shown in Fig. 1. This tap has proved practical and has given very good results. An accurate thread is produced, there is less heating in tapping, and a greater number of pieces can be tapped in the same time, with less chance of breakage. One tap, 1 15/16 inch in diameter with two threads per inch, left-hand, was used for tapping seventy-five pairs of Le Blond heavy-duty lathe half-nuts, and not a scratch could be seen on the thread when the last pair was removed from the jig; the tap was ground twice.

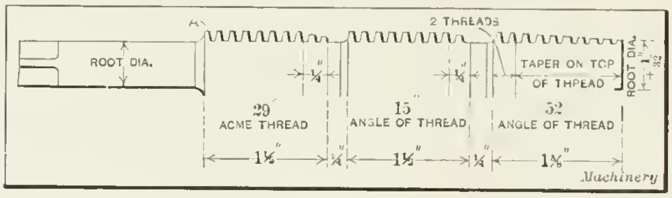


Fig. 1. Method of making Acme-thread Taps

When making this tap a tool is first ground to a 52-degree angle, as indicated by the gage shown in Fig. 2. This tool is used for threading the first third or roughing part of the tap. The thickness of the tooth at the bottom of the thread in the tap is made 0.010 inch less than the figures given in a table of the standard Acme thread dimensions. The next third of the tap is made with a tool having a 15-degree angle, the flat at the top of the thread being made 0.010 inch smaller than the Acme standard. A small round on each corner of the tool is made as shown in Fig. 2. This is a good feature as it makes the tap less liable to break when straightened after hardening. The last third of the tap is made with a regular Acme thread, except that the thickness at the bottom of the tooth is 0.005 inch less than standard, in order to allow this amount to be removed by a hand tap.

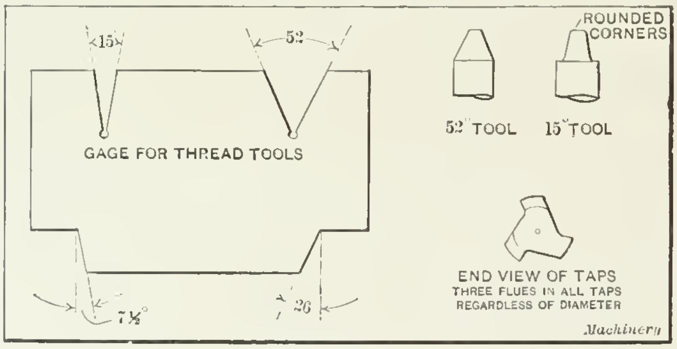


Fig. 2. Gage for Special Thread Tools, Shape of Tools, and End View of Fluted Taps

The diameter of the shank is made equal to the root diameter, and its length depends on the length of the piece to be tapped. The square in this case is hardened and tempered, as this tap is driven by a tap socket having its square at the outer end, so that the shank has no bearing in the socket and the square does all the driving. A small round corner should be left between the sides of the square, as this strengthens the square. The tap shown in Fig. 1 is ¾ inch in diameter with six left-hand Acme threads. The one-half of a thread shown at *A* should be ground off from each tap, as otherwise it may become distorted in hardening and mar the tapped pieces, and the trouble may never be located. In chasing the threads in the tap, a ⅜-inch square piece of high-speed steel is used in an Armstrong toolholder when the space of the thread does not exceed the width of the tool.

It may be of interest to some of the readers of MACHINERY to know that the hand taps made in our shop are not made exactly to the standard formula, but the outside diameter is made with the following allowances:

Outside diameter, up to 1 inch diameter = nominal diameter + 0.005 inch.

Outside diameter, from 1 to 1½ inch diameter = nominal diameter + 0.007 inch.

Outside diameter, from 1½ inch diameter and over = nominal diameter + 0.010 inch.

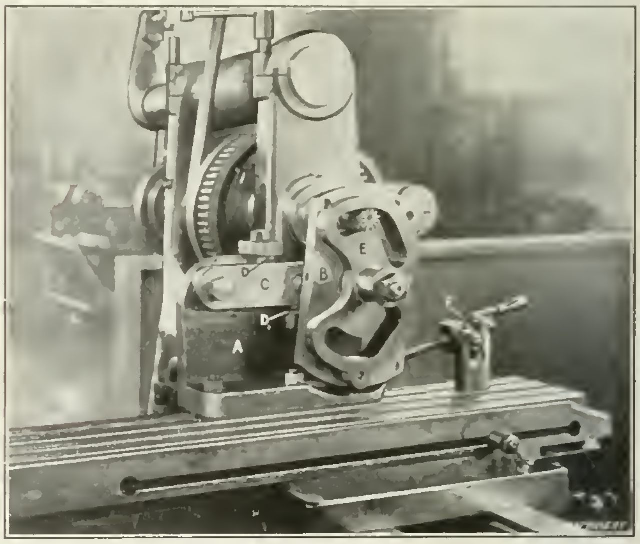
The length of the flute is 2½ inches in all cases. This applies to hand taps only.

* * *

SHIFTER CAM MILLING ATTACHMENT

The cams used on metal planers for shifting the belts require to be accurately formed and smoothly finished. The accompanying illustration shows a simple milling attachment used by the Cleveland Planer Works, Cleveland, Ohio, for milling out the slots.

The attachment consists of an angle-plate *A* on which is mounted a master cam *B* pivoted in the center. The master cam is not mounted directly on the angle-plate, but on a horizontal piece *C* which has a limited up-and-down motion. This piece is held in a horizontal position by two short coil springs, *D* and D_1, oppositely placed.



Belt Shifter Cam Milling Attachment

The cam to be milled is mounted on the master cam-plate, as shown at *E* in the illustration, and an end milling cutter having a shank that closely fits the slot in the cam-plate is placed in the spindle. The slot is milled with a horizontal feed of the machine until the curve is reached, when its feed is thrown out. The cam-plate is then rotated by hand by means of the screw and handle *F*, shown at the right. When the curve has been traversed, the horizontal feed is again thrown in and the cutter traversed to the end of the slot.

This simple attachment is found valuable. It insures accuracy of the slots, interchangeability, and saves the time of a first-class mechanic filing out the slots by hand. A boy runs the machine carrying the attachment successfully, and produces work superior to that turned out by a mechanic at the vise.

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NOVEL USE OF RETOUCHED MACHINERY PHOTOGRAPHS

Manufacturers that issue illustrated catalogues and circulars accumulate retouched photographs and wash drawings that represent many dollars' investment. They are usually kept carefully stored away where no one sees them except when they are resurrected for use in making new illustrations. That machinery photographs and drawings can be put to other good use is shown in the illustration which shows how the Kearney & Trecker Co., Milwaukee, Wis., utilizes the retouched photographs of its "Milwaukee" milling machines and details of the same. The photographs, large and small, are mounted under mats and glass in oak panels on the four walls of the the president's and secretary's office. In this form the photographs make an effective and pleasing ornament to the office. The large photographs show details of the machines advantageously, and can be studied more easily than if they were loose or in an ordinary portfolio, and the color effects make them more attractive than ordinary catalogue illustrations.

Novel Use of Retouched Machinery Photographs in Kearney & Trecker Co.'s Office

The frames of the panels are of oak, the same as the desks and furniture. Each top and bottom strip of the sections is in one piece and is screwed to the wall, as are the vertical division strips between them. The panes of glass are independently mounted so that changes can be made in any section without disturbing the others. Ordinary picture mats are used with holes cut through of the size of the photograph that is to be shown. Back of the mats and photographs is placed a layer of ordinary corrugated backing which holds the glass against the molding.

The arrangement of the panels and pictures extends all the way around the office with breaks for doors and windows only, and the whole makes a most effective feature, which in this case partially solves the problem of properly taking care of retouched photographs and using them to good advantage.

TAPS AND TAPPING*†

The average user of machine screws and bolts may hear little about the theories and other details relating to tap- and die-making, but he must be interested, nevertheless, in being able to buy or make screws and bolts which can be depended upon to fit the tapped holes in the product he is making. There must always be a difference in dimensions of the screws and the tapped holes in order to make up for unavoidable imperfections in manufacture and for wear of the taps, and also to allow sufficient freedom of fit. The difference, however, should be confined to such limits that the smallest permissible diameter for the tap should be but slightly larger than the largest permissible diameter of the screw. If the limits are too large, a screw which happens to be used in a hole tapped by a maximum size tap would be too loose; again, if the limits are too small, interchangeability when assembling would be impossible, and the taps would not allow a reasonable amount of wear.

The two most vital factors are the size and the lead. In order to talk intelligently about the size, we must understand how a tap is measured. The fit of any screw should be on the sides of the angle of the thread, as the outside and root diameter have comparatively little to do with the actual fit. Unless the angle and the lead of the threads are the same in both screw and tapped hole, and the diameters measured across the angle of the threads are relatively right, a proper fit cannot be obtained.

In Fig. 1 is shown the effect of having nuts and screws of

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[*] Abstract of a paper by Mr. F. O. Wells, read before the American Society of Mechanical Engineers, March 12, 1912.

[†] See also the following articles on this and kindred subjects previously published in MACHINERY. "Hook-fluted Taps," October, 1911; "Taps and Tapping," June, 1911, and the articles there referred to; "Rules for Threading Square Thread Taps" and "Making Hand Taps in Sets," May 1911, engineering edition; "Rapid Nut Tapping," April, 1911; "Dimensions of Bit-brace Taps," March, 1909; "Power Required for Tapping," June, 1909; "Power Tapping," February, 1909.

different angles of threads fitted together. In this case the screw is shown with a more obtuse angle than the nut, and the bearing between them will be on the sharp, fragile apexes of the teeth. The necessity of measuring correctly in the angle of the thread has led to the adoption of the term "pitch diameter" for screw threads, the same as for gears. In Fig. 2 is shown a micrometer for measuring the pitch or angle diameter. The merit of this tool is that it is not rendered inaccurate by the helix angle of the thread. It will, therefore, measure the finest lead as well as the coarsest within its range.

Fig. 3 shows how variation in the lead will affect the fit between the screw and the nut. The angle in this case is assumed to be correct, but the nut has been tapped with a tap having a long or stretched lead, with the result that at the base there will be a bearing on two threads only, as indicated at *A*, *B*, *C* and *D*. This is not an unusual condition, and explains why a nut tapped with a large enough tap will often start freely on a screw, turn a few turns and then bind. This also places all the strain on one tooth at a time, making it possible, with a sufficient longitudinal strain, to strip one tooth after another with a shearing action.

The difficulties due to variations in the sizes of screws and taps are well known to those who have to use them. For this reason many are using limit gages which are made especially to measure the screw diameters across the angle, and thus insure uniformity, within working limits, of the screws to be used. Figs. 4 and 5 show one of these gages in use. The screw being measured has just passed the "go" or maximum limit in Fig. 4 and with the same movement of the hand is carried down to the "not go" or minimum limit, as indicated in Fig. 5. The rapidity and accuracy of this method of gaging is apparent. An inspector can pass on seven hundred and fifty ¼-inch taps per hour, both as regards angle and outside diameter, using, of course, two limit gages of this style. For ordinary screw work requiring less accuracy, he could pass on even a greater number.

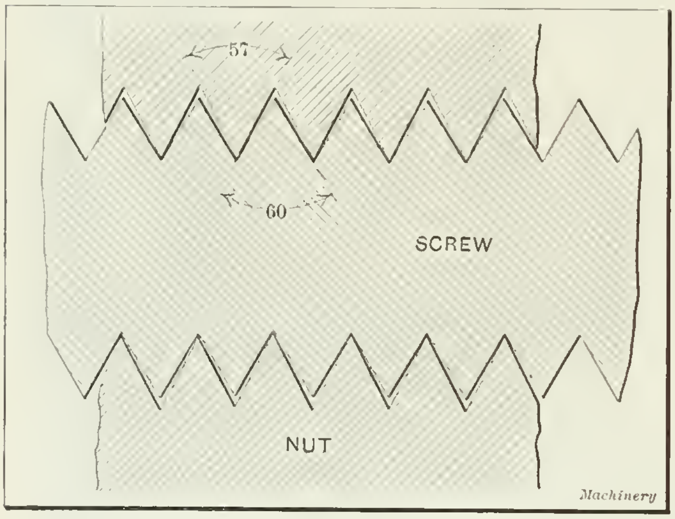


Fig. 1. Effect of Difference in Thread Angle of Nuts and Screws

As regards the lead of taps, it must be remembered that all steel will change somewhat in length in hardening; hence the lead of taps will vary somewhat from the standard. If in addition to this the hardened tap is warped on the threaded end, the condition of the tapped hole will be as indicated in Fig. 6.

We have now seen the effects that errors in lead, angle, angle diameter and warping in hardening will have on the taps. Add to this the effect of usage, reducing the size of the tap by wear, and then add the commercial variation in the lead, angle and diameter in screws and bolts, and it will be readily seen that under the best possible conditions, there will be a multiplicity of minute errors that must be taken care of by an allowance between the minimum limit of the tap and the maximum limit of the screw. There must also be a maximum limit for the tap and minimum limit for the screw in order to prevent too much looseness in the fit of the threads. There is at the present time a great diversity of opinion among tap and die makers, as well as among screw makers in general, as to what these allowances should be for the regular U. S. standard sizes, and hence the buyer of taps and screws is working under a serious difficulty in his efforts to obtain proper fits and interchangeable work. The standard adopted by the American Society of Mechanical Engineers for machine screws has been of great value, but the question of limits for the larger sizes of screw threads is still unsettled.

When a tap breaks or anything goes wrong in connection with its work, it is probably the most natural thing in the world to blame the tap maker. In many cases, however, the trouble is due entirely to the condition under which the tap is working. In order to determine some of the practical questions in this connection, such as the proper sizes of tap drills, the best lubricants, the correct cutting angles and shapes of the flutes, the right number of threads among which the cutting should be distributed, the best method of hardening to increase the life and strength of the taps and to prevent undue distortion and shrinkage, the proper way to grind cutting edges, etc., the Wells Bros. Co., of Greenfield, Mass., built special testing machines showing the power required to drive any tap. A record of the cutting action was taken on indicator cards or charts.

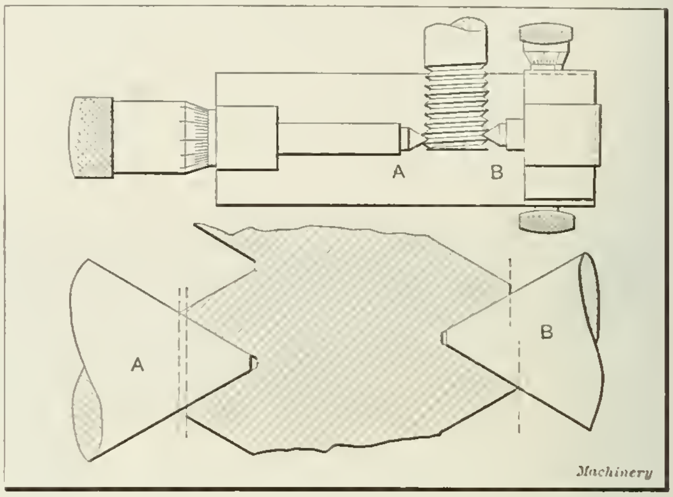


Fig. 2. Device for Measuring Angle Diameter, and Enlarged View showing its Application

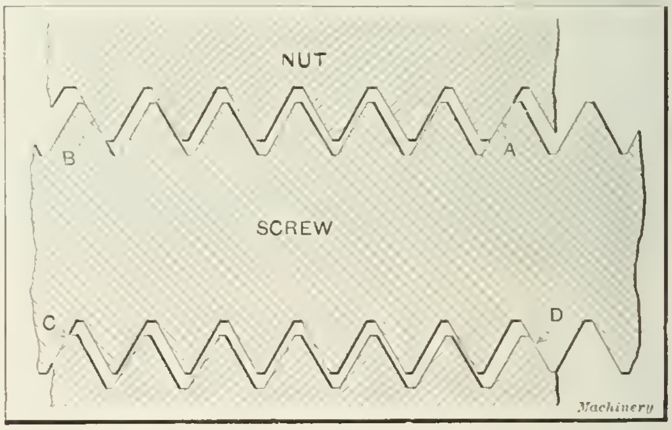
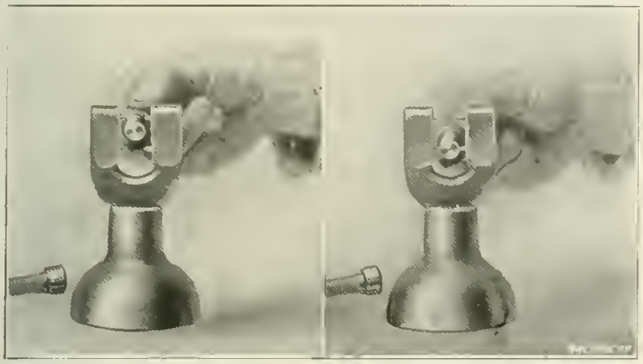


Fig. 3. Effect of Difference in Lead of Screw and Nut

Tap manufacturers often find that users of taps actually punch or drill the holes to be tapped of a smaller diameter than the root diameter of the thread, so that the end of the tap must act as a reamer before the thread can be cut. In Fig. 7 are shown sections of such nuts through which taps have passed. In this case the tap becomes a taper reamer, reaming a tapering entrance to the hole, as shown in the nuts at the top. Frequently the tap will refuse to "catch the thread" at all and will ream clear through the nut. Should the thread happen to "catch" after reaming part way, however, a short, weak thread results, as indicated by the two nuts at the right in the lower part of the illustration. This condition evidently requires considerable power, and explains why taps frequently break as soon as they begin to cut. When it is remembered that generally not more than 80 per cent of the standard thread depth is necessary in ordinary manufacturing work, and that in many cases not more than 50 per cent is required, it is apparent how useless it is to have the holes too small, and, in most cases, to even attempt to secure a full thread.

Tap drill sizes for machine screws, in particular, should be varied according to the material to be tapped and the depth of the tapped hole. In general, for holes where the screws enter more than one and one-half times the diameter, one-half of the full thread is usually sufficient. Soft, tough materials, such as copper, Norway iron, drawn aluminum, etc., should have a larger hole for the tap than the hard, crystalline materials, such as cast metals. The reason for this is that otherwise the taps of the threads of the softer materials will be torn off, thus actually decreasing the effective depth of the thread of the tapped hole as compared to what it would be had the hole originally been drilled larger. On the other hand, if the hole is originally drilled large, the tap will, when cutting tenacious materials, especially after the keen edge has been slightly dulled by use, reduce the size of the hole by drawing the metal at the top of the thread, thereby increasing the depth of the threads. It should also be remembered that it is impracticable to tap a hole with the basic root diameter size, unless serial taps or taps with long steps are used, so as to divide the work into a series of successive operations.


Figs 4 and 5. Limit Gage for Screw-thread Diameters, and its Use

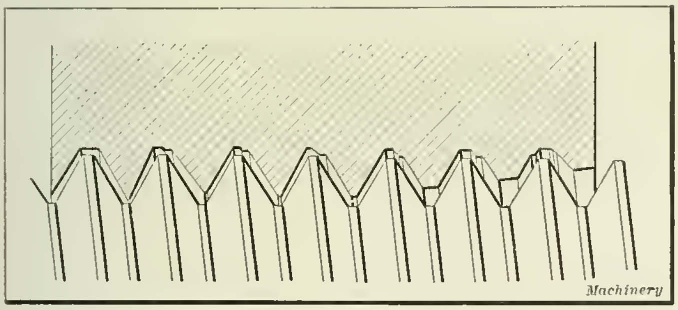


Fig. 6. Thread resulting from Tapping with a Warped Tap

The size of the hole also affects very materially the power required for tapping. This is particularly important in machine tapping. The power is also affected by the kind of lubricant used, by the condition of the tap as regards being sharp or dull, by the shape of the cutting edges and their effect on the shape of the chip, and by the shape of the flutes. In Fig. 8 are shown three taps with different kinds of flutes. The tap in the middle (having what is called a "hook" flute) produces a long, curling chip which in a deep hole will have sufficient length to curl up tightly, jam the tap and cause it to break off if there is sufficient driving power. The chips from this tap are shown in Fig. 9. In Fig. 10 are shown two nuts in which these long curled chips have rolled up and broken the tap. The end of the broken tap is also shown.

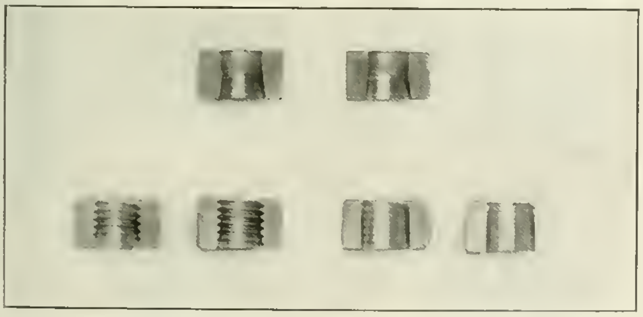


Fig. 7. Nuts, having too Small Tap Holes, reamed by End of Tap

The tap shown to the right in Fig. 8 does not cut properly, but pushes the metal ahead of it, often accumulating so much compressed metal as to resist further compression, which causes the tap to break. This tap broke while tapping cold punched nuts, twisting off near the shank at a strain of 1100 inch-pounds. The work was divided between 48 cutting teeth. The chips made by this tap are shown in Fig. 12. They are compressed in character and show by their appearance the relatively large amount of power required for tapping. In Fig. 13 are shown sections of four nuts tapped with the type of taps mentioned, and which broke while being tapped. The compressed mass of metal still adhering to the thread should be noted.

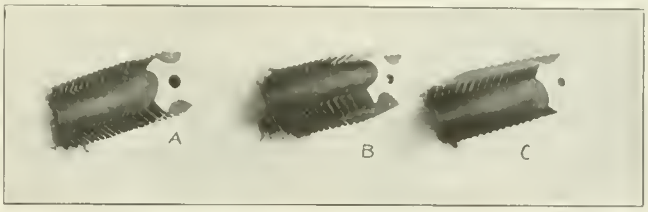


Fig. 8. Taps with Different Flutes having Different Cutting Action

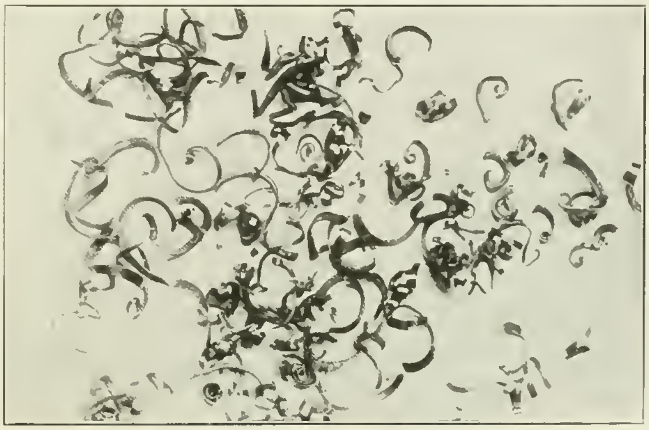


Fig. 9. Chips produced by Tap B, Fig. 8

The tap shown to the left in Fig. 8 is properly made. It produces a slightly curling chip, which breaks up into short lengths and easily slides out through the flutes. This tap requires only about one-third of the power of the tap to the right. The chips cut by this tap are shown in Fig. 14. Fig. 11 shows a section of a nut in which this last style of tap was started, and the nut was then cut open to show the action of the chip. The smooth thread and the clean, short chips just at the point of breaking should be noted.

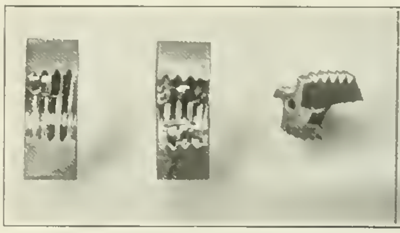


Fig. 10. Nut tapped by Tap B, Fig. 8, and Part of Broken Tap

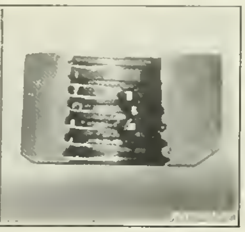


Fig. 11. Nut tapped by Tap A, Fig. 8

As almost all machine tapping is in through-holes, and bottoming taps are seldom used, experiments have been made to determine the effects of sharpening or grinding the taps back from the end for a varying number of threads, so as to ascertain the effect of dividing the work between a greater or smaller number of cutting teeth. By repeated tests and careful records it has been found that it requires approximately 25 per cent more power to drive a tap which has been ground back only four threads (which in a four-fluted tap divides the work between 16 teeth) than for one which has been ground back six threads (thus having 24 cutting teeth); the latter tap produced a much smoother thread and cut more closely to size.

Chattering in tapping is often due to burrs thrown up on the cutting edges of the tap during its manufacture, and it is very necessary that the taps be free from burrs. Considerable attention should be paid to this point in order to produce good taps.

TABLE I. POWER IN INCH-POUNDS, REQUIRED FOR TAPPING VARIOUS MATERIALS

Taps, ½ inch, U. S. S. Tap drill hole, 0 420 inch. Depth of tapped hole, ½ inch

Material	Test Numbers of Taps													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Hexagon drawn brass	60	62	62	60	65	70	60	90	60	60	60	60	60	65
	65	60	65	60	65	80	60	95	62	60	60	62	65	65
Crucible tool steel	220	242	250	230	240	280	250	375	210	270	260	270	260	258
	225	265	268	250	230	260	235	380	205	280	275	260	260	270
Cold punched hexagon steel nuts	148	158	168	170	155	150	150	340	165	195	165	175	148	180
	130	130	175	190	160	180	132	360	140	160	225	200	180	180
Hexagon screw stock	140	150	165	188	178	180	155	250	140	240	235	168	225	230
	160	170	185	165	210	268	170	430	155	190	200	160	205	205
Drawn hexagon phosphor-bronze	210	175	250	200	230	240	170	338	160	200	220	222	265	210
	190	200	300	250	200	250	182	320	190	330	210	245	205	210

TABLE II. EFFECT OF VARIOUS LUBRICANTS AND DIFFERENT DIAMETERS OF TAP DRILL HOLE

By multiplying the percentages given by 10, the actual average power required for tapping in inch-pounds, may be obtained.

	Lubricant	Animal Lard Oil	Sperm Oil	Graphite, 10 per cent; Tallow, 90 per cent	Cataract Soap Compound	Mineral Lard Oil	None (Tapping Dry)	Machine Oil
0.425 Diam. Tap Hole (75 % Thread)	Power required*...	15.9	16.5	16.9	18.9	19.9	29.9	34.2
	Breakages in tests†.	None	None	None	None	None	14	15
	Quality of thread..	Smooth	Smooth	Smooth	Smooth	Smooth	Rough	Torn
0.410 Diam. Tap Hole (90 % Thread)	Power required*...	....	23	....	25.1	36.5	60.2	62.5
	Breakages in tests†.	....	None	....	None	None	50	71.5
	Quality of thread..	....	Smooth	....	Smooth	Smooth	Rough	Badly torn
0.400 Diam. Tap Hole (Full Thread)	Power required*...	....	35.5	....	41	57.5	71.8	100
	Breakages in tests†.	....	None	....	None	None	66	100
	Quality of thread..	....	Smooth. Taps torn	....	Slightly Rough, Taps torn	Smooth, Taps torn	Torn, partly stripped	Torn. Chips wedged

* In per cent of breaking strength of tap. † In per cent.

The power required for tapping different materials is shown in Table I. This table gives the results found from tapping five different materials with fourteen different taps. The maximum and minimum power required by each tap when tapping consecutive test pieces is given in inch-pounds. The taps Nos. 6 and 8 had a slightly poorer form of flute than the rest and did not cut as smoothly nor as easily. Table II shows the effects of variations in the tap drill sizes as well as the effect of different lubricants. In this chart, which is the final result of a long series of tests, it is assumed, for comparative purposes, that the breaking strength is 100, and the strain produced by tapping holes under different conditions is given as a percentage of this. The power required to break a properly made ½-inch, 13 threads per inch, U. S. S. tap, is approximately 1000 inch-pounds; hence by multiplying the percentage given in the table by 10, the actual average power required, in inch-pounds, may be obtained. The test pieces were common hexagon cold punched nuts, accurately reamed to the respective sizes of holes, the taps being regular taps taken from the stock-room.

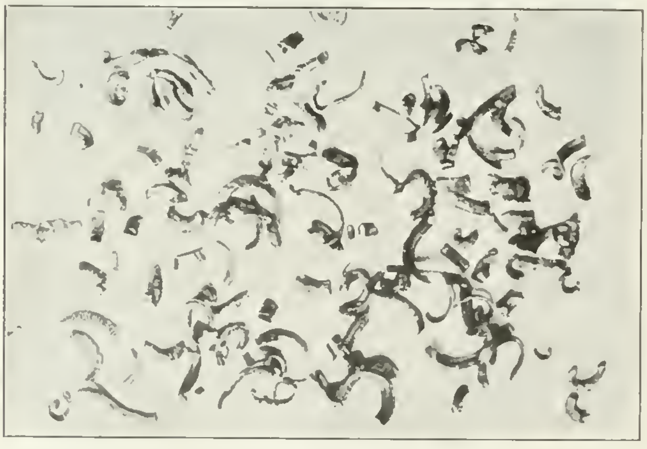


Fig. 12. Chips produced by Tap C, Fig. 8

The points brought out by this series of tests were:

1.—The lubricants used, up to a certain point, have the same effect on the power required for cutting as if more or less metal were to be removed; for instance, to tap a one-half inch nut having a hole of 0.425 inch diameter, using machine oil instead of sperm oil, would have practically the same effect on the power required as if the diameter of the hole to be tapped were reduced 25 per cent of the total depth of the thread. It will be seen in the table that the power is approximately doubled in both cases. When changing from sperm oil, the increase is from 16.5 per cent to 34.2 per cent while when changing from 0.425 inch to 0.400 inch tap drill the increase is from 16.5 per cent to 35.5 per cent.

2.—Animal lard oil, sperm oil, and graphite and tallow mixture are the best lubricants of those tested.

3.—A good soap compound is better than mineral lard oil for tapping.

4.—Machine oil is a detriment instead of an advantage. Taps cut better dry than with this lubricant.

5.—The breakage of taps is greatly reduced by the using of a proper lubricant. Taps should never be used without a lubricant when tapping steel.

6.—The diameter of the tap drill hole should not be smaller than is absolutely necessary to give the required strength. If for any particular purpose the full depth of the thread is required, it would be advisable from a tapping standpoint to gain strength by using a larger size thread instead.

7.—If for any reason it is necessary to produce a thread of full depth, serial taps should be used, with the best lubricant obtainable.

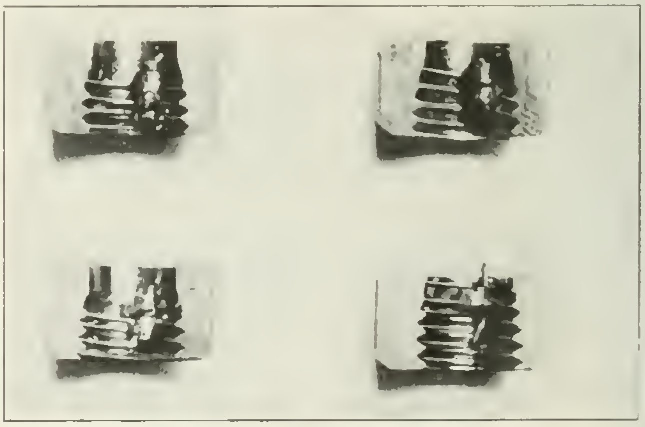


Fig. 13. Nuts tapped by Tap C, Fig. 8

8.—Every decrease of even one-thousandth inch in the diameter of the tap drill hole materially increases the power required for tapping and also the percentage of broken taps.

Referring to the sperm oil column in Table II, it will be seen that the decrease of 0.015 inch in diameter from 0.425 to 0.410 inch, required only 6.5 per cent additional power, or 65 additional inch-pounds. This is an average of a little over 4 inch-pounds per 0.001 inch. A decrease in the tap-hole size of 0.010 inch, from 0.410 to 0.400 inch, required 125 additional inch-pounds of power, or an average of 12.5 inch-pounds per each thousandth inch.

Discussion of the Paper

In the discussion that followed the reading of the paper abstracted in the foregoing, several interesting points relating to the inspection and use of taps were brought out. Mr. A. A. Fuller spoke of the relation between errors in lead and angle diameter, and presented diagrams showing how limits can be established that take into account the combined effect of these errors. The principle involved was the same as that explained in MACHINERY, July, 1907, in an article entitled "Remarks on the Making of Hand Taps," but Mr. Fuller's method was a refinement of this, and the definite limits established were indicated. It was pointed out that the shorter the hole, the greater could be the allowable error in the lead; but as it is more difficult to tap a long hole with a minimum error than a short hole, it is best, in practice, to adhere to an allowable error per inch in the lead and to compensate for that error by varying the angle diameter. The increase in diameter, for one inch depth of hole and 60-degree thread, should equal the error in lead divided by 0.58. If the depth of the hole is less or more than one inch, it is only necessary to correct the diameter in proportion. The error in lead, however, is more objectionable than the error in angle diameter, on account of the lack of bearing which the former produces.

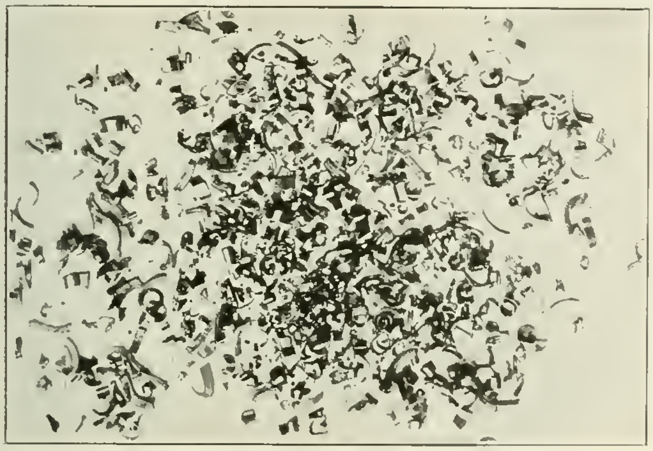


Fig. 14. Chips Produced by Tap A, Fig. 8

Mr. L. D. Burlingame presented a paper the object of which was to arouse the engineering societies and the manufacturers to the needs for a fine screw thread standard with U. S. S. threads, similar to that adopted by the Engineering Standards Committee of Great Britain, for Whitworth screw threads. (See MACHINERY, October, 1906, "British Standard Fine Screw Thread.") A comparative table of different screw thread standards was also presented. Mr. George W. Adams called attention to the need of education among foremen and machinists relative to the measuring of screw and tap threads. He thought that the tap manufacturers could do a great deal in this respect by giving a greater amount of useful information in their catalogues, and he said that he believed that they would find it to their own advantage to do so, as it would lessen the number of complaints of their products, many of which are due simply to ignorance on the part of the user.

Mr. C. B. Russell stated that in order to determine the progress of the adoption of the U. S. standard thread as compared with the sharp V-thread, he had looked up the sales of the Wiley & Russell Mfg. Co., Greenfield, Mass., and had found that 93 per cent of all tapper taps sold were of U. S. standard, as compared with 7 per cent of the V-form. Of hand taps, however, 50 per cent are still of the V-form.

With respect to lubrication, Mr. J. E. Winter mentioned that in threading steel pipe, cottonseed oil gives even better results than lard oil. The only objection to this oil is that it tends to "gum up" the machines, but it can easily be cleaned off by kerosene oil. Cottonseed oil is much cheaper than lard oil. Mr. G. Pickop mentioned that grape-seed oil has about the same efficiency as lard oil, and is extensively used as a threading lubricant.

Mr. F. O. Wells stated that when new an ordinary commercial tap has an average factor of safety of 2. He also called attention to the influence of lubrication on the size of the hole tapped or screw cut. If a screw is cut with a die using lard oil as a lubricant, the size sometimes will be from 0.007 to 0.008 inch smaller than when a soap compound is used as the lubricant.

* * *

DON'TS FOR GEAR-HOBBERS

By A. E. BOWYER-LOWE[*]

Don't forget to keep your hobs sharp.

Don't forget to put the key in the hob.

Don't forget to put the covers on the gears.

Don't start the cut before the pump is working.

Don't expect a fine finish if you crowd the feed.

Don't mesh the dividing or feed gears in too tightly.

Don't forget to give the table-driving worm plenty of oil.

Don't forget to pack up the blank on as large a diameter as possible.

Don't bush a large gear to fit a small mandrel; make a large mandrel.

Don't forget to see that the blank runs true before you start cutting.

Don't try to cut a spiral gear without first keying the job to the mandrel.

Don't forget to pull the machine around by hand before starting a new job.

Don't take the numbers stamped on the change gears for granted; count the teeth.

Don't try to hob a wormwheel, without first clamping the hob carriage to the column.

Don't forget to look now and again at the wire rope holding the hob carriage balance weight.

Don't omit to center a tooth of the hob; it doesn't take long, and if it does no good it certainly does no harm.

Don't try to hob steep angle spirals without knocking off the partial teeth at the leading end of the hob.

Don't forget to use both ends of the hob, in addition to the center; it saves a lot of grinding, and the hobs last longer.

Don't set the feed knock-off when hobbing spiral gears, without being at hand to stop the machine as soon as it operates.

* * *

As an example of the effect upon production, and the consequent financial results, of the use of automatic machinery, under efficient management, I cannot refrain from mentioning the Singer Sewing Machine Co., where I have reason to believe that the application of automatic machinery has reached one of the highest marks in this country. It is a recognized fact that automatic machinery, under efficient management, has been the chief cause of the tremendous financial success of this company. The original investment of this company was only $600,000. It has declared a stock dividend of $75,000,000. It has paid $440,000,000 in dividends to its stockholders, and is now paying 12 per cent dividends on a capitalization of $100,000,000. The figures are those of Mr. Robert Hearne in a statement before the Senate finance committee on the Underwood steel bill at a hearing in Washington a couple of weeks ago. Mr. Hearne also claimed in this connection that in spite of the fact that labor is about 40 per cent cheaper in Europe than in the United States, sewing machines can be and are manufactured cheaper in the United States than abroad, a fact which can be attributed largely to the use of automatic machinery, superiority of American workmanship and that American labor is more experienced and better equipped. As a proof of his statement, he pointed to the fact that the United States exports annually $9,000,000 worth of sewing machines, meeting foreign competition in its home markets.—*From an address by A. L. Valentine on "Comparison Between Industrial Conditions in the United States and Europe," before the American Society of Swedish Engineers.*

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THE CARE AND REPAIR OF HYDRAULIC JACKS*

By ARTHUR J. HUMPHREY†

Many mechanics who use hydraulic jacks are unfamiliar with their construction and the methods employed in the repairing of them. Hydraulic jacks are manufactured in a variety of types and sizes, but they are all fundamentally of the same construction. For the purpose of illustration in this article, I have selected a vertical single inside pumping type of jack. More recent types of jacks are on the market, some having double pumps for light or heavy duty, but there are probably in use to-day more jacks of the type chosen than of any other, and as the principle upon which all types of jacks work is the same, the following description will apply generally.

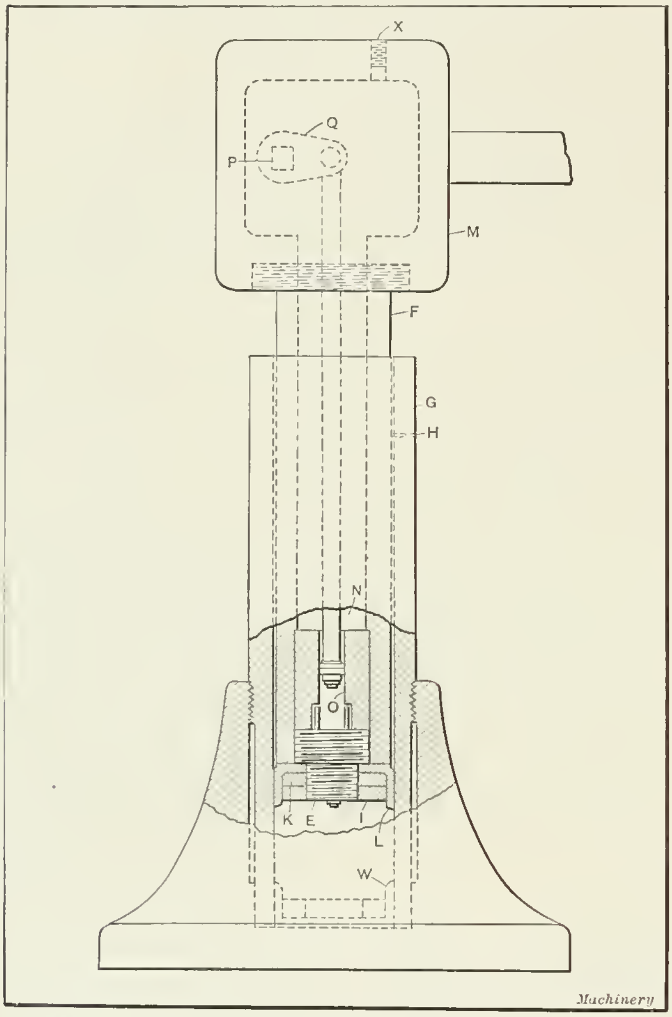

Fig. 1. Elevation of a Vertical Single Inside Pumping Type of Jack

In the type of hydraulic jack illustrated in Fig. 1, the head and interior tube or ram form a reservoir in which the liquid flows to the pump. From the pump the liquid is forced by the downward stroke of the piston past the lower valve into the cylinder, and as the latter is closed at the bottom, the ram rises to allow space for the liquid. When lowering, the lower valve *A*, Fig. 2, is pressed from its seat by the end of the piston rod, and the liquid returns to the upper part of the jack by passing around the piston through small port-holes *B*.

To illustrate the proper procedure to follow in repairing a hydraulic jack, suppose that a jack has been reported as failing to work. Now the jack may fail in a number of ways and from various reasons, and the nature of the failure may indicate the location of the trouble and how to remedy it. For instance, there may not be any liquid in the jack, in which case the jack will certainly not work. To remedy this, it is only necessary to fill the jack with liquid, provided it has not been emptied long enough to dry out the leather packing on piston and ram. If the jack raises the load, but will not lower it, the bottom valve *A* is probably too short, so that the piston when clear down will not force the valve from its seat. To remedy this a longer valve is inserted, or if there is no valve available and it is necessary to use the jack before one can be secured, a small amount of solder may be dropped on the end of the valve to lengthen it. However, this is not recommended, and should only be used as a makeshift.

If the jack lifts, but will not hold a load, it is evident that the liquid, after being forced into the cylinder, must be leaking out again. By observing the jack while under pressure, and noting whether the liquid leaks around the bottom or over the top of cylinder *G*, we can determine which particular packing leather needs renewing. If no leak appears at these points, the liquid must be slowly leaking to the top of the jack through the ram valve *A*, piston valve *C* or around the piston packing *D*.

The valve seats and piston packing if only slightly cut will allow a light load to be raised quickly, but as the liquid leaks out the ram will slowly drop down again. Of course, if the seats are cut considerably, the jacks will not raise or lower at all. It is sometimes found that pieces of grit or dirt lodge on the valve seats, or the valves stick to their seats and prevent the jack from working. By giving the jack lever a firm quick jerk up and down, the dirt may be dislodged and the valve released. If when pumping or under pressure the lever rises when the hand is removed, there is something under the ram valve *A*, or the seat is cut so that the liquid returning through the pump plug *E* communicates pressure to the piston, raising it to the top of its stroke. Probably the most common jack failure is that of not raising the load due to leakage in the valves or looseness in the pump packing. Assuming that such is the case and that it is necessary to overhaul the jack, proceed as follows:

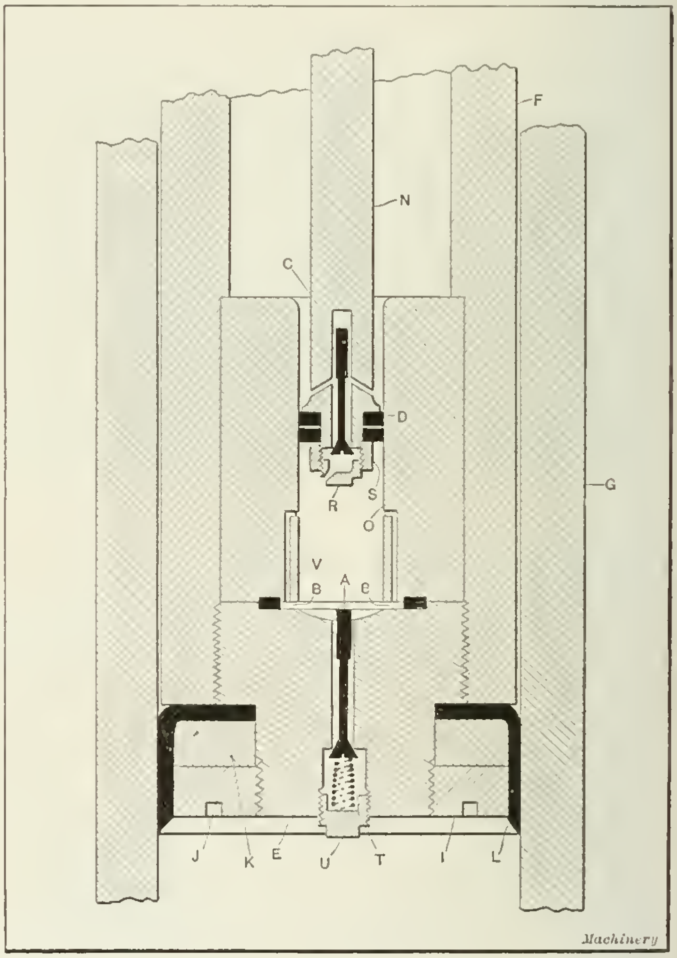

Fig. 2. View of the Principal Working Parts of the Jack shown in Fig. 1

Referring to Fig. 1, remove the ram *F* from the cylinder *G* by pumping it up as far as possible and lifting it out of the cylinder. If the ram is too heavy, or the packing too tight to permit this, the ram may be entirely removed by driving a wooden plug into the small vent hole *H* in the side of the cylinder. This vent hole limits the travel of the ram, so that when it is plugged and sufficient water is poured into the reservoir to entirely fill the cylinder, the ram can be removed. If it should so happen that the ram cannot be pumped out, it may be necessary to pull it out with a crane, or force it out with a long lever. The jack lever should be pressed down before attempting to do this.

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* For additional information on hydraulic jacks and kindred subjects, see the following articles previously published in MACHINERY: "Dudgeon 'Universal' Hydraulic Jack," March, 1910; "Notes on the Manufacture of Hydraulic Machinery Gathered in the Shops of the Watson-Stillman Co.," October, 1899.

† Address: 144 Teller Ave., Grand Junction, Colo.

Let the liquid stay in the jack cylinder for the present, and grip the ram in a vise, taking care not to mar it. Unscrew the nut *I* (see Fig. 2) with a spanner fitting in the holes *J* and remove the ring *K* and the ram packing *L*. Now unscrew from the ram the pump plug *E*, and the head *M*, Fig. 1. The pump piston *N* may now be withdrawn from the pump cylinder *O*. If it is desired to inspect the socket packing, this may be done by loosening the set-screw and withdrawing the socket *P* from the arm *Q*. To renew the packing, cut a washer from sole leather, making the inside of the diameter slightly smaller than the socket, and the outside diameter the same as the recess. After inserting the new packing washer, remove all small pieces of leather which have been cut off from the washer, then drive the socket in place again through the ram and tighten the set-screw.

To examine the pump cylinder *O* to see if it is cut, drive it out with a wooden plug. If the cylinder is badly worn it should be trued by reaming. Then force the cylinder over the piston and note if the piston packing is a tight fit in the cylinder. Sometimes it will be found that the piston packing is tight at the ends of the cylinder but quite loose in the middle, indicating that the cylinder has become worn where most of the travel is. If this is found to be the case, it is necessary to ream the cylinder and straighten it up, removing as little material as possible and using oil as a lubricant. After enlarging the cylinder, the piston packing must be renewed. To do this remove the brass valve bonnet *R*, piston packing ring *S*, piston packing *D* and valve *C*. Now insert a new packing leather washer on the piston, then a cup packing leather, with the cupped side facing bottom of jack; then screw up piston packing ring fairly tight, and fit the packing in the cylinder with a clean file.

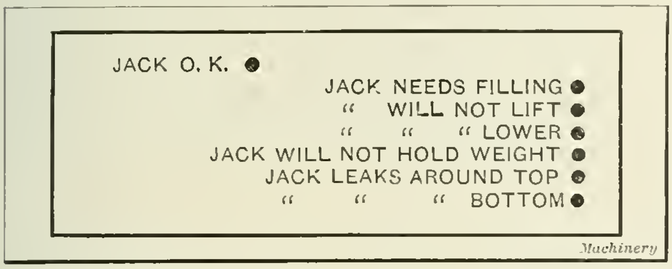


Fig. 3. Repair Report Nameplate fastened on Each Jack in Use

Proceeding with the inspection, examine the valve *C* and its seat; the latter will usually be found to be all right, but if the seat is deeply cut, it should be "reset," with a set having an included angle the same as that on the valve. If the valve is much worn a new one should be put in. An old valve may be fitted, by carefully filing and then grinding it into the seat with oil and flour emery. If the ram packing *L* has become worn and the liquid has been leaking over the top of the cylinder or through the vent hole, place a strip of thin tin around ring *K*. After ascertaining that all the port holes, etc., are free from dirt and grit, assemble the ram by replacing the head, piston and then the cylinder. Before replacing the pump plug *E*, inspect the leather washer *V* to see that it makes a tight joint between the plug and cylinder. If it does not fit tightly, a new one should be inserted. Examine valve *A* and its seat and grind them if necessary. After the plug *E* is in place, the valve *A* should be inserted and tested, to see whether it will release the jack or not. To ascertain this, press the valve to the seat and force the piston down to the bottom of the cylinder, at the same time observing if the valve is pressed from its seat—a space of 1/8 inch is sufficient; then replace spring *T*, bonnet *U*, ram packing *L*, ring *K* and nut *I*, and empty the liquid from the cylinder *G*.

The bottom packing *W*, Fig. 1, seldom gives trouble, but if it should become necessary to renew it, remove the old packing and drive the new packing and ring in from the upper end of the cylinder by means of a wooden plug, which is slightly smaller than the cylinder bore. If the cylinder is badly cut and it is impossible to renew it, it can be repaired by reboring it and then forcing in a cold-drawn tube lining of the proper size.

After washing out the cylinder, wipe and oil it and then insert the ram. A handy appliance to assist in starting the packing into the cylinder, is a clamp made of thin sheet iron. This clamp encircles the packing and the ends are turned outward to receive a small bolt for tightening it. After pressing the jack lever down in order to open the valve so that the air may escape, push the ram down and strain the liquid into the jack through the filling and air plug *X*. The liquid recommended for use in hydraulic jacks is as follows: To one part of grain alcohol add two parts of water. This liquid is probably the best as it does not freeze in cold weather, corrode the pump, gum and clog the valve, and has not a deteriorating effect on the leather packing. Never fill a jack without straining the liquid.

After a jack has been overhauled, it is advisable to put it under pressure and let it remain so for a few hours. This will test the jack and set up the packing. If the jack has been fitted with new packing, it is well to let it remain over night before using it in order that the leather may be thoroughly soaked. If the repair has been handled in the proper manner the jack will give good service. It is essential, however, to keep it in good order, and without this precaution it is useless to expect satisfactory service from it. Most of the trouble met with in using hydraulic jacks is caused by neglect—allowing rust or foreign substances to collect, or broken and dried-up packing to remain; another precaution is not to overload the jack. The ram should be down when the jack is filled to prevent using more liquid than the reservoir will hold. If a jack is full when the ram is run out, and the cylinder under the ram is also full, it would be possible to burst the reservoir if the ram was lowered while under load and the air-hole in the reservoir had become plugged.

Always keep the ram quite down within the cylinder when not in use, otherwise the piston and ram packing may be out of the water and so become dry. For the same reason do not jack a load up to the full extent and let it remain so for several days, rather block under the load and remove the jack. Do not push the operating lever down too quickly, nor check the lowering of the load suddenly, especially under a heavy load. The sudden checking of a heavy load traveling at a high momentum, is likely to swell the cylinder to a permanent set, which will ruin it. To lower the weight, push the lever to the bottom of the stroke, then take it out and turn it with the projection upward, and with a slight pressure of the hand, the weight may be lowered as slowly as required and stopped at any point.

In large shops and round-houses where a number of hydraulic jacks are in constant use, the repairs may be made much more quickly by adopting the following system: A brass plate, Fig. 3, similar to a nameplate is attached to each jack, say on the outside of the cylinder, and a number of small holes drilled and tapped as shown, and provided with a thumb-screw to fit the hole. When the jack is sent in for immediate repair, whoever has condemned the jack, should remove the screw from the hole opposite "Jack O. K." and place it in the proper hole, designating why the jack has been sent in for repairs. Each jack is numbered and a record is kept by the man in charge of repairs; then by noting in which hole of the plate the thumb-screw has been placed, and by referring to the record book to see what repairs were made in the past, it is possible to determine very quickly just what must be done to make the jack fit for service as soon as possible. After the jack is repaired, the thumb-screw is placed in the "Jack O. K." hole again. Of course a printed report blank or card sent in with the jack would answer the same purpose as this plate, but it is difficult to get the mechanics using the jack to take the time and trouble to fill out the blank, and the thumb-screw is much handier. The plate may be cast or cut out of sheet brass and stenciled, or a printed card may be pasted on it and covered with white shellac.

LETTERS ON PRACTICAL SUBJECTS

We pay only for articles published exclusively in MACHINERY.

NARROW VS. WIDE GUIDES FOR MACHINE TOOLS

In the January number of MACHINERY, Mr. J. S. Detrick, of the Detrick & Harvey Machine Co., explains why his firm has adopted the narrow guide for machine tools in preference to the wide, and gives the readers to understand that by reducing the ratio between the length of the guide and the width it was found that cross-winding was considerably reduced.

Theoretical considerations of the problem indicate, however, that the width of the guide has no vital influence upon the amount of cross-winding which can take place, but that the length of the guide has. This is explained in the following treatment of the case. Let L = the length of the guide; B = the width of the guide; and db = the amount of play between the surfaces of the guide and those of the sliding part.

These conditions are indicated in the accompanying diagram in which the amount of slack or play is shown considerably exaggerated. The angle α is the angle of cross-winding of the sliding part on the guide, this angle being formed by the diagonal of the sliding part in two positions, namely, the intermediate or normal position and one of the extreme positions. Let the length of this diagonal be denoted by x. Then, from an inspection of the diagram, it will be seen that

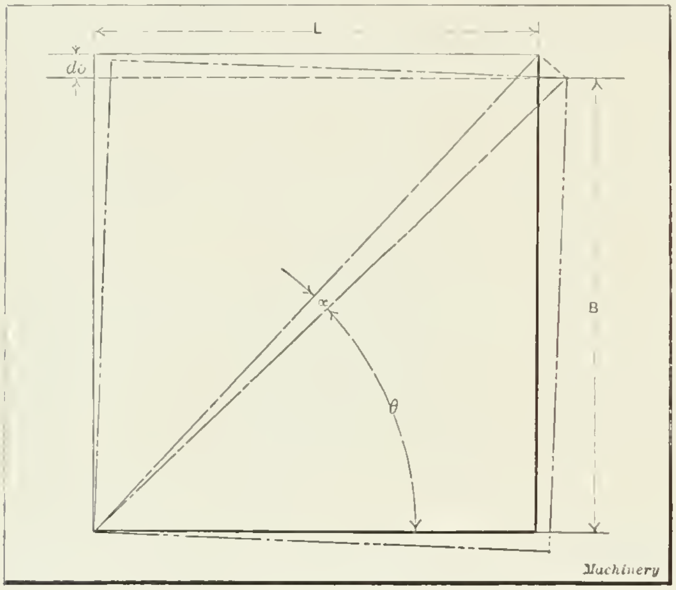


Fig. 1. Showing that the Angular Displacement for Given Clearance is nearly the Same on Wide and Narrow Guides

$$\frac{B + d\,b}{x} = \sin\,(\theta + \alpha) = \sin \alpha \cos \theta + \cos \alpha \sin \theta$$

Now, $\sin \theta = \frac{B}{x}$; $\cos \theta = \frac{L}{x}$ (practically); $\sin \alpha = \alpha$ (practically) because α is very small; and $\cos \alpha$ = unity for the same reason. Hence,

$$\frac{B}{x} + \frac{d\,b}{x} = \alpha \times \frac{L}{x} + 1 \times \frac{B}{x}; \text{ therefore}$$

$$d\,b = \alpha \times L, \text{ and}$$

$$\alpha = \frac{d\,b}{L} = \frac{\text{amount of slack}}{\text{length of guide}}$$

This shows that the amount of cross-winding is inversely proportional to the length of the guide or slide, always assuming, of course, that the amount of slack or play is a very small quantity, and that the width-dimension is not a factor in this connection.

This conclusion is opposed diametrically to the conclusion Mr. Detrick arrived at as the result of practical considerations, and it would be very difficult indeed to explain the difference between them. One explanation which has occurred to the present writer is that it is much easier to machine narrow guides which are reliable and parallel than it is to machine wide guides possessing the same qualities. This appears, however, to be a point which requires the results of a series of reliable experiments for its satisfactory elucidation.

Sheffield, England GEORGE W. BURLEY

[Although it is true that the angle of deflection due to cross-winding is the same with wide and narrow guides, other conditions being the same, the lateral pressure on the sides of the guide and slide is greater on a wide guide than on a narrow guide for any given eccentric load. Referring to the diagram, Fig. 2, suppose an extreme case in which the pressure required to move the slide is applied at one corner directly over the edge of the guide and the resistance to movement is all at the diagonally opposite corner, as shown at P and R. Then the turning moment is $\frac{P \times W}{L} = P \tan \alpha$. In the case of the narrow guide, Fig. 3, it is apparent that $P \tan \beta$ will be less than $P \tan \alpha$. Hence the greater angle α is, the greater will be the lateral pressure, approaching infinity as W becomes very wide or L very short. Therefore friction and wear are greater on wide guides than narrow ones.—EDITOR.]

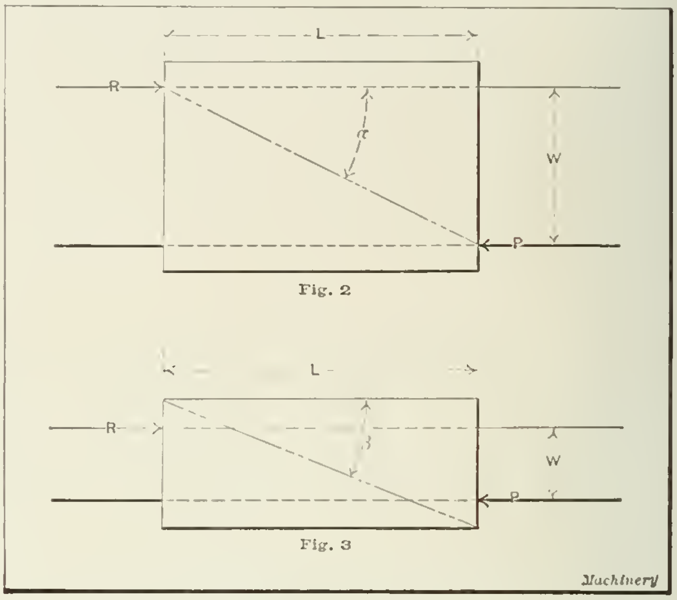


Fig. 2

Fig. 3

Figs. 2 and 3 Showing that Lateral Friction and Wear are Greater on Wide Guides than on Narrow Ones

POWER REQUIRED TO DRIVE REAMERS

Recently we wrote to three manufacturers of reamers and one of our prominent colleges asking if they had ever made tests to determine the difference in power consumed as between three-groove spiral chucking reamers and four- or six-lip parallel reamers. None of them had made tests or knew of any results to which they could refer us.

With so much being written on efficiency and economy in manufacturing, is it not rather curious that there should be no data on this subject?

The writer has used both kinds of reamers, and knows there is a great difference in the amount of power required to drive these reamers. The feed and speed that can be used with spiral reamers is much greater than with parallel reamers and much less care is required for the belts. In fact we can almost feel safe in saying that the saving is fifty per cent. We can get all the data necessary as to rake, clearance, etc., on lathe or planer tools, also on drills. We can get the horsepower consumed driving these tools with these various clearances and angles, but who can tell us the difference in horsepower consumed as between three-groove spiral chucking reamers and four- to six-lip parallel reamers?

Auburn, N. Y. A. A. BERTRAND

DEVICE FOR TESTING AND MEASURING GEARS

The device shown in Fig. 1 has been used for several years with very satisfactory results. Differences in diameter and eccentricity of 0.01 millimeter (0.00039 inch) can be measured by it, and the exact meshing of a couple of gears can be accurately tested. On the cast-iron base are fitted two slides, each being provided with a spindle to hold the gears to be tested. The slide to the right is moved by means of a long adjusting screw; the one to the left has only a very limited adjustment, but transfers its motion, greatly magnified, to an index placed on the front side of the base. Fig. 2 is a longitudinal section of the device; it clearly shows how the motion is transferred to the index, which measures the differences in eccentricity and the errors in mesh with great accuracy. To detect differences in eccentricity, it is most convenient to place the gear to be tested on one spindle, and to use a blank with a single tooth on the other. This tooth is meshed in succession with all the teeth of the gear under test, and by observing the different positions of the index while each tooth is measured, the eccentricity may be determined with great accuracy.

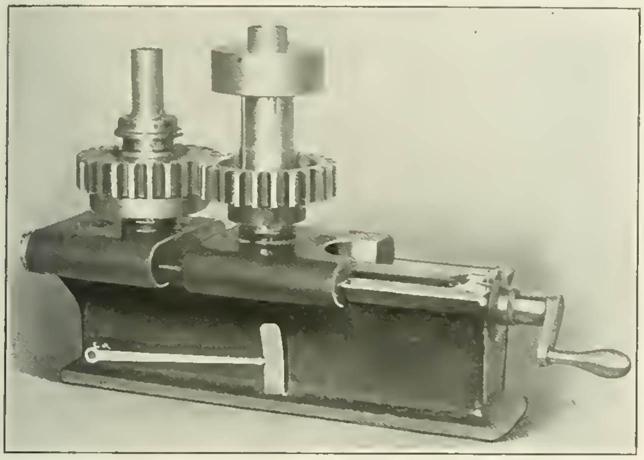


Fig. 1. Device for Testing Gears

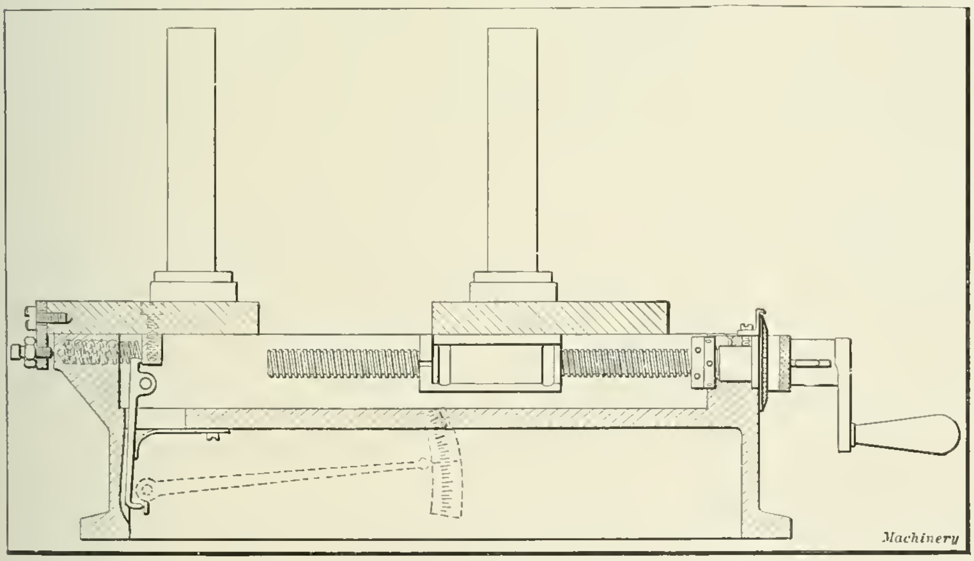


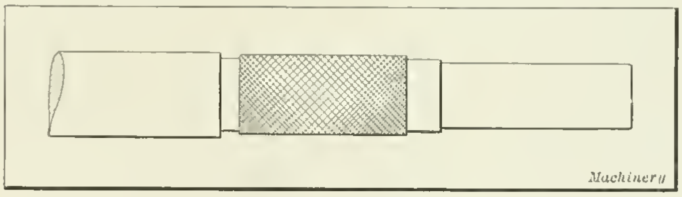
Fig. 2. Section of Device for Testing Gears

Torino, Italy. C. Boella

SAVING A SHAFT BY KNURLING

It has been common shop practice to condemn shafts, axles, etc., which have not met the allowance required for a press fit. This practice has made the manufacturer as well as the mechanic suffer for slight errors, and the junk dealer alone has profited. The manufacturers have lost thousands of dollars yearly due to small errors, such as shafts or axles being, for example, 0.0005 inch or 0.001 inch too small for the gears, pulleys, collars, flanges, etc., into which they are to go, or because commutator shells are from 0.0005 to 0.001 inch too large for a press fit.

Here is where the knurl plays a big role by rectifying even larger mistakes in a few minutes. Suppose that a commutator shell, pulley, or gear has accidentally been reamed or bored 0.001 or 0.005 inch too large. Instead of scrapping and duplicating these parts, put the shaft between the lathe centers, and knurl the seat for the press fit as shown.



Saving a Shaft by Knurling

The knurl should be coarse and can be straight, spiral or cross-cut, and of any size or width, although for a small shaft a narrow knurl is required. After knurling, the shaft will be about 0.020 inch larger, depending upon the coarseness of the knurl. After this operation the shaft can be turned down again to the press fit allowance. This simple operation will prove very satisfactory in any line of work where press or shrinkage fits are used. J. E. U.

MULTIPLE-THREAD INDEXING IN THE LATHE

The following formula will be found useful to any machinist or toolmaker. The writer has had occasion to cut multiple-thread worms or spiral gears in the lathe, and in not one instance has the operator been able to do the proper indexing. It is quite simple to index for a double or triple thread, but few average workmen know what to do when the number of threads is greater than that. Therefore the writer has formulated the following rule which will cover every case:

Multiply the number of threads per inch of the lead-screw of the lathe by the lead of the spiral to be cut, and multiply this product by the number of teeth in the gear on the lead-screw; then divide that product by the number of starts or teeth in the worm or spiral. The quotient is the number of teeth the lead-screw gear will have to be turned to give the proper indexing.

For example, we want to cut a spiral gear having 8 starts or teeth, with a lead of 1½ inch in a lathe having a lead-screw with 6 threads per inch. We first figure our gearing for the lead, which gives a gear having 24 teeth for the lead-screw. According to the rule, we then have

$$\frac{6 \times 1\frac{1}{2} \times 24}{8} = 27 \text{ teeth, as the}$$

number of teeth the lead-screw gear must be turned. Cut the first thread, bring the lathe to a stop, mark the intermediate gear and the gear on the screw, disengage them, move the lead-screw one full turn and 3 teeth, engage the gears, and the next thread may be started. Repeat this until the gear is finished.

Of course if the product in the formula does not contain the divisor without a remainder, the gear on the lead-screw must be changed until one is obtained which will give the desired results. The ratio must, of course, be retained.

Detroit, Mich. John G. Paine

[The reason why this rule will give correct results may not immediately be apparent. It is evident that what we want to do is to move the carriage forward a distance equal to the distance from one thread to the next, that is, equal to the linear pitch of the worm; in the example given this distance is 1½ ÷ 8 inch. As the lead-screw has 6 threads per inch it makes 6 revolutions when moving the carriage one inch. Hence, to move the carriage 1½ ÷ 8 inch, it will make (1½ ÷ 8) × 6 revolutions. For each revolution 24 teeth are engaged. Hence, the total movement from one thread or start to the next equals (1½ ÷ 8) × 6 × 24, which may also be written in the form used by our correspondent.—EDITOR.]

THE PRINCIPLES OF PROJECTION

The writer believes that the general principles of projection—the reasons why the views are placed on a drawing the way they are—are not generally understood by mechanics and sometimes not even by draftsmen. In America, the method indicated in Fig. 2 appears to be universal, but in England there is really no universal way of projecting one view from another, as some use first-angle and some third-angle projection. In Fig. 2 is shown what is ordinarily termed third-angle projection, and which, undoubtedly, is the best way to show an object in a drawing. In this case the end views are placed nearest the end from which they are viewed. The plan is placed above the front elevation, and the bottom view or inverted plan is placed below the front elevation. An excellent way to demonstrate to students the reasons for showing the views in this manner, is as follows: Imagine a box having six glass sides as shown in Fig. 1. Place an object inside of the box and draw the view of each side on the face opposite it. Then open the box and the views will be presented in a plan as indicated in Fig. 2. The writer has found this to be the best way of demonstration, and the easiest way to remember.

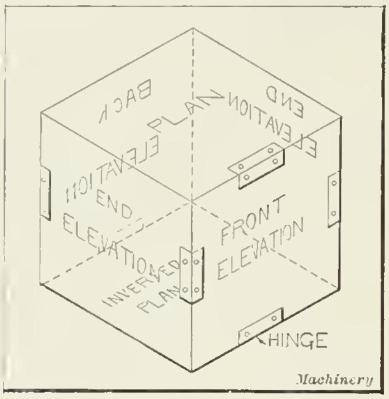


Fig. 1. The Third-angle Method of Making Projections as followed in America

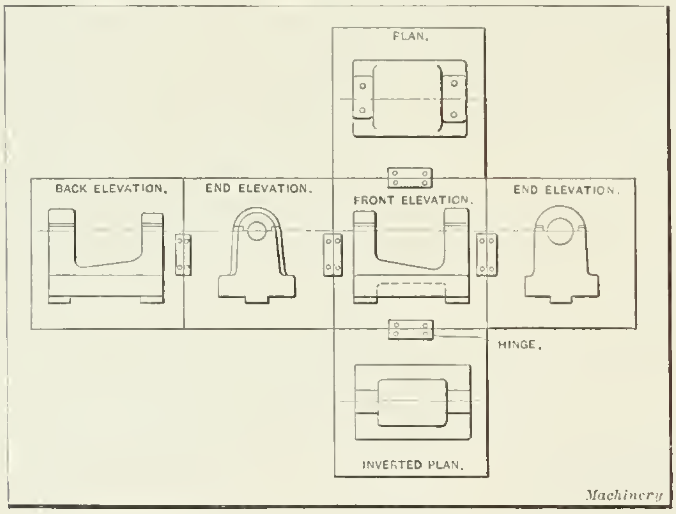


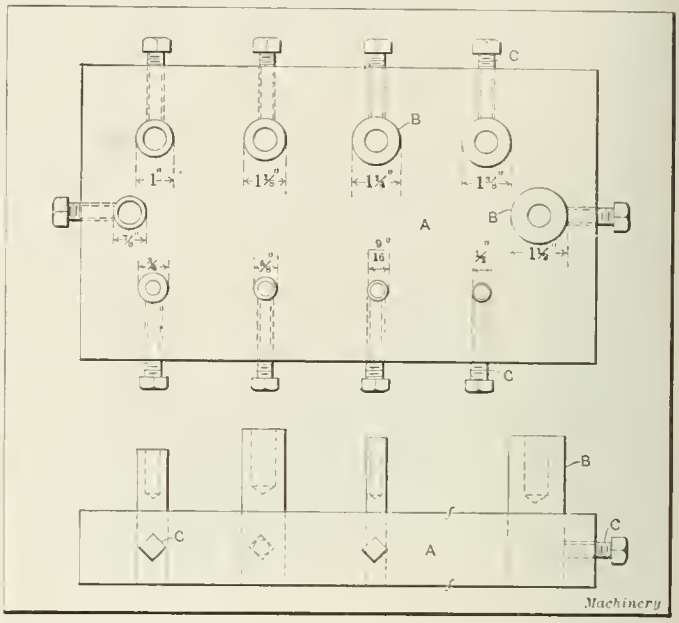
Fig. 2. A Simple Method to follow in making Correct Projections

Belvedere, Kent, England. A. W. BOASE

FIXTURE FOR HOLDING LEVERS, ETC., WHEN FACING THE BOSSES

Every mechanic knows how troublesome it is to face the bosses of levers and brackets and get the faces true or at right angles with the holes. When the lever or bracket is strapped onto the drill press table, it is liable to spring in clamping, which results in the faced surface of the boss not being true with the hole.

The fixture shown in the accompanying illustration consists of a cast-iron parallel block *A*, 14 inches long by 8 inches wide by 2 inches thick, finished on both sides. This block has ten holes drilled in it varying in diameter from ½ to 1½ inch. Of course any number of holes can be drilled and the block made of a suitable size to handle the work for which it is to be used. The holes drilled in the block *A* are made to receive the studs or pins *B* which should be made from cold-rolled steel and casehardened. These studs have a hole drilled in one end to receive the pilot of the counterbore, and are adjustable in the fixture, being held when set to the desired height by means of the set-screws *C*. In the fixture shown in the illustration, the holes in the small studs are made ⅜ inch in diameter, while the holes in the large studs are made ⅝ inch. The studs *B* should be made to fit the hole in the lever or bracket snugly so that the boss will be faced true with the hole.



A Fixture for Holding Levers or Brackets when facing the Bosses

In use, the block *A* is fastened by clamps to the drill press table and the hole in the stud *B* is set in line with the pilot of the counterbore. The lever or bracket, after the hole has been drilled, is slipped onto the stud *B* and swung around until it touches one of the other studs, which acts as a stop. Stud *B* may now be set to the desired height, so that the lever will be faced to the required distance when the counterbore touches the top face of the stud. DAVID McINNES

Plainfield, N. J.

CHAIN CASES

In the February number of MACHINERY, Mr. J. F. Winchester defends the unprotected chain on motor trucks. It seems to be his contention that trucks operate under conditions and on roads that are worse than those under which pleasure cars operate; hence, chains should not be protected. The truth of relative road conditions alone might properly be questioned, because touring cars are usually to be found wherever there are trucks, and very often in places impossible of access by trucks; but, granting the necessity for operating trucks on poor roads, does it not make the need of a protected chain all the more urgent?

Bearings in machines that do not operate in dirty surroundings do not need protection, as, for example, in the high-speed stationary engine. We have seen them operate successfully without being enclosed, and it was only a few years ago that completely enclosed splash oil systems of lubrication were first made. Such engines are now found in the cleanest power houses built, where the enclosure can be of value for facilitating lubrication only. Where there is dust and dirt, the covering serves a double purpose; the dirtier the surroundings, the greater the value of the cover. Certainly, if trucks run on dirtier roads, they are in greater need of protection.

Chain cases do not require much space on a vehicle and need not lessen the clearance between road and sprocket more than an inch, at most. Any driver who is competent enough to negotiate a road that is full of ruts without chain cases on his car, but who would break the cases, were the same chains covered, would be a refined driver indeed. Besides, can a sprocket and chain withstand more rough treatment than a solid braced cover?

Chain cases as ordinarily located are in a large measure protected by the wheels. Hence, they are in less danger than gear boxes, which are invariably located in the center of the rear axle and directly exposed to the point where obstructions on unpaved roads usually exist. Yet, geared drives are invariably enclosed! The writer has several times repaired gear cases broken by striking obstructions on country roads. In every case, however, the vehicle was not immediately rendered useless. The oil ran out of the gear case, to be sure, and for that reason the transmission efficiency may have been slightly impaired by the accident, but the vehicle was still operative. If the uncovered gears had struck the obstructions, would they have kept going merrily on?

It is not illogical to compare chains and gears because of the difference in construction. In the operation of each form there is sliding contact—more in the gears than in the chain. true enough—and wherever there is sliding contact, abrasion is augmented by grit and dust: everybody knows that. The figures reported in the November issue of Machinery show this nicely. Chain manufacturers cannot compel machine manufacturers to cover the chains they use, nor do they insist on it strongly. It might be of interest, however, to know that one of the largest manufacturers of chains is endeavoring to show the user the importance of using cases, and in many instances this chain manufacturer's suggestions have been advantageously heeded. More data such as contained in Machinery's November editorial will be of much value to automobile and chain manufacturers.

New York City W. F. Schaphorst

MORE COMMENT ON AUTO-TRUCK TRANSMISSION CHAINS

The use of uncovered chains is certainly indefensible on motor cars—trucks or touring. Any car, to be sure, is liable to have its chain break; but when that chain becomes laden with foreign material, the chain- and sprocket-wear increases to a great extent. The life of both the chain and the sprocket is shortened, and the car is out of commission oftener while renewals are being made. It is a small matter to design a chain case that can be removed quickly; the cost is nominal, and compared to the cost, the results are phenomenal.

No doubt the makers of chains know more about them than anyone else, so let me quote from the catalogue of one of the largest manufacturers of chains: "Chains should be housed and run in oil, the same as are gears, to give best results; but as an alternative they should by all means be protected from heavy grit or mud, the deposit of which increases the base diameter of the sprocket, resulting in rapid wear and elongation of pitch of both chain and sprocket." While we all did not wear out chains and sprockets on our bicycles, it is a matter of easy recollection how much easier "she" ran after we had taken off the chain and cleaned and greased it.

C. P. W.

WHY THE SHOP DOES NOT RETAIN THE SKILLED MECHANIC

In the January number of Machinery I noticed an article entitled, "Why the Shop Does not Retain the Skilled Mechanic," and would like to make a few comments on the opinions there expressed. I believe that the expert machinist and toolmaker is not required to the same extent today as he has been heretofore. Different methods of management are gradually eliminating the all-around man and developing specialists in all lines of work—expert lathe hands, planer hands, etc. Young men do not wish to start in as apprentices and work for $3.00 to $5.00 per week for several years, when they can start in with small experience on some one machine and earn considerably more. The young man of today does not want to waste his time—he considers it waste—by acquiring knowledge that he thinks he will never need. It is to be regretted that this type of man is becoming more and more common, but this is the reason, principally, why many large firms have discontinued their apprentice systems.

In regard to placing machinists and toolmakers on the honor system, it may be said, in the first place, that in very few shops does one now find any employes, except stenographers and bookkeepers, employed on the honor system. It has been proved that this system does not "work out" with the average man. It is too easy for him to be late or absent when no record is kept of his coming or going. Time-clocks would not have been installed if it had not been found to be necessary. Consider for a moment a large manufacturing plant employing, say, one thousand men. If only a few men were making a practice of being absent all or part of each day, the routine of the work would suffer. The time-clock is necessary for the simple reason that the average man thinks of no one's convenience but his own. It is much easier to come in late than on time, and those who may mean well enough, soon become careless.

It was also mentioned that it takes more skill to become a machinist or toolmaker than to become a draftsman, and, therefore, the former man should have as much, if not more, consideration than the latter. Perhaps the writer of the article referred to, never worked as a draftsman, and in that case he is excused for the remark. Comparatively few machinists or toolmakers, when they have finished their day's work, give a thought to it until the morrow. On the other hand, most draftsmen, no matter in what line of work they may be, have to study or work out problems that have come up in their daily work, at least, say, three nights a week. A writer in a magazine recently said that "men employed in engineering work have a most confining life for that very reason." Besides this, a draftsman has to work hard many years with his books before he is able to fill his position.

I do not mean this to be direct criticism of the position taken by the former writer, for he may have found the facts as he stated them to be true in his case; but the opinion I have expressed is based on the facts as I have found them in a number of large manufacturing establishments.

Philadelphia, Pa. Edward R. Glenn

A SIMPLE TAPPING FIXTURE

Having occasion to tap several thousand swaged nuts of the form shown in Fig. 1, a fixture to be used on a horizontal tapping machine, as shown in Fig. 2, was designed. This fixture consists of a cast-iron angle-plate *A*, to the front face of which is attached a soft-steel block *B*. Fastened to this block *B* are two guide strips *C*. Two hardened shoulder pins *D* which pass through the blocks *A* and *B* act as stops for the nut while being tapped. Attached to these stops and fitting over a groove turned on them, is a flat steel spring *E*. The holes in this spring are made keyhole-shaped, so that the spring can be inserted over the pins and then brought down into position, where it is held with the block *F*, a screw, and two dowel pins, as shown. The top of this spring is formed into a ring, so that it can be conveniently handled.

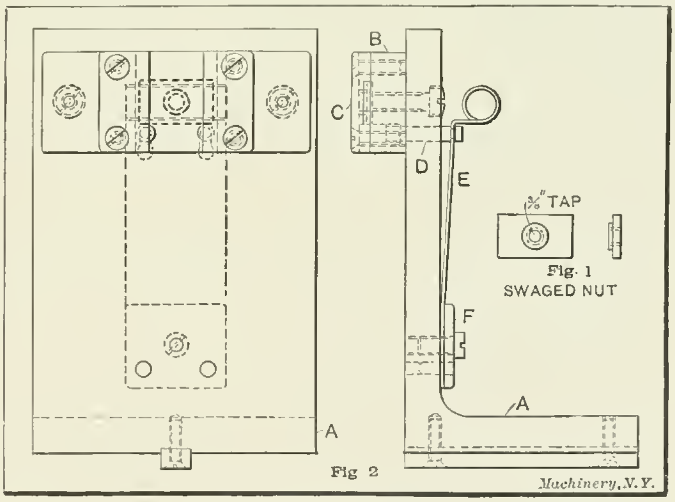


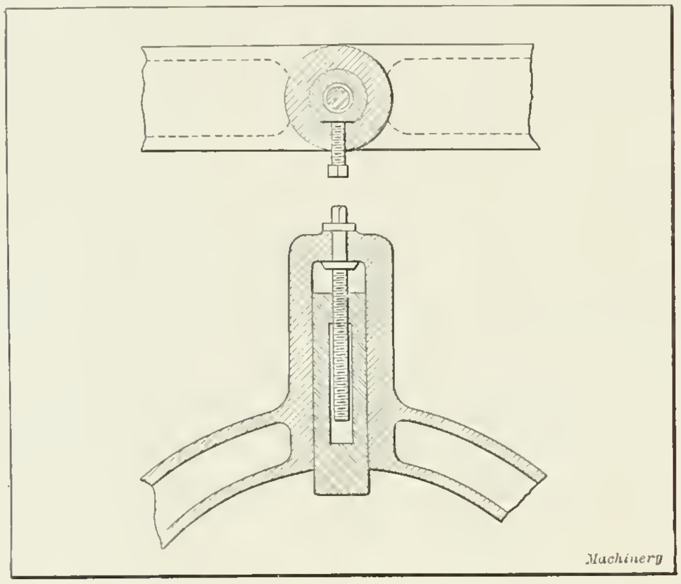
Fig. 1. The Swaged Nut. Fig. 2. The Fixture used for Holding the Nut while tapping

In operation, the nut shown in Fig. 1 is placed in the guides, and rests on the pins *D*. The machine table is then moved forward, carrying the angle-plate, and the tap passed into the nut. The table is then withdrawn, and when the tap emerges, the spring *E* is pulled back, which withdraws the pins *D*, thus allowing the nut to drop into a pan placed on the table to receive it. This device can be cheaply made, but should be judged from its efficiency rather than its simplicity.

Detroit, Mich. ARON LAWRENCE

A LATHE STEADYREST OF UNCOMMON DESIGN

The accompanying illustration shows a lathe steadyrest which varies from that usually supplied by the lathe builders of today. The general outline and construction of the rest is the same, but the jaws are different. The ordinary rectangular jaw is replaced by a cylindrical piece fitting snugly in a bored hole, as shown, which is adjusted by means of a screw. These jaws may be made of any material depending upon the work on which they are to be used. We use jaws made from steel on heavy lathes, when large cast-iron drums are turned. This construction is very rigid and is of simple design. H. TERHUNE



A Lathe Steadyrest of Simple and Rigid Construction

Plainfield, N. J.

THIS IS "ABSOLUTELY" TRUE

"Say, Bill, what was the matter with the boss and the young fellow that just left?"

"Well, you see, everybody, in the last few years, has been using the word 'absolute' in connection with the work turned out on their machines. That fellow came in and said to the boss, 'You ought to plane those plates on one of our machines; they plane absolutely true surfaces,' and I heard the old man tell him a little experience.

"'Young man,' he said, 'I want to give you a pointer. I had heard one fellow say that his machine grinds absolutely true, another that his turns absolutely true, another that his mills absolutely true, and another that his pulleys and shafting run absolutely true, for so long that I got the disease and agreed to build a machine for that old fellow down by the railroad track who hammers saws and does blacksmithing, that would grind saws absolutely true on their sides. Now I will tell you what happened to me because I did not know what the word 'absolute' meant. After I had built the machine and sent it down, and thought I had given him about enough time to pay for it, I decided to call around for the money. Now, I had seen some of the work turned out on it and had a letter from a man who had seen it wanting me to build one for him, so I felt sure everything was O. K.

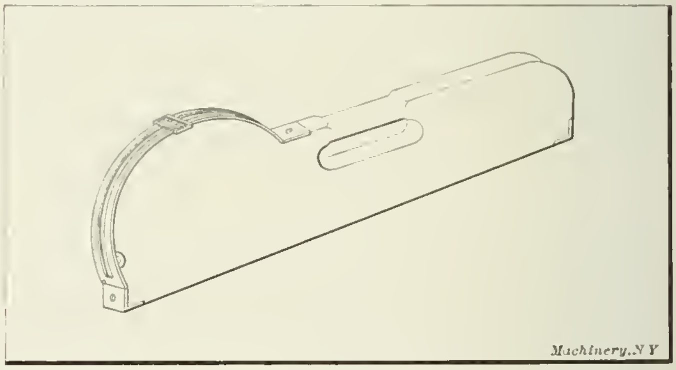
"'As I entered and stated my reason for calling, he asked me to look at some of the saws which were ground on this machine. He reached up on a shelf and got a nice new straightedge, and suspended a saw by a string hooked over the teeth and then held the straightedge against it. With the other hand he shoved the 0.004 inch blade of a feeler through, between the straightedge and the saw. Then without saying another word, he got my contract and pointed to the clause in which I agreed to produce a machine which would grind absolutely true. I requested him to put a saw in the machine and let me adjust it, and I proceeded to grind a saw. When I had it finished and the saw tallied with the straightedge, I called him over. He looked at it, and then got a surface plate about 10 inches square, and thinly covered it with lamp black and rubbed it over the surface just ground. Upon removing it, he informed me that the machine must grind absolutely true before he paid the bill.

"'Then it dawned upon me that I had used a word to convey one meaning that really meant another. I could not convince him of the injustice of his demands, and we went to law. My attorney could make no impression upon the court, which simply stated that if I agreed to build a machine to fly ten miles, the simple fact that it was impossible to do so did not entitle me to receive pay for a machine that would nearly fly. The above incident took place twenty years ago. We have since accomplished what was then considered an impossible thing, *viz.*, the flying machine, but are practically as far from producing machinery that does work absolutely true, as we were then. The only satisfaction which I got was that the machine was returned to me. I soon disposed of it, but it taught me a lesson.'" J. G. D.

GONIOMETER OR ANGLE-MEASURER

The goniometer, or angle-measurer, illustrated herewith is the invention of a German and is intended to measure the angle of an object on which it is placed without the use of any ways, screws, etc., it being merely necessary to lay the instrument on the object and read the angle off directly on the semi-circular scale at the left.

It consists essentially of a glass tube, bent into a circular form and filled with liquid; a bubble in this liquid, as in ordinary levels, tends to keep to the top. A sliding piece on a circular scale is placed over the bubble and set in that position, thereby indicating the angle. This sliding piece also makes it possible to set the indicator and then remove the goniometer to a lighter place where the angle may be more easily read. In making this instrument, the one precaution necessary is to bend the glass tube containing the liquid to a perfectly circular form. ROBERT GRIMSHAW



The Goniometer, a German Instrument for Measuring Angles

Dresden, Germany.

A COUNTERBORING TOOL AND FIXTURE

While the automobile engineers are busy improving and perfecting their latest models, incidentally they are developing some very interesting machine and tool problems. The latest of these to come to the writer's attention was the facing and counterboring of a 5-inch diameter by 6-inch stroke cylinder. It appears that by the constant wearing of the piston rings upon the cylinder wall, a slight shoulder was formed near the extreme end of the piston ring travel in the cylinder. This shoulder however slight causes a piston knock when the piston ring reaches it. The resulting sound or knock could hardly be distinguished in the open, but as the knock occurs inside the cylinder which is closely connected with the crank case, the latter acts as a sounding box deceiving the ear to such an extent that it is necessary to use a phonendoscope or vibracator to make sure of its location. To overcome this noise our engineer decided to relieve the cylinder bore at the upper end, so that the upper piston ring would travel about one-half its width above the counterbored recess. The tool shown in Fig. 1 was designed to perform this operation and was used in the fixture shown in Fig. 2, the fixture being held on a machine of the two-spindle vertical type which was formerly used for reaming cylinders.

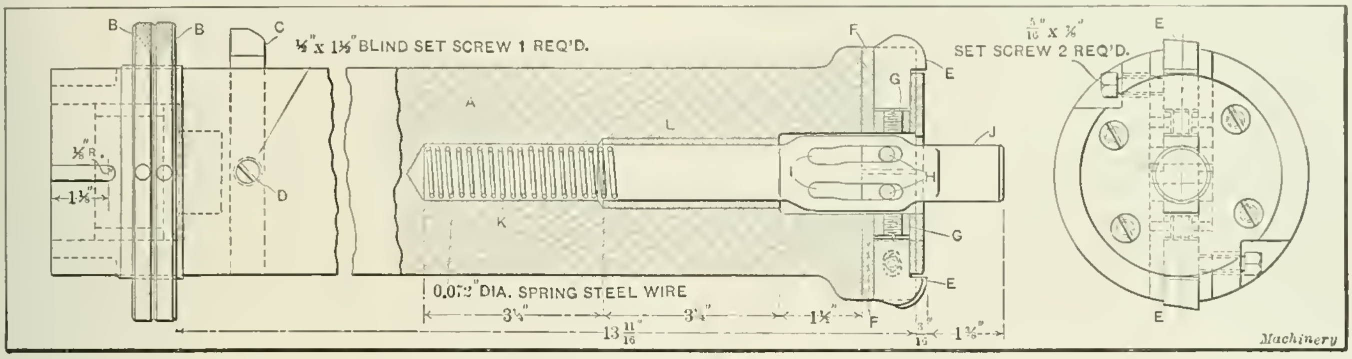


Fig. 1. Details of the Counterboring Tool

As shown in Fig. 2, the counterboring tool extends down into the cylinder to the required distance, and the tool-heads carrying the turning tools are operated by cam grooves in the central plug. The body of the tool *A* is made of machine steel, threaded in the upper end to closely fit the nose of the spindle of the machine. The total length of the body of the tool is 16 inches, and it is made of large diameter so as to afford sufficient support to the cutters to prevent chattering. The position of the counterbored recess is governed by stop collars *B*, which gage from the upper surface of the jig that holds the gas engine cylinder. Held in the body *A* by a screw *D* is a tool *C* which chamfers the open end of the cylinder to an angle of 45 degrees. The counterboring tools *E* are held in the tool-holders *F* and are adjusted by screws *G*. Driven into the tool-holders *F* are pins *H*, which operate in cam slots *I*, cut in the central plug *J*, the latter being operated upon by the spring *K*. The central plug *J* is fitted in a bronze bushing *L*, held in the body of the holder.

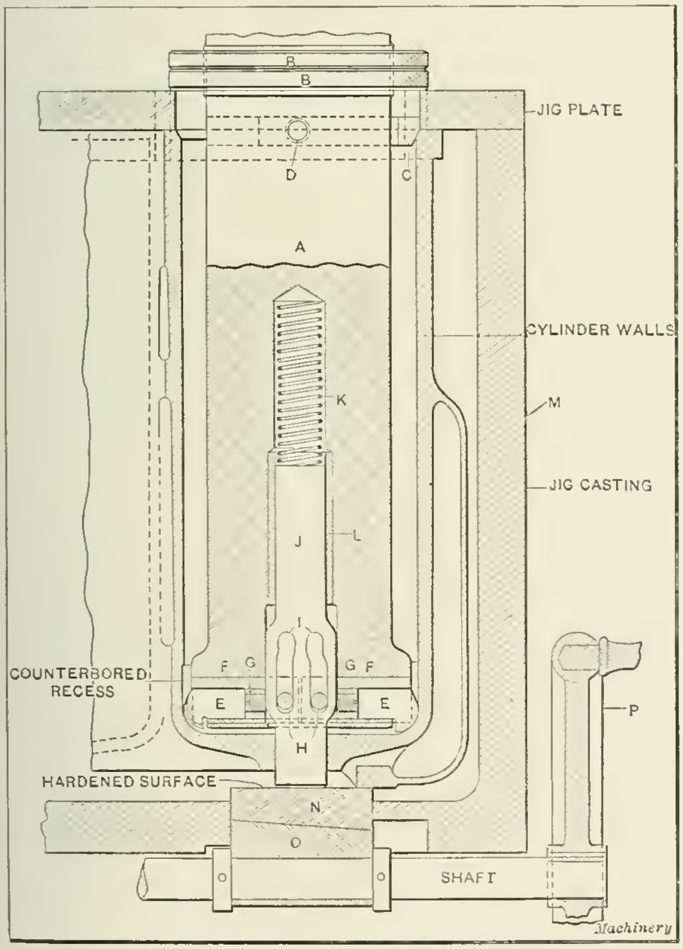


Fig. 2. Showing the Cylinder in the Fixture and the Counterbore at Work

In operation, the cylinder is clamped in the jig *M*, Fig. 2, and the body *A* inserted until the stop collars *B* come into contact with the top of the jig. At the same time the central plug *J* comes in contact with a hardened wedge *N*, which forces the former up into the body against the tension of the spring *K*—thus expanding the cutters. As the body *A* still continues in its downward movement, the cutters are kept to the same diameter by means of the straight portion of the cam slots, the extreme downward position of the cutters being governed by the washers *B* as previously mentioned. Adjustment for the central plug *J* is provided by a hardened wedge *N*, which is operated by the beveled plug *O* and handwheel *P*. The spring *K* has a very important function to fill, as the operation of the cutter depends entirely on its action. The tool-holders *F* are made from tool steel and are somewhat expensive to make, but as it is possible to hold short tools in them, a saving in steel is thus effected. The constant cutting in the hard scale and sand in the cylinder dome, requires frequent resharpening of the cutting tools, and when worn to the limit of the adjusting screws *G*, they must be replaced. The best high-speed steel obtainable is used for these cutters so that the smaller the cutter, the less the cost of maintenance will be.

Lansing, Mich. E. H. PRATT

SOME OBSERVATIONS ON GEARING

Speaking from practical observation and experience I believe that it is wrong to calculate the strength of steel gears as if they were able to continuously transmit two or more times the power transmitted by cast iron. I am not referring now to gears that run only intermittently, because with them it is more a question of strength than of wearing qualities, and I am referring only to ordinary steel forgings and castings, and not to alloy steels.

Ordinary cast iron on cast iron is a good combination so far as wear goes, while soft steel on soft steel, or on steel castings, is an exceedingly poor combination, as anybody can prove by using a steel shaft in a steel bearing. Why then should we expect steel teeth to wear as well as cast-iron teeth for the same load? And further, why should we expect them to endure under twice the load that cast iron is supposed to be able to carry? As a matter of fact, steel gears thus loaded are short-lived and uneconomical when run for eight or ten hours a day. I know of a great many instances that could be cited in support of this statement, and if any one of the readers of MACHINERY could name a case where steel gears will wear well when continuously transmitting anything like the loads allowed by the Lewis factors, I would be interested to know the details. I do not want it understood that I advocate cast-iron gears for I do not, but I advocate using the same factors when calculating steel gears as when calculating cast-iron gears, as far as the teeth are concerned. An ample margin for wear is just as important an economy for the purchaser of gears as it is in any other machine part. This is particularly true in the case of gears, where the labor cost is great in proportion to the cost of the material.

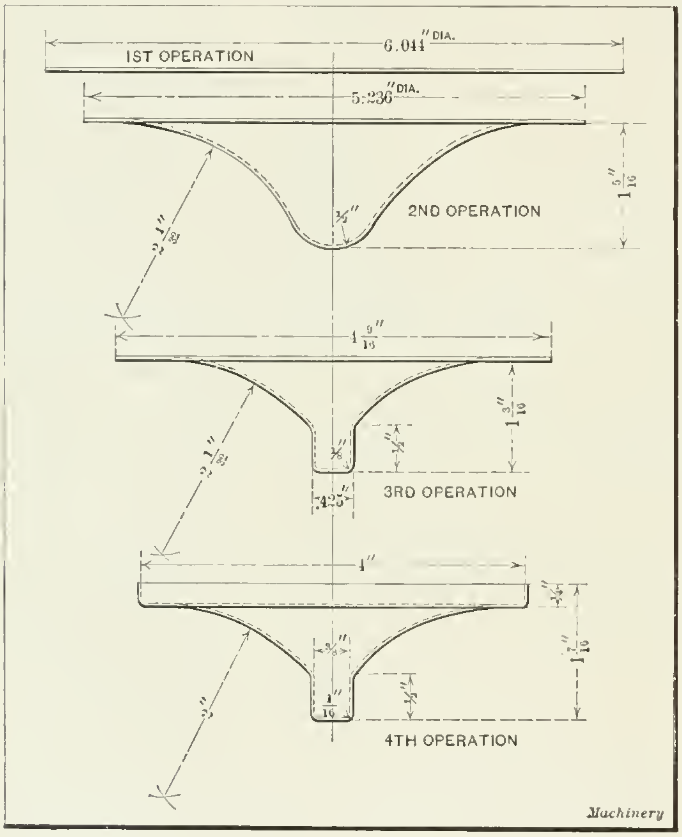
There is another thing that observation leads me to believe is more often done wrong than right, and that is the locating of the shaft centers for a pair of gears. I believe that they should be located enough closer than the theoretical distance, so that when the thrust of the teeth forces them apart by the amount of play there is in the bearings, they will be at the correct center distance. I believe that a great many breakdowns are due to the fact that the teeth do not mesh properly, because the centers of the gears are forced too far apart when loaded.

From a somewhat limited experience with worm-gear drives I have concluded that a well-designed worm and worm-wheel of high thread angle, made of the right materials and working well inside of the safe limits of pressure and speed, are much more satisfactory than two spur gears and two bevel gears to gain the same reduction and change of direction.

Scottdale, Pa. F. D. Buffum

THE DRAWING OF AN ODD-SHAPED CUP

In the February number, J. M. asks for advice relative to the drawing of an odd-shaped cup. In the writer's opinion this is a job in which considerable difficulty will be encountered. Owing to the small dimensions of the shank on this piece it does not seem feasible to do the work in less than four operations, as shown in the accompanying engraving.



Successive Operations in Drawing an Odd-shaped Cup

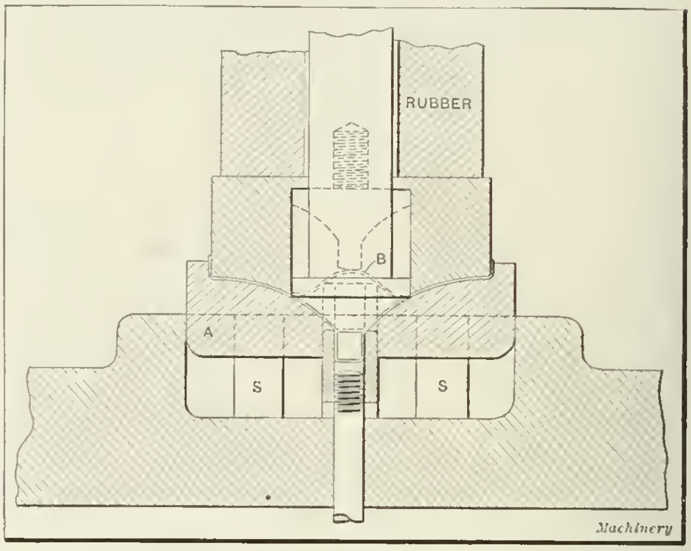
If it were attempted to do the work in a smaller number of operations, there would be considerable waste, in rejected pieces, as the metal would not flow fast enough to fill up, and the punch would break through.

As will be seen from the illustration, the metal is drawn out by easy stages until somewhat near the finished outline, before the sharp corners required are given to it. By the form of the question, the writer is led to think that J. M. is not equipped with good die-makers for making the dies. If that is the case it would be advisable to submit a sample of the piece required to some firm making a specialty of this class of work, so that this firm could bid on the dies, and decide exactly how they ought to be made and what would be the cost.

Fort Wayne, Ind. H. R. Talmage

DRAWING AN ODD-SHAPED CUP

In the February number of Machinery, J. M. asks for information regarding the tools necessary to make an odd-shaped cup. The accompanying illustration may serve as a suggestion as to the main features of the die equipment required. The dotted lines at *B* show the shape of the cup after the first operation, a combination cutting, drawing and embossing die being used for this. The dotted lines also indicate the location of the blank at the beginning of the working stroke of the second operation. With a two-inch stroke, provision must be made for the removal of the cup after forming. As a suggestion, the slots *S* are indicated, into which parallel wedge blocks are placed. These can be withdrawn after the stroke is completed, to allow the lower pressure ring *A* to fall and provide the required opening between the dies.



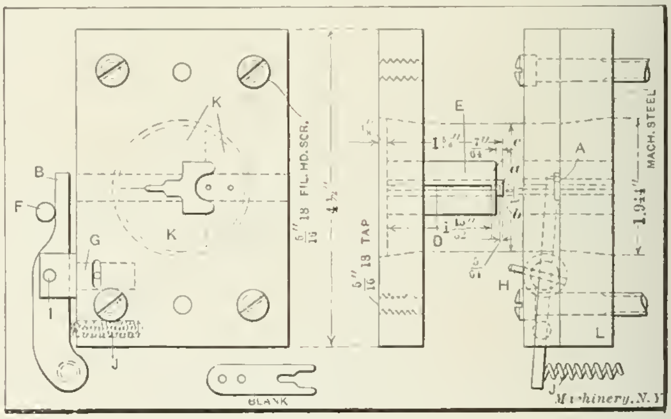
Suggestion for Making Dies for Drawing an Odd-shaped Cup

Columbus, Ohio. Otto R. Winter

A PIERCING AND CUTTING-OFF PUNCH AND DIE

An interesting punch and die for piercing and cutting off a typewriter part, is shown in the accompanying illustration. The stock which is a narrow strip, is fed through the channel *A* against the stop *B*, and is pierced and cut off by the punches *D* and *E*. The face of the punch *E* is made of varying heights, the forward part or face *a* and the following part or face *b* are both lower than the cutting-off face *c*, so that the slot will be cut in the blank before it is severed from the strip. The small holes in the forward end of the blank are pierced by the punches *D*, the faces of which are higher than the faces of the blanking and cutting-off punch *E*.

In operation, when the stop *B* is lifted, it swings in toward the die and rests on top of the finished blank, which is forced out of the channel when the strip is fed forward. When the blank drops out, the stop snaps down and engages the end of the strip, and is forced by the latter against the pin *F*. The stop *B* rotates on the pin *G*, which is prevented from pulling out by the pin *H*. The stop *B* swings laterally on the pin *I*, and springs *J* are for actuating the stop.



Progressive Piercing and Cutting-off Punch and Die

The die proper is made up of three segments *K*, which are tapered and are driven into the die-block *L*. Two of these segments are symmetrical and can be milled out in one piece, then sawed apart before the taper for fitting them in the die-block is turned. To turn the taper on the die, the three pieces are soldered together and the punch is used as an arbor.

Designer

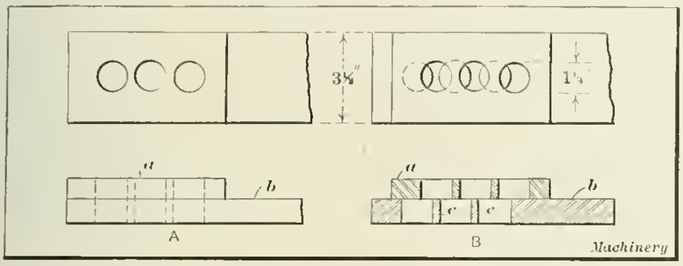
SHOP KINKS

PRACTICAL IDEAS FOR THE SHOP AND DRAFTING-ROOM

Contributions of kinks, devices and methods of doing work are solicited for this department. Write on one side of the paper only and draw sketches on separate sheets.

DRILLING ELONGATED HOLES

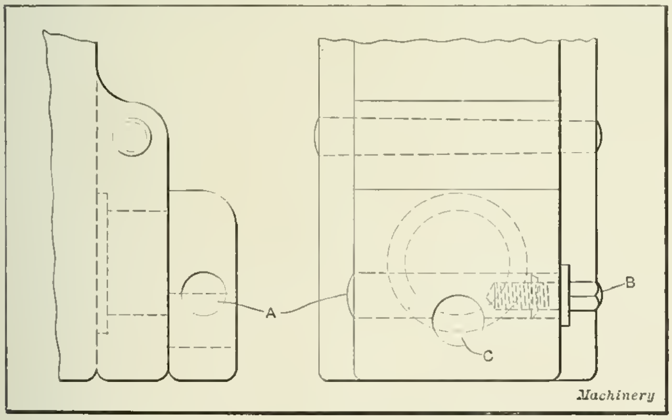
A simple method of drilling elongated holes is shown in the accompanying illustration. A plate *a*, which can either be made of machine steel and casehardened or furnished with hardened bushings, is clamped to the piece *b* to be drilled. The three holes, as shown at *A*, are then drilled clear through, after which the block *a* is shifted to the position shown at *B*, and the remaining webs *c* are drilled out with an ordinary twist drill, ground square on the end. Preferably a high speed and light feed should be used; high-speed drills will be found to give better satisfaction than ordinary carbon drills.



SUBSCRIBER

EXTENSION TOOL-HOLDER FOR A SMALL SHAPER

In model and experimental work it frequently happens that the work to be handled in the shaper requires a tool projecting further than can be obtained with a regular tool. To meet such cases the clapper block shown in the accompanying illustration was made for the purpose of holding an extension bar, in the end of which the cutting tool is held.



Referring to the illustration, *A* is a round rod into the end of which is tapped a hole for the screw *B*. A hole *C*, bored in the block at right angles to the rod *A*, provides an opening for the extension tool-holder. By tightening the screw *B*, after placing the tool-holder in position, the latter is held securely, the rod *A* acting as a clamp.

Hartford, Conn. F. CHARLES SCRIBNER

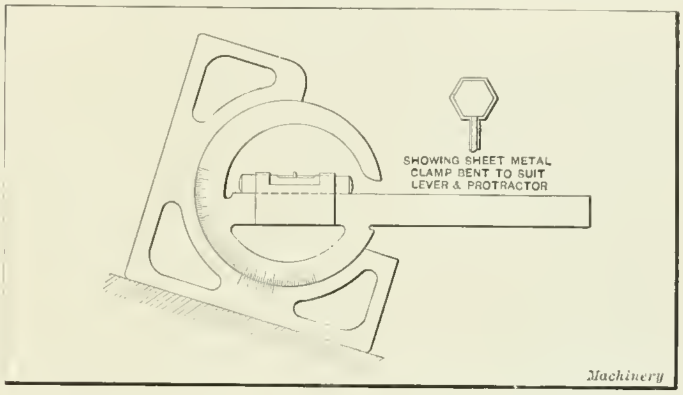
FACING WORK ON THE LATHE FACEPLATE

In facing on the lathe faceplate, it is common practice to pack up the work with tissue paper to prevent it from slipping around, and also to avoid the necessity of clamping it too tightly. Another method which is equally as good, if not better, is to deposit a thin coating of oil and fine emery between the work and the faceplate, spreading it evenly. This method allows a heavy chip to be taken when the work is clamped lightly. Still another method is to apply a thin coating of hot shellac to the faceplate, and also a thin coating to the side of the work that will be placed next to the faceplate. The faceplate is removed from the lathe and the work placed on quickly and moved around; then a weight is placed on it and left until the shellac is dry, after which the faceplate can be put on the lathe and the cut taken. This method requires no clamps at all, and was used with satisfactory results by the writer in taking a finish-facing cut from a cast-iron disk 6 inches in diameter and 1/32 inch thick.

Newark, N. J. H. E. WOOD

OBTAINING ANGULAR MEASUREMENTS WITH A B. & S. DRAFTSMAN'S PROTRACTOR

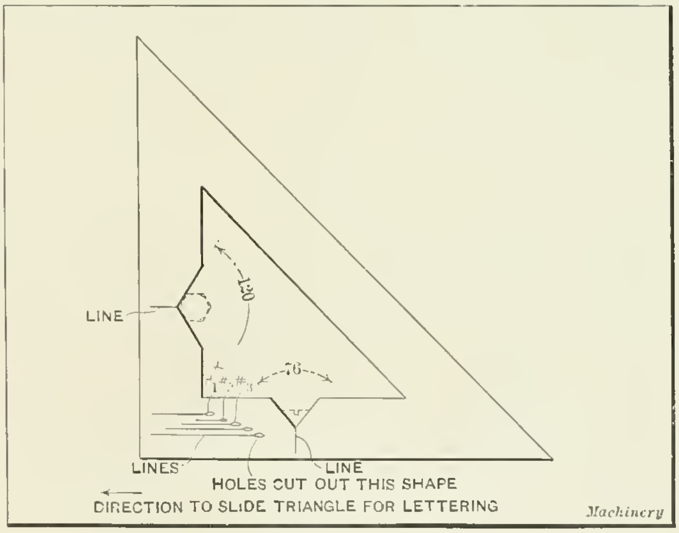
It frequently happens that a draftsman finds it necessary to measure an angular surface on a machine, but cannot do so because there is no finished surface to take the measurement from. The accompanying illustration shows how an angular measurement can be taken. This is accomplished by means of a Brown & Sharpe draftsman's protractor to which an L. S. Starrett level is attached by means of a piece of flexible material such as sheet tin, zinc or steel. The protractor can be placed on the angular face of the machine and the arm raised until the spirit level shows that the arm is in a horizontal plane, when the angle can easily be found.



F. D.

DRAFTSMAN'S TRIANGLE FOR DRAWING BOLT AND SCREW HEADS

The triangle shown in the accompanying illustration will be found convenient for drawing bolt heads, flat-head screws and laying out spacing lines for uniform lettering. Take a 45-degree triangle, preferably celluloid, and lay out the angles, as shown. The portion cut away at 120 degrees is for hexagon-head bolts, while that part cut away at 76 degrees is for flat-head screws. The small holes marked Nos. 1, 2, 3, etc., are so arranged that different spacings for lettering can be obtained. The space between 1 and 2 is ⅛ inch, while the distance between 1 and 3 is 5/32 inch. The point of the pencil may be inserted in these holes, and the triangle moved along in the direction indicated, thus drawing the spacing lines for the lettering.



H. F. FLOHN

Newark, N. J.

HOW AND WHY

DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST

Give details in full and name and address. The name and address will not be published with the answer

METAL PAINT TO WITHSTAND ALCOHOL

S. J. B.—It is required to paint a brass vessel having a glass top with white paint which will successfully withstand the action of diluted alcohol in the proportion of 2 to 1 without the paint changing color. What mixture of paint should be used?

This question is submitted to the readers.

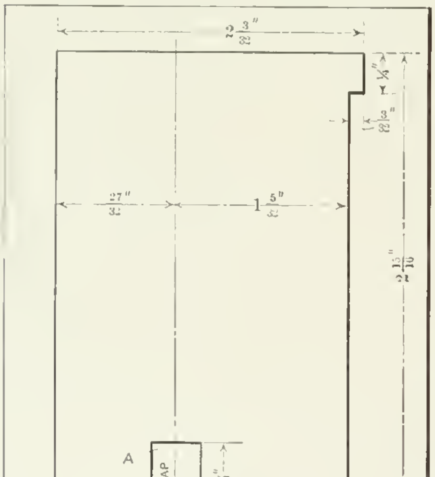
PROPORTIONS OF SHORT HYDRAULIC CYLINDERS

J. C. S.—The formula $\frac{R}{r} = \sqrt{\frac{S+P}{S-P}}$ in which R is the outer radius of the cylinder; r, the inner radius; S, allowable unit stress; and P, maximum pressure, gives the ratio between the outer and inner radii of thick hydraulic cylinders for given internal pressures. This formula does not apply to very short cylinders, however, because of the reinforcing effect of the thick head. The rule given by Kent for short cylinders is to make the thickness one-tenth the inner circumference for pressures of 3000 to 4000 pounds per square inch. I have to design a cylinder for 5000 pounds pressure, 8¾ inches internal diameter and 3 inches stroke. The material will be semi-steel, having a tensile strength of about 25,000 pounds per square inch of cross-section. Figured by the Kent rule an external diameter of 14¼ inches is safe for a pressure of 4000 pounds. Will a diameter of, say, 15¾ be safe for 5000 pounds? Figured by the first-mentioned formula the external diameter must be 22 inches, allowing a fiber stress of 7000 pounds per square inch.

The question is submitted to readers who are familiar with the modifications of theoretical design in such cases, enforced by commercial considerations.

BROACHING SCREW THREADS IN THIN PLATES

R. H. F.—I am building a machine in which there are 35 steel knives 3/32 inch thick which are held on a spider or knife plate with 5/16 inch—18 thread screws tapped into the slot *A*. The metal is cold-rolled steel, and the slot is 1/2 inch long. We punch the slot in a punch press and then put the knife in a small jig and tap the threads by hand. What I wish to know is, can the knives be tapped more rapidly in some other way, as our present method is slow and expensive?



A.—Inasmuch as the threads are tapped into the edge of the knife blade which is only 3/32 inch thick, the angle made by the thread is practically negligible. We suggest that the outline of the threads be broached with a suitable broach in a power press. The screw will have practically as good a hold of the knife when screwed into the broached thread shapes as though they were tapped. Of course, the bearing of the screw will not be theoretically correct, but by the time the screw is screwed home the bearing should be practically as good as is required for this class of work.

STATUS OF "PATENTED" ON MACHINES

S. J. R.—What is the law regarding the use of the word "patented" on manufactured articles; also with regard to blanket nameplates giving the dates and numbers of all patents owned by the concern making the products? I have noticed machine tools bearing nameplates on which legends similar to this appear: "Made by the Brown & Smithson Machine Tool Co., Brownsmithsonville, Ohio, operating under patents," followed by a list of all the patents owned by the company, giving the numbers and dates of issue. The machine carrying the nameplate may be a standard machine tool without a single patentable feature, yet it appears to be plastered with patents.

A.—Section 4900 of the United States Revised Statutes provides that when a patented article is not marked "patented" no damages shall be recovered by the plaintiff unless he proves that the defendant was duly notified of infringement. Section 4901 provides a penalty for marking "patented" on unpatented articles when done for the purpose of deceiving the public. So far as we can ascertain no decisions of the courts have been recorded regarding the use of blanket nameplates on machines, listing all the patents owned by the manufacturer. The practice has certain advantages for both the maker and user. It enables one style of nameplate to be used on all styles of machines produced, irrespective of their characteristics. The user is informed just what patents are owned by the company, but whether any of them apply to a particular machine is left in doubt.

JIGS AND FIXTURES—HOW DEFINED

D. T. H.—What are your definitions of "jig" and "fixture"?

A.—The answer is in the editorial under the above heading in the February, 1905, number, part of which follows: "Jig and fixture are words used interchangeably; a drilling-jig and a drilling-fixture may be one and the same thing—and they may be different, as we shall see later. Broadly, a jig is a device used in interchangeable manufacturing of machine parts for holding the work pieces and guiding cutting tools in any machining operation thereon; hence it may be used for drilling, boring, milling, planing, shaping, etc., but, we believe, it is preferably limited in general use to the first two operations, that is, drilling and boring. While fixture is a term generally used to mean the same thing, we believe that it is more comprehensive, and that it includes a lot of things which would not ordinarily be called jigs. If the device is of such a nature that it incloses and holds the work so that it can be lifted and transported as a whole, and, perhaps, has provision for a number of operations in different planes, we should surely call it a jig, but if it were the radius attachment to a planer for planing locomotive links, we should call it a fixture, although it is by no means a fixed or permanent part of the machine. A drilling vise is more of a fixture than a jig, but if it is provided with guide bushings we would term it a drill-jig or a jig-vise. Again a fixture may be one of the tools of a machine, as for example, the tools and fixtures of a turret lathe. A tool-post is an example of a fixture, but it is not a jig in the ordinary sense of the word. An "old man" for ratchet drilling is a fixture, as is also a former used on a planer as in planing relief for locomotive driving boxes, or as applied to the lathe for turning machine handles. A bending device which insures exact duplication is usually called a fixture, in preference to jig. A device for holding work pieces on the milling machine so as to insure duplication of parts is preferably called a fixture, although in many shops it would be called a jig. Hence the difficulty in assigning any definite and limiting meaning for either term. One difference that may be assumed to exist between jig and fixture is that a jig holds the work and guides the cutting tool independently of the machine supplying the driving power and feed, while the fixture is usually dependent upon the machine to guide the cutting tool or the work; one is self-contained and the other is not. We are fully aware that this distinction does not exist in actual practice, but it is one put forward as a suggestion for those shops which wish to define shop terms precisely."

STRESSES IN ELASTIC COUPLING

H. M. L.—The accompanying illustration, Fig. 1, shows a flexible coupling of the type in which a leather belt, looped around pins, transmits the power. How can the stress in the belt wound around the pins be calculated?

A.—In Fig. 2 a diagram is shown, indicating the necessary geometrical construction for finding the stress in the belt.

The radius of the outer pin circle is R and of the smaller, r. The radius of the pins is p, the number of pins is N in each pin circle, and a denotes the angle between the lines through the centers of adjoining pins. The requirement is to find the angle that line DE makes with a tangent to the outer pin circle, so that the tangential force to be transmitted can be translated into belt stress along line DE. Angle $a = 360 \div 2N$. As we also know R and r, we can find the length of side BC in triangle ABC, by a simple trigonometric formula, and also the angle ABC. Then, in triangle CDF, $CF = \frac{1}{2} BC$, $CD = p$, and angle CDF is a right angle. Hence angle CFD can be found, the sine of this angle being equal to $CD \div CF$. The angle that DE makes with AB, then, is equal to angle ABC — angle CFD, and the angle that line DE makes with a tangent through B equals 90 degrees minus this angle. The angle with the tangent will be denoted β. For the sake of simplicity, assume that the tangential force acts at the center of the pin, at B. In the force diagram, at the right, KL represents the tangential force at each pin, and KM the stress in the belt, the angle between the direction of these forces being β. Assume that P represents the total tangential force to be transmitted. If the horsepower to be transmitted is known, then $P = (33{,}000 \times \text{H. P.}) \div (2 \pi R \times \text{R. P. M.})$, and the force represented by $KL = P \div N$. From this we find KM, or the belt stress, is expressed as:

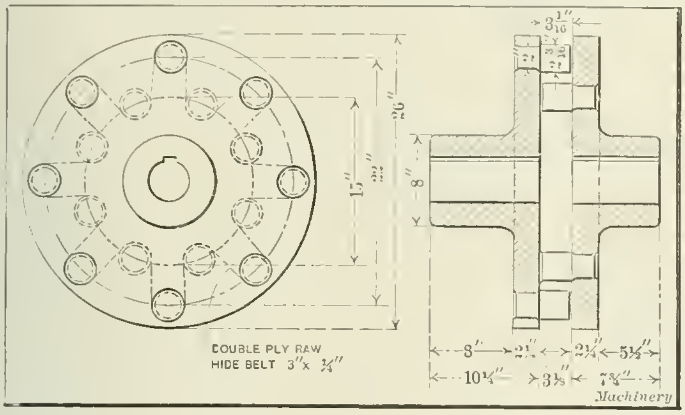


Fig. 1

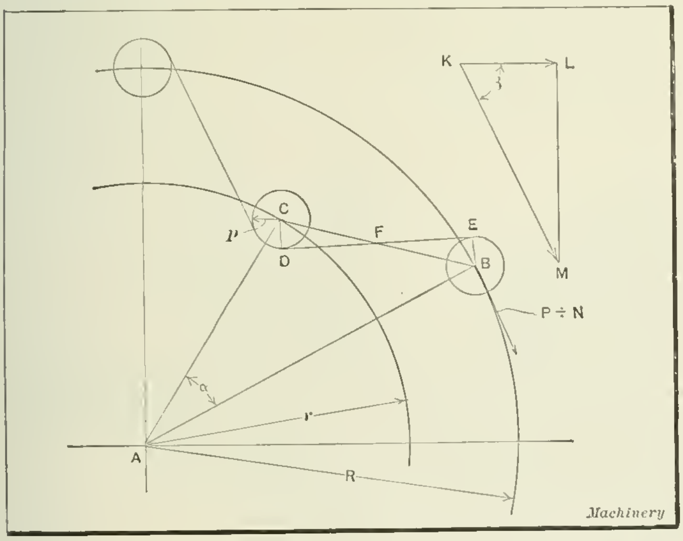


Fig. 2

$$KM = \frac{P}{N} \div \cos\beta = \frac{P}{N \cos\beta}$$

Extreme refinement in this calculation is not necessary, as the relative positions of pins B and C do not remain constant, due to the elasticity of the belt, and hence the value of angle β will vary. The value found as shown, however, is the one which produces the maximum stress; with the coupling in torque, angle β will decrease, in which case the stress in the transmitting belt will decrease also. It is evident that the stress becomes very great if β is large, and as this angle depends upon the arrangement of the pins, it is advisable to make the difference in the radii of the pin circles as small as is consistent with the angular displacement required to absorb the shocks of transmission.

SPIRAL-FLUTED HOB ANGLES*

By G. H. GARDNER†

It is, of course, desirable that hobs should be fluted at right angles to the direction of the thread. Sometimes, however, it is necessary to modify this requirement to a slight degree, because the hobs cannot be relieved unless the number of teeth in one revolution, along the thread helix, is such that the relieving attachment can be properly geared to suit it. In the following it is proposed to show how an angle of flute can be selected that will make the flute come approximately at right angles to the thread, and at the same time the angle is so selected as to meet the requirements of the relieving attachment.

Let C = pitch circumference,
T = developed length of thread in one turn,
N = number of teeth in one turn along thread helix,
F = number of flutes,
a = angle of thread helix.

Then (see illustration):

$C \div F$ = length of each small division on pitch circum.

$(C \div F) \times \cos a$ = length of division on developed thread.

$C \div \cos a = T$.

$$\text{Hence } \frac{T}{(C \div F)\cos a} = N = \frac{F}{\cos^2 a}$$

Now, if $a = 30$ degrees, $N = 1\ 1/3\ F$,
$a = 45$ degrees, $N = 2\ F$,
$a = 60$ degrees, $N = 4\ F$.

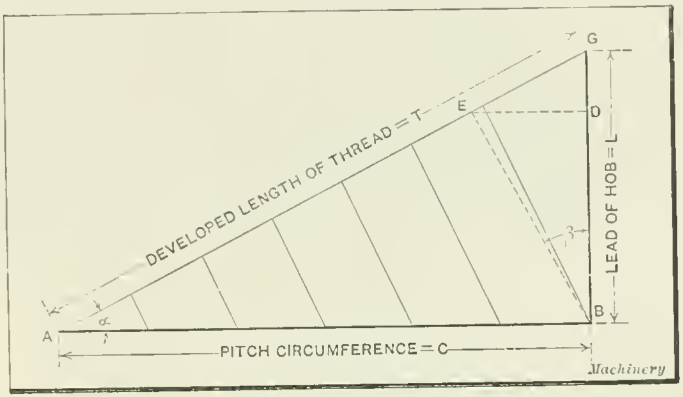


Diagram for Derivation of Formula for Spirally Fluted Hobs

In most cases, however, such simple relations are not obtained. Suppose for example that $F = 7$, and $a = 35$ degrees. Then $N = 10.432$, and no gears could be selected that would relieve this hob. By a very slight change in the spiral angle of the flute, however, we can change N to 10 or 10½; in either case we can find suitable gears for the relieving attachment.

The rule for finding the modified spiral lead of the flute is: *Multiply the lead of the hob by F, and divide the product by the difference between the desired value of N and F.*

Hence, the lead of flute required to make $N = 10$ is:

Lead of hob $\times$ $(7 \div 3)$.

To make $N = 10\frac{1}{2}$, we have:

Lead of flute = lead of hob $\times$ $(7 \div 3.5)$.

From this the angle of the flute can easily be found.

That the rule given is correct will be understood from the following consideration. Change the angle of the flute helix β so that AG contains the required number of parts N desired. Then EG contains $N - F$ parts. But $\cot\beta = BD \div ED$, and by the law of similar triangles,

$$BD = \frac{F}{N} \times BG, \text{ and } ED = \frac{N - F}{N} C$$

The lead of the spiral of the flute, however, is $C \times \cot\beta$.

Hence, the required lead of spiral of the flute:

$$C \times \cot\beta = \frac{F}{N - F} L$$

This simple formula makes it possible always to flute hobs so that they can be conveniently relieved, and at the same time have the flutes at approximately right angles to the thread.

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* See also MACHINERY, December, 1910, engineering edition, "Gashing Spiral Fluted Hobs."

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NEW MACHINERY AND TOOLS

THE COMPLETE MONTHLY RECORD OF NEW DESIGNS AND IMPROVEMENTS
IN AMERICAN METAL-WORKING MACHINERY AND TOOLS

BROWN & SHARPE INTERNAL GRINDING MACHINE

The Brown & Sharpe Mfg. Co., Providence, R. I., has recently placed on the market an internal grinder that is designed for general internal grinding operations. This machine has a capacity for grinding holes varying from 2½ to 12 inches in diameter and 8 inches deep, and the machine will swing 18 inches. By using a special spindle, holes less than 2 inches in diameter, but not exceeding 12 inches deep, can be ground. This machine is especially adapted for grinding holes in hardened steel gears, cutters, collets, bushings and similar work. Taper holes can also be ground as easily and accurately as those that are straight, and such work as facing recesses in automobile gears to obtain a bearing true with the hole can be done without removing the piece from the machine.

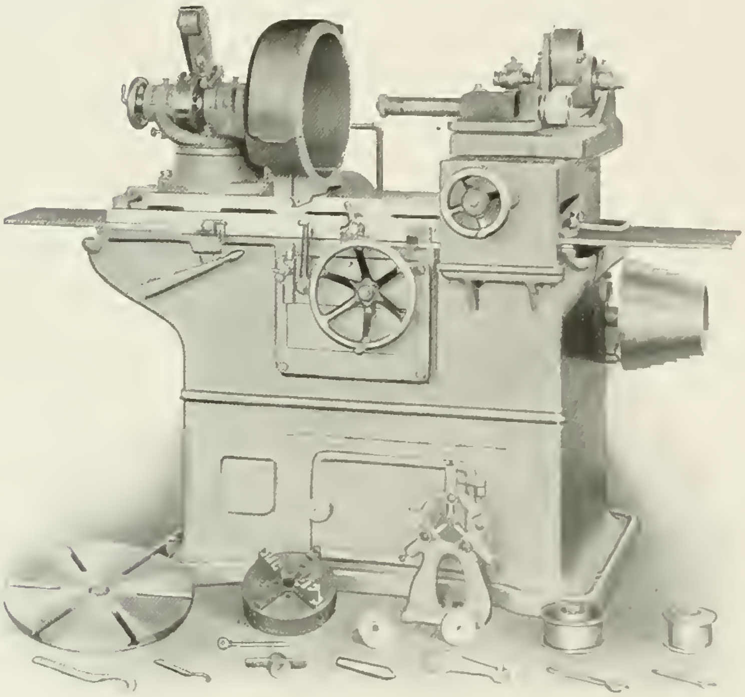


Fig. 1. Brown & Sharpe No. 22 Internal Grinding Machine

The design and construction of this machine, front and rear views of which are shown in Figs. 1 and 2, respectively, gives evidence of a careful study of the requirements for a grinder of this type. The general operation of the machine is as follows: The work to be ground is fastened either in a chuck or on a faceplate mounted upon the work spindle, which is driven from the overhead works. The headstock carrying the work spindle is fastened to the table of the machine, and the latter has an automatic, reversing, longitudinal movement similar to that of universal and plain grinding machines. The grinding-wheel stand and slide are mounted on a heavy bridge, which is bolted to the right-hand end of the machine bed and spans the work table. The grinding-wheel spindle is driven by a web belt from an intermediate shaft mounted at the back of the wheel-stand as shown, and this intermediate shaft, in turn, is belted to the over-head works.

The work speeds and table feeds of this machine are independent, the same as with the universal and plain grinders built by this firm. This arrangement makes it possible to obtain a correct table feed for any work speed. For example, when it is desired to remove stock rapidly, a slow speed and fast feed are available. Both work and table feeds are started and stopped by a single lever located on the front of the machine.

All wearing surfaces throughout are adequately protected from grit. The ways of the bed are always covered and the oil holes are protected from grit and dust. All screws, bolts and nuts requiring frequent adjustment are hardened. The handwheels and levers for controlling the various movements of the machine are all placed at the front.

Wheel Spindle, Stand and Slide

The wheel-spindle is of hardened tool steel and is enclosed in a heavy sleeve that extends practically its full length. The spindle and sleeve form a separate unit, which can be removed easily and quickly in case another spindle and sleeve of smaller size is to be used. At the front end of the spindle and close to the wheel there is a phosphor-bronze box in the sleeve, and at the pulley end an annular ball bearing is provided to take the pull of the belt and reduce friction to a minimum. The different grinding wheels used are mounted on a sleeve, which has a taper hole that fits the end of the spindle.

An ample range of independent spindle speeds is obtained by the use of interchangeable split pulleys on the intermediate shaft at the back of the wheel-stand. An idler pulley is provided to keep an even tension on the belt and take up the slack resulting from the use of pulleys of different diameters. Three split pulleys are furnished providing for speeds varying from 3990 to 7300 revolutions per minute.

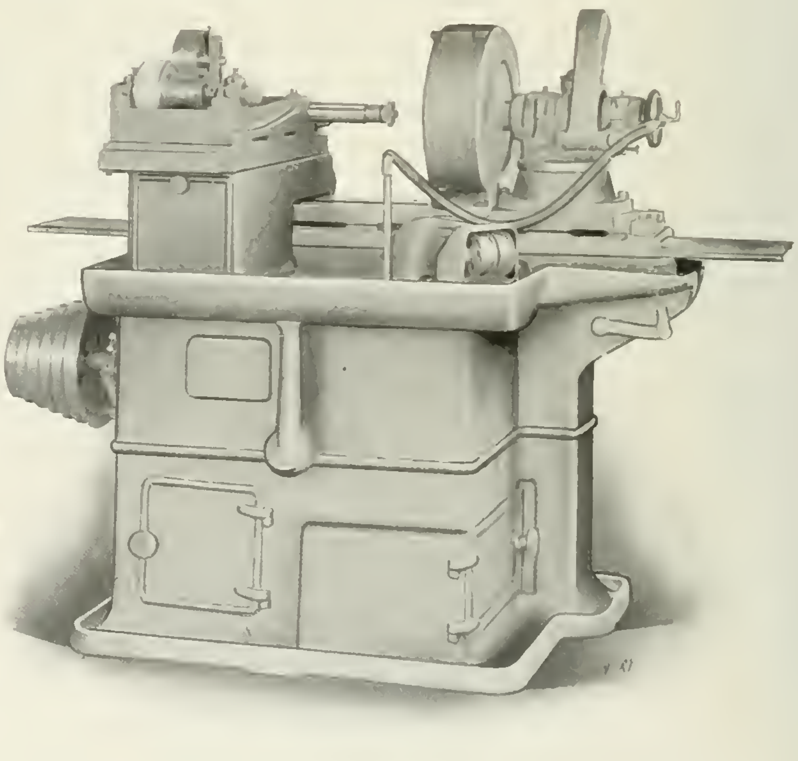


Fig. 2. Rear View of Brown & Sharpe Internal Grinder

The wheel-stand and slide are both of heavy, rigid construction, capable of resisting vibrations which would cause inaccuracy in the work. The wheel-stand swivels, thus permitting the spindle to be set at an angle when grinding the faces of cutters or automobile gears. This feature is also convenient when a hole has been ground, and it is desired to grind the face of the work before removing it from the machine. The ways of the wheel-stand slide are long to insure alignment, and are amply proportioned to resist vibrations. A transverse movement of the slide is obtained through a worm and wheel, actuated by a handwheel at the front of the machine. When it is desired, an automatic cross-feeding mechanism, similar to that found on all Brown & Sharpe universal and plain grinding machines, can be furnished.

Headstock

The headstock is of a rigid design and is firmly fastened to the swivel table by means of bolts that slide in a T-slot. It swivels and can be set at any required angle, the amount of adjustment being indicated by graduations on the base. The spindle is hollow and runs in bronze boxes provided with means of compensation for wear. It can be locked in position when removing the faceplate, chuck, or an attachment. Over the spindle pulley there is a belt tightening device consisting of a small pulley mounted on a bracket that can be drawn forward or pushed back by means of the handle shown. The forward adjustment puts the driving belt in tension and causes the spindle to revolve and drive the work. When the idler is swung back, the spindle can be quickly brought to a stop for changing the work, or it can be revolved easily by hand when centering a piece. A range of twelve work speeds, varying from 40 to 340 revolutions per minute are provided.

Sliding Table

The sliding table is of rigid construction and its bearing surfaces are scraped to fit the ways on the bed which are aligned with master straightedges. The travel of the table is automatic and entirely independent of the speeds of the work and wheel. It is controlled by adjustable dogs on the front of the table that operate against a reversing lever in the usual manner. The dogs can be raised and the table run beyond the reversing points without disturbing the adjustment, which is a valuable feature when withdrawing the work from the wheel. When the work is finished the trip dog nearest the wheel is raised; the table then moves to the left until the power feed automatically disengages. The table can then be moved farther away by the large handwheel shown. After a new piece of work is inserted, the table is moved up by means of this handwheel until the work nearly reaches the grinding wheel, when the power feed automatically engages again.

Provision for Wet Grinding

The soda water for wet grinding is pumped from a tank located in the bed and is fed to the wheel through the hollow work-spindle. The pump consists of a simple fan, revolving in a case, and, as it is immersed at all times, no packing is required. The tank is readily accessible for cleaning. The hood or water guard shown on the machine is furnished for covering the work.

In other details, the construction of this machine differs but little from that of the Brown & Sharpe universal grinding machines. The swivel table, however, pivots on a stud located beneath the headstock. This gives a long leverage from that point to the end, thus enabling very fine adjustments to be made when setting to grind straight or when adjusting to an exact angle for taper work, after the headstock has been set as closely as possible by the graduations on its base. There are six changes of table feed, varying from 15 inches to 48 inches per minute. The equipment furnished with the machine is shown about the base in Fig. 1. The overhead works, which are not shown, are also included in the equipment.

WALKER SURFACE GRINDER

The Walker Grinder Co., Worcester, Mass., is building an improved design of "single-stroke" surface grinder which is adapted for grinding concave as well as flat surfaces. This machine is of the cup-wheel type and has a heavy column on which are mounted upper and lower vertical slides. The upper slide carries the grinding wheel, and the lower slide has a rotary magnetic chuck on which the work is mounted. When the machine is in operation, the wheel is fed down against the work until the latter is finished to the required thickness. The wheel slide is fed against a positive stop and the thickness of the work is varied by adjusting the lower slide which is equipped with a vertical feed-screw. This screw is operated by the large handwheel (seen at the left of the slide) which is graduated in thousandths of an inch. When this adjustment of the lower slide is once made, it is not changed for successive operations except to compensate for wheel wear. The feeding movement of the grinding wheel is effected by the hand lever seen at the right of the wheel slide. This same lever also controls the starting and stopping of the work spindle, the switching on or off of the magnetizing current for the chuck, and it also controls the de-magnetizing current for neutralizing the residual magnetism always found in a magnetic chuck after the electric current has been switched off.

All of the power movements for this machine are derived from a horizontal shaft at the rear on which are mounted tight and loose pulleys. The wheel spindle is driven independently by a quarter-turn belt which passes over idlers as shown. The spindle pulley is wide enough to permit the required vertical movement of the slide. The work table is driven from the drum pulley seen at the rear of the column. This pulley receives its motion through gearing from an intermediate vertical shaft which, in turn, is driven by a quarter-turn belt connecting with the inner end of the horizontal driving shaft. The drum pulley is also wide enough to permit the necessary vertical movement of the lower slide. The wheel slide is counterbalanced by a weight inside the column, so that when the operating lever is thrown back, the slide returns to its upper position, thus leaving plenty of room under the wheel for placing or removing work. The link and lever connections seen at the side of the column, connect the wheel slide with a jaw clutch inside the work-table driving drum, and disconnect the latter from the shaft on which it is mount-

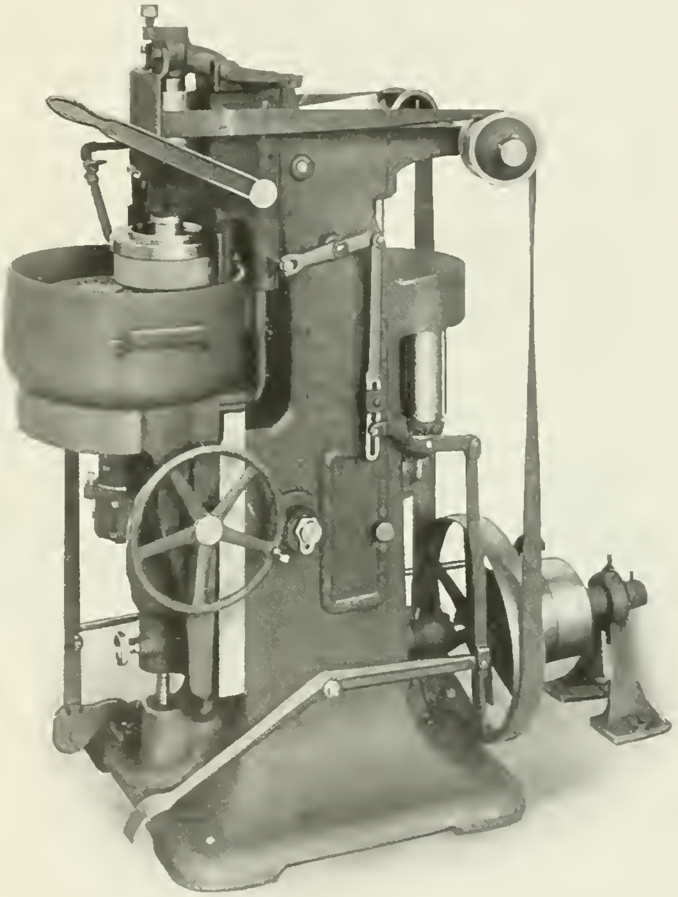


Fig. 1. Walker Surface Grinder

ed, when the wheel slide is in the upper position. By this means, the work spindle is automatically stopped whenever the wheel is raised from the work. It is sometimes advisable to clean the chuck face while in motion and, in such a case, the drum-clutch operating mechanism may be disengaged, thus giving an independent control of the work spindle through the foot lever seen at the base of the machine.

When this machine is to be used for concave grinding, the knee supporting the work table is tilted to the required angle. The knee is separate from the slide and has an overlapping ledge at the top, on the outer corners of which are set-screws. These set-screws provide means of correct alignment in one direction and form pivoting points. The tilting movement is effected by the knurled screw seen near the lower end of the knee. The latter is held against the slide by four cap-screws which have located quite near them, four adjusting set-screws. These set-screws are permanently set for aligning the knee, but can be re-adjusted at any time if necessary. The knee has an adjustment of two degrees and can be quickly reset in a level position without re-aligning.

Work having a concave surface is not held directly against the magnetic chuck, but on an auxiliary plate. The magnetic power of the main chuck is transmitted through this auxiliary plate, the upper surface of which is shaped to suit the work. The use of the auxiliary plate in connection with the grinding of a milling saw is illustrated in Fig. 2. After the saw is ground concave on one side it is held for grinding the opposite side on a plate having a convex face. If the saw were held for grinding the last side, against the flat face of the regular chuck, it would be pulled down in the middle, thus making it impracticable to concave both sides alike. Fig. 3 shows the method of grinding such work as dies, disks, etc., and Fig. 4 illustrates how piston-rings or similar parts are held. Fig. 5 shows how a number of small washers can be ground at one setting. These washers are separated by a perforated iron or brass disk, which acts as a retainer and holds the parts in the required position over the poles of the magnetic chuck. Fig. 6 illustrates how parts can be located on a chuck for multiple grinding, so that they support each other, thus making it unnecessary to use stays. These different views are shown to indicate, in a general way, how various kinds of work is ground on a machine of this type.

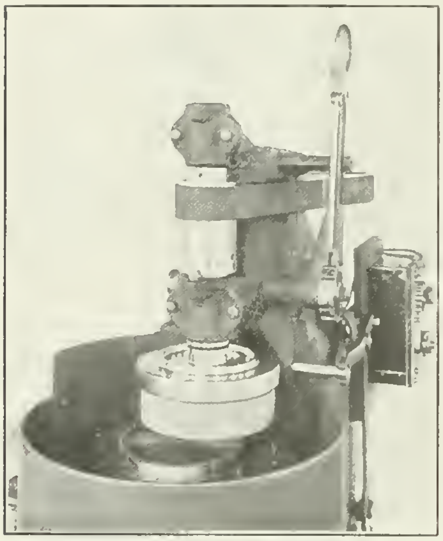


Fig. 2. Grinding a Concave Saw

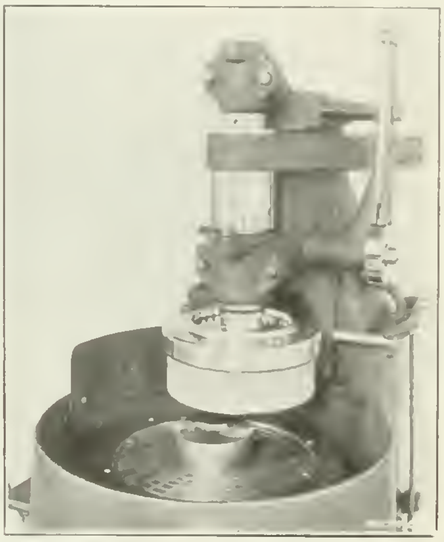


Fig. 3. Grinding a Die

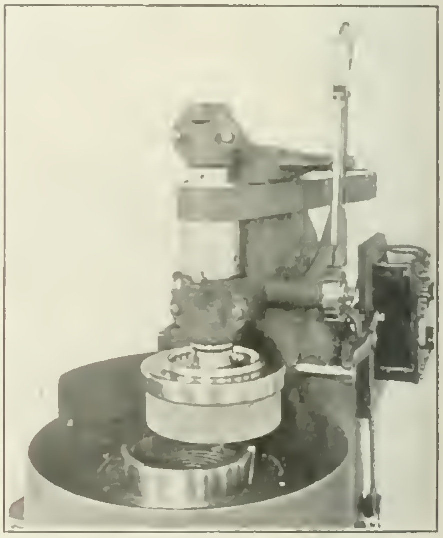


Fig. 4. Method of Holding Piston-ring

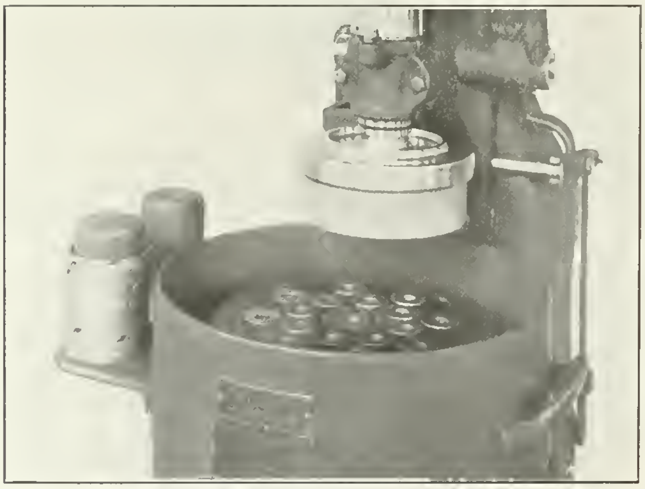


Fig. 5. Multiple Grinding of Small Washers

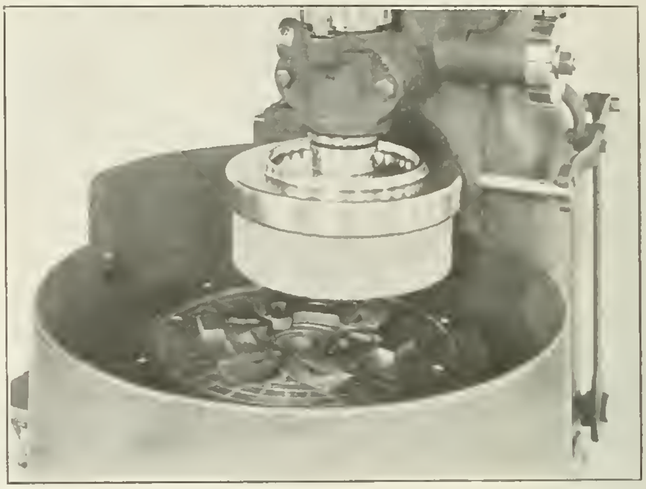


Fig. 6. Small Parts placed on Chuck so as to support Each Other

BAKER BROTHERS AUTOMATIC DRILLING MACHINE

Baker Bros., of Toledo, Ohio, have brought out a new type of drilling machine designed to reduce the idle or non-productive period connected with drilling operations. The maximum time required for drilling many classes of work is not consumed while the drill is passing through the material, but while the operator is placing the work in position, advancing the tool to the work through the jig bushing or clearance space, engaging the feed, withdrawing the tool and removing the work. After considerable study and experimenting, this company has developed a machine to perform these operations automatically—as far as the movement of the drill-spindle is concerned—and in a minimum of time. This machine, which is illustrated in Figs. 1 and 2, is so simple in construction that changes for different classes of work can be made quickly. The spindle is fed to the proper depth and returned by means of a cam which gives a powerful feed and a quick return movement. The feed also has a dwell at the end of the downward movement, which adapts the machine for accurate facing operations.

Either a plain work-table or one having an automatic indexing movement is provided. The automatic table is intended for work which is comparatively small, thus permitting a number of parts to be held in a suitable fixture around the periphery of the table, as shown in Fig. 2. As the forward and return movements of the drill spindle are automatic, the operator simply inserts new blanks and removes those that are drilled. The automatic indexing motion takes place as soon as the spindle is withdrawn and rotates the table to the next position, thus bringing a new piece of work under the drill or other tool. The period required for withdrawing the tool and indexing the table varies from two to three seconds. Change-gears are provided for indexing the table any required number of divisions from five to eighty. As the table can be adjusted in or out, holes can be drilled on circles of any radius within the capacity of the machine, by providing the proper change-gears for the indexing movement. The standard machine will drill holes in circles varying from four to twenty inches in diameter. A scale is provided which shows the diameter of circle on which the drill is set for any position of the table. When this machine is used for chuck work, the table usually has from six to eight chucks, and all the workman has to do is to insert and remove the work, as the machine itself requires no attention other than to see that the tools are kept sharp. If a drill should break, the machine can be stopped instantly. In case it should be desirable, the machine can be made to skip any number of chucks when indexing.

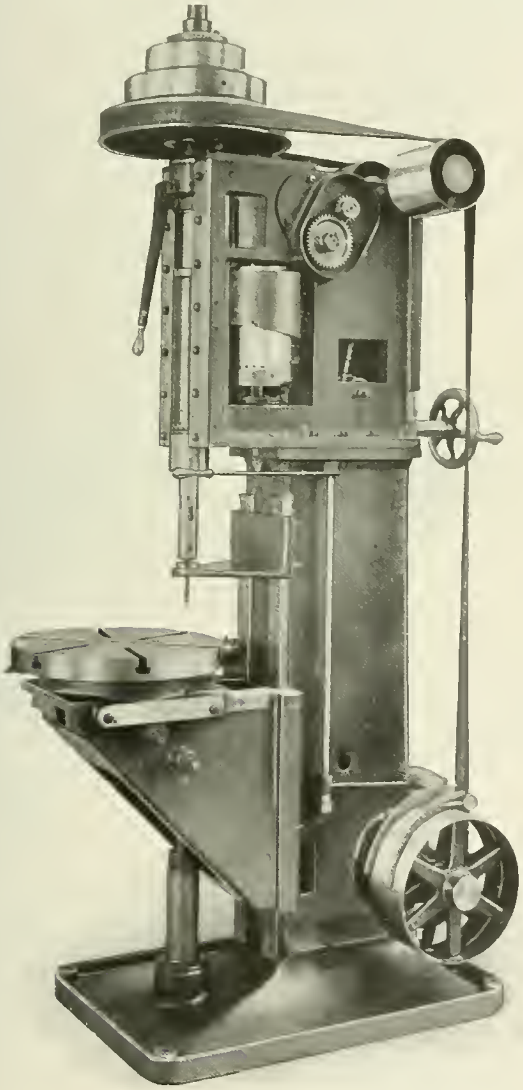


Fig. 1. Baker Bros. Automatic Drilling Machine

When a plain table is used, the operator places the work under the drill-spindle and trips the machine by a foot-lever, the same as he would a punch press. The spindle then advances and the drill passes through the work, after which the spindle returns quickly to its upper position. The operator then removes the finished piece of work, places another blank in position and trips the foot-lever as before, which causes the spindle again to feed down and return automatically. As the machine is entirely controlled by the foot-lever, the operator can use both hands for inserting and removing the work, thereby securing a very rapid production. The plain table is used for work which, because of its shape or size, could not be handled on a machine of the automatic indexing type, such as is shown in the accompanying illustrations.

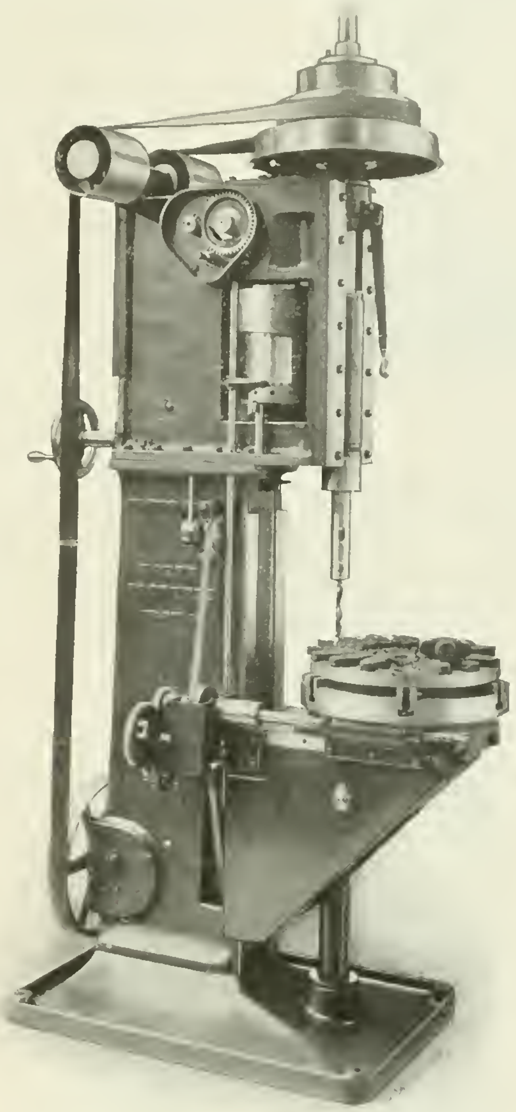


Fig. 2. View of Baker Bros. Drilling Machine showing Table Indexing Mechanism

This machine has a capacity for drilling 1-inch holes in steel when using high-speed drills. The automatic indexing type will drill ¾-inch holes through a piece of cast iron ¾ inch thick, at the rate of eight holes per minute. The spindle is mounted in a bronze-bushed slide which operates on carefully scraped ways. The revolving cam-drum, which imparts a feeding movement to the spindle, acts against a roll attached to the spindle saddle. This cam, in addition to "slip" change-gears, gives the required feed variations. One cam is provided with each machine.

The spindle has a vertical movement of 6 inches. It is made of high-carbon, hammered crucible steel and has a minimum section of 1¾ inch. The end is bored to a No. 3 or 4 Morse taper. There are six spindle speeds ranging from 200 to 800 revolutions per minute, the changes being obtained by means of the three-step cone pulley shown, and a two-speed countershaft. The idler pulleys at the rear are mounted on a vertical slide which can be adjusted to align the pulleys with different steps on the spindle cone, by means of the handwheel seen at the rear. The spindle is driven by a 2-inch belt and the distance from the center of the spindle to the frame is 8 inches. All the running bearings of this machine are equipped with ball bearings. The machine can be arranged for either motor or belt drive.

NEW BRITAIN SCRAPING STAND

The stand shown in the accompanying illustrations is used for holding work while scraping the bearing surfaces. This stand is especially useful in connection with the scraping and fitting of dovetail ways or bearing surfaces which are at an angle with the face of the work. The table to which the parts are clamped can be adjusted to hold the work in a horizontal position, or it may be tilted to locate the surface being scraped in a more convenient position for the workman, as indicated in Fig. 2.

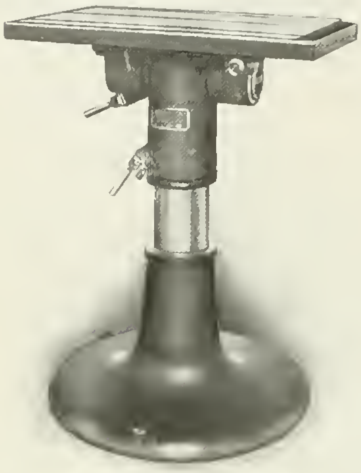


Fig. 1. New Britain Scraping Stand

The table is locked in position by means of hinged clamping levers which are permanently attached to the stand. The table may be inclined to any angle up to 90 degrees. The face of the table is 16 by 30 inches. The work is held in position by means of bolts that engage T-slots cut in the table face. The height of the table can be varied from 28½ inches to 34½ inches. This adjustment is effected by means of a "quick-pitch" screw located within the column. After the table is raised to its extreme height, it still has a bearing on the column so that it cannot be accidentally turned out of the base. The vertical adjustment permits the work to be held at the most convenient height for the workman. This scraping stand is made by the New Britain Machine Co., 64 Bigelow St., New Britain, Conn.

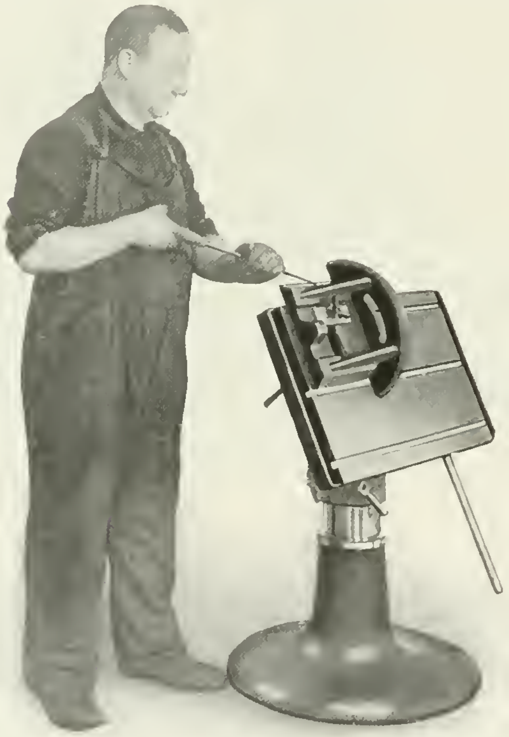
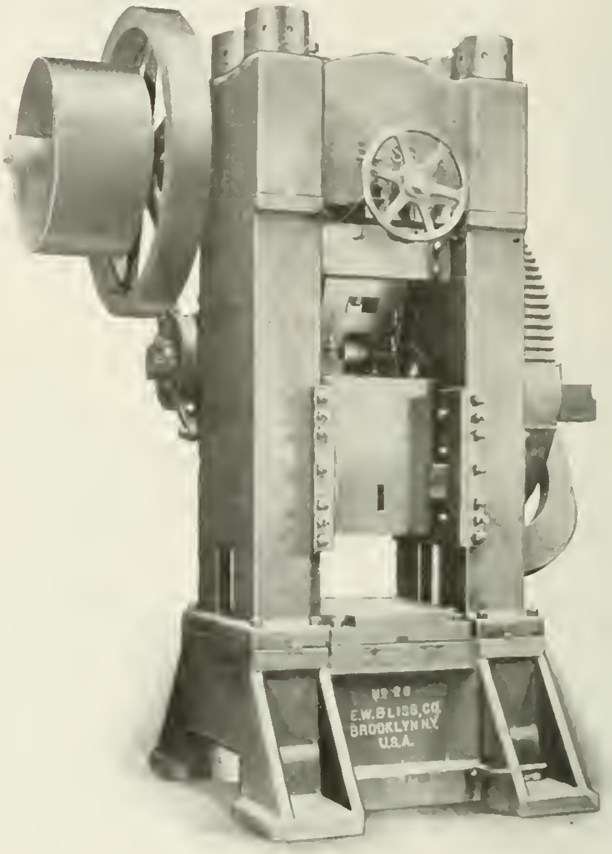


Fig. 2. Stand set for Scraping Angular Surfaces

BLISS "KNUCKLE-JOINT" PRESS

Power presses of large proportions and great capacities are being used increasingly in connection with many manufacturing operations, owing to the fact that many articles can be produced more economically and uniformly in a press than by the methods formerly employed. The E. W. Bliss Co., 5 Adams St., Brooklyn, N. Y., is now building a new line of knuckle-joint presses, one size of which is shown herewith. These presses are used for heavy stamping and embossing operations on steel, brass, copper, silver, Britannia, etc., and they are particularly adapted for embossing operations in the manufacture of medals, coins, jewelry, etc. The toggle-joint gives a powerful movement to the slide at the end of the stroke when the work is being done. A comparatively slow movement is also obtained at the end of the stroke which is desirable when it is necessary to have the metal flow while under pressure, as in embossing.

This machine is capable of exerting a pressure of 800 tons. The toggle links are placed above the slide in the same position as the pitmans of an ordinary crank press, and they are operated by a crankshaft in the rear of the press. This construction permits the use of positive knockout attachments in the bed and cross-bar knockouts in the slide. The powerful jaw clutch on this machine has three engaging points and is operated by the foot-treadle seen at the right. The necessary adjustment for dies and pressure is obtained by a taper wedge adjustment. The position of this wedge is changed by means of a screw, which, in turn, is operated by the handwheel shown.

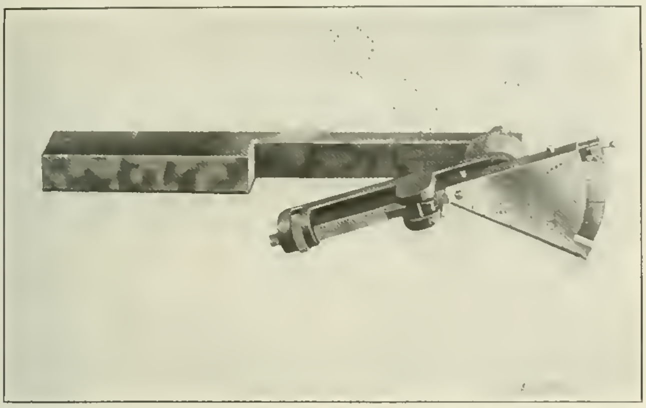


Large Toggle-joint Embossing Press

This press is of the tie-rod construction, the bed and crownpiece each being separate castings. The side housings, which take any side strain and provide bearing surfaces for the slide and crankshaft, are also separate and of box section. Four large tie-rods pass through the side housings and take the entire strain when the press is at work. This construction not only prevents breaking the frame, but also provides a means for releasing the press should it become stalled on its center, as the tie-rods may be heated and expanded through suitable openings provided. The distance between the uprights of the press is 28 inches; the stroke of the slide is 2 inches, and the total weight of the machine is 45,000 pounds.

TEST INDICATOR

A new type of test indicator recently developed for use on a lathe, milling machine or in connection with tool-room work, is shown in the illustration. The instrument proper is very light and sensitive and has a scale with graduations reading to 0.0005 inch. Since these graduations are spaced ⅛ inch apart, a reading of 0.0001 inch can be obtained. As the tool is mounted on an adjustable holder, it can be set in any direction as indicated by the lines. The position with relation to the work can be varied by an adjusting nut at the end of the tool, and there is an elevating nut for raising or lowering the indicator to bring it in alignment with the center line of the lathe. This indicator, when arranged as illustrated, can be used in an ordinary toolpost, and when the holder is removed, the stem fits the toolpost of any bench lathe or it can be clamped to the spindle of a surface gage in place of the scratch awl or scriber. Direct contact is made with work by a small ball point, which, through a system of levers, gives a reading on the scale that is multiplied about two hundred times. The contact point is removable and can be replaced by finer ball points, flats or any special shape required. The working parts of the indicator are all carefully protected from injury by a metal shield. This indicator has been placed on the market by the American Watch Tool Co. of Waltham, Mass. It is an accurate and inexpensive instrument for use in machine shops or laboratories.

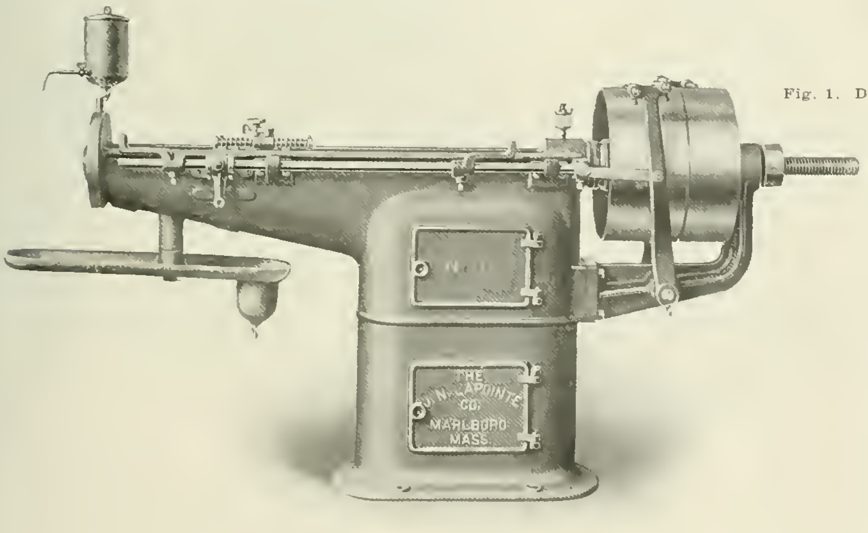


Test Indicator made by American Watch Tool Co.

LAPOINTE BROACHING MACHINE

A light type of broaching machine has been designed by the J. N. Lapointe Co., Marlboro, Mass., for keyseating comparatively small parts, such as the change- or feed-gears used on various types of machines. This machine is said to cut keyways in work of this kind at the rate of from 150 to 200 pieces per hour. It has a capacity for broaching keyways up to $\frac{3}{8}$ inch in width, and usually from two to four parts can be broached simultaneously.

The construction of this machine is very simple. There is a sliding head having a stroke of 40 inches, which is actuated by a 2-inch non-revolving screw. This screw passes through a revolving bronze nut which is inserted in the hub of the driving pulley. Two loose pulleys are mounted on the hub of the tight pulley, this hub acting as a bearing for the driving mechanism. This combination of pulleys and also the belt shifting device, is similar to the arrangement used on planers. The driving belts can be shifted by hand, or automatically by means of adjustable dogs. The rod which carries the stop-dogs, is connected with two swiveling belt-forks which are mounted on a shaft passing through the bracket shown. When the sliding head comes in contact with one of the stop-dogs, either the forward or return belt is shifted onto the tight pulley, thus reversing the movement.



Lapointe No. 1 Broaching Machine

The stroke of the sliding head is varied according to the length of the broaching tools used, by simply changing the position of the stop-dogs. The driving nut is so arranged that it can be removed quickly for replacement, when necessary, by unscrewing a cap at the end of the driving pulley hub. This machine has a ball bearing thrust to eliminate excessive friction and wear on the nut and screw, especially when heavy broaching is being done. The ball bearing reduces the power required for operating the machine. This machine is also adapted for broaching square holes up to $\frac{5}{8}$ inch.

DWIGHT SLATE AUTOMATIC DRILLING MACHINES

The multiple-spindle machines illustrated in Figs. 1 and 2 are automatic in that the feeding and return movements of the drill spindles are obtained from cams. These cams are mounted on a shaft at the rear and are spaced at equal angles, thus giving the same intervals of time between the movements of each spindle. For example, the cams of a four-spindle machine are 90 degrees apart, whereas the cams of a six-spindle type are 60 degrees apart. When the machine is in operation, the various spindles move progressively and continuously, and the workman's entire time is utilized in loading jigs and removing the drilled parts, so that a very rapid production is obtained.

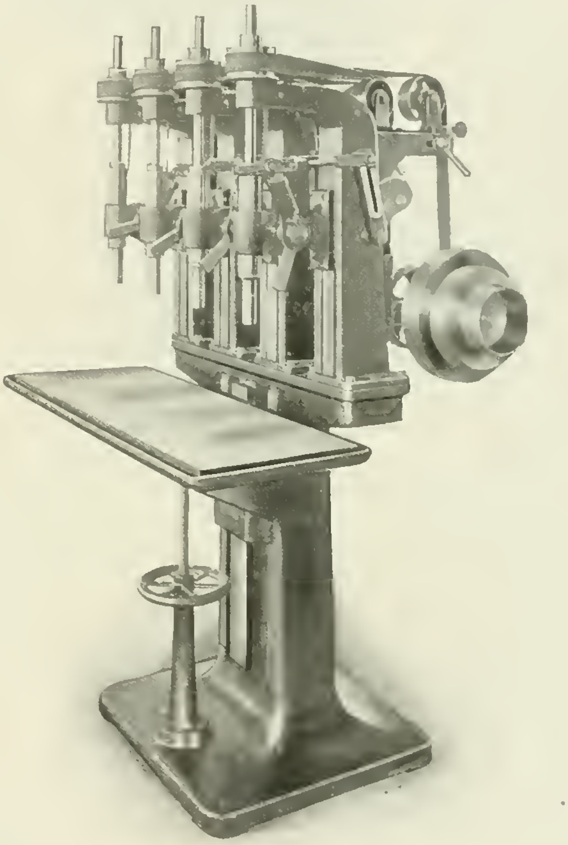


Fig. 1. Dwight Slate Cam-feed Automatic Drilling Machine

These machines are of an improved design now being manufactured by the Dwight Slate Machine Co., Hartford, Conn. The machine shown in Fig. 1 has four spindles, and Fig. 2 is a rear view of a six-spindle type. Any number of spindles ranging from two to eight can be furnished. The number that one man can operate depends, of course, on the time required for drilling the work. The end view, Fig. 3, shows the arrangement of the cam feed. The required movement for each spindle is obtained from an independent cam *C* which engages a roller on slotted arm *A*. The latter is connected to the pinion shaft by rod *B* and the lever shown.

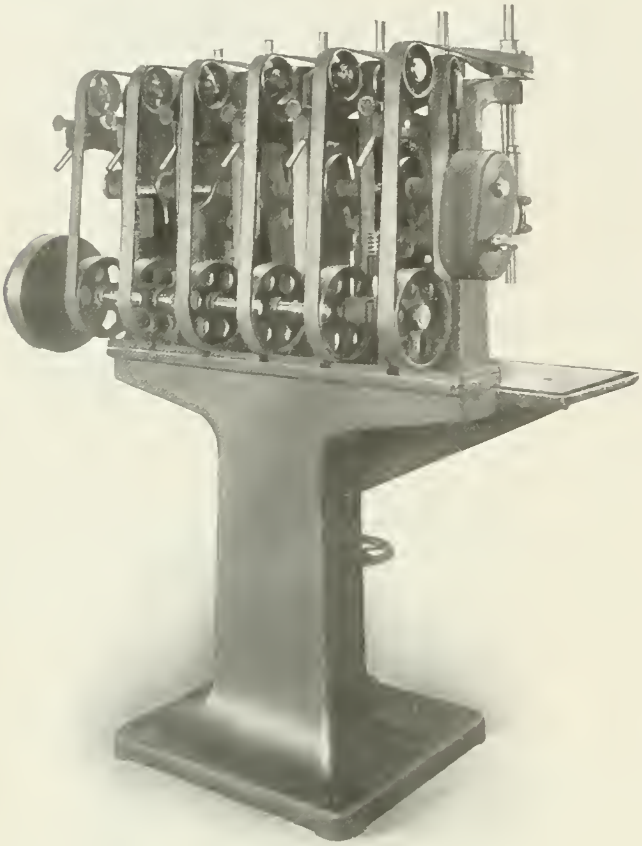


Fig. 2. Rear View of Six-spindle Cam-feed Drilling Machine

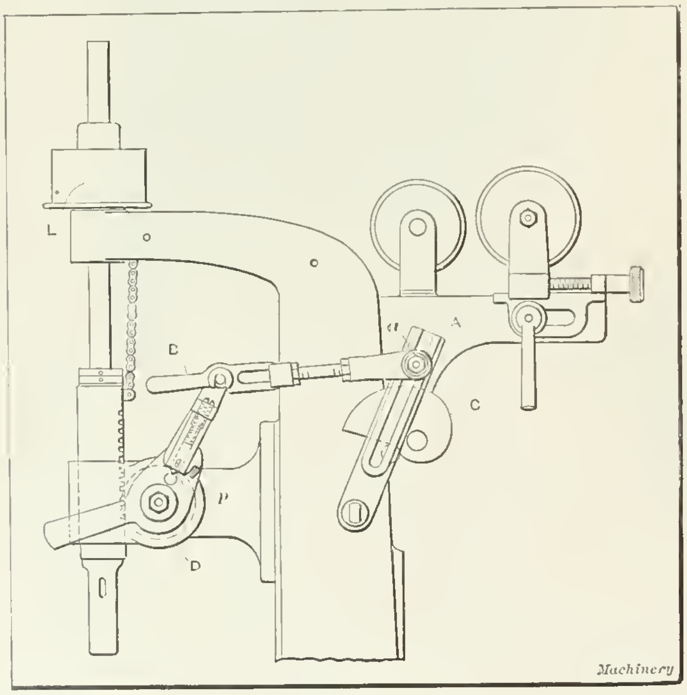


Fig 3. Detail of Cam-feed Mechanism

The stroke of the spindles is varied for drilling holes of different depths, by adjusting nut *a* on the slotted arm. The position of each spindle can also be adjusted independently for leveling the drill points, by loosening nut *D* and turning the feed lever with relation to the pinion shaft. The end of this pinion shaft is tapering and fits into a hole of corresponding taper in the hub of the feed lever, which connection enables the adjustment to be made. The feed lever is made in two parts and is equipped with a safety device for stopping the feed in case of an overload at the drill point. The safety stop consists of a hardened, adjustable spring-plunger *p* which is inserted in the upper half of the feed lever and engages a notched stud attached to the lower half. If an overload occurs, plunger *p* is disengaged from the stud, thereby protecting the feed mechanism and preventing the breaking of drills to a large extent. The tension on this plunger can be varied for drills of different diameters. In case it is desired to feed one of the drill spindles by hand, this can be done by disengaging link *B*.

As the amount of feeding movement is limited to the throw of the feed lever, this machine is restricted to the drilling of holes not exceeding $1\frac{1}{2}$ inch in depth. The cam-shaft is driven from the main shaft through worm gearing and the feed change mechanism seen to the right of the machine in Fig. 2. This gear box gives three feed changes which are obtained by shifting a small pull-pin. There are also three spindle speeds obtained by the three-step driving cone pulley. The spindle driving belts have adjustable idlers at the rear for varying the tension, and the spindle belt pulleys are equipped with oil reservoirs and an ingenious method of providing continuous lubrication.

The work table of this machine is securely locked to the column by a narrow gib located on one side of the central dovetailed way seen in Fig. 1. When this gib is drawn outward by a stud passing through the saddle, the table is clamped tightly against the outer bearing surfaces shown, and it is also securely locked to the central dovetailed way. The elevation of the table is effected by the screw and handwheel shown. This machine is especially adapted for drilling small duplicate parts such as are used in the manufacture of locks, light hardware, small tools and similar parts.

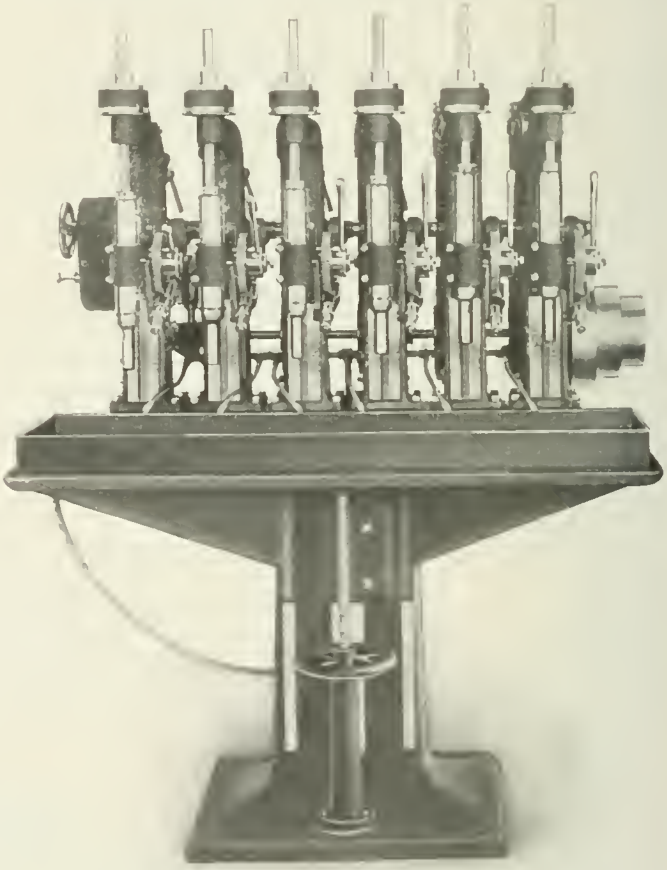


Fig. 4 Automatic Drilling Machine with Worm Feed

Fig. 4 shows another multiple-spindle machine of the same type but equipped with a different feeding mechanism. The arrangement of this feed is shown in Fig. 5. The feed movement is derived from a back shaft *U*, which is driven from the main shaft through a change-gear box, the same as with the cam-feed design. The feed worm *F* is supported and held in engagement with worm-gear *K*, by a latch-arm *A* which normally engages a supporting stud *I*. The adjustment of the automatic feed trip for drilling holes of any depth between 0 and 5¼ inches, is obtained by setting the adjustable ring *B* in the proper relation with the pinion shaft. This ring has a projecting lug, as shown, which disengages latch-arm *A* and throws out the feed. The distance that the projection on ring *B* travels before disengaging the latch, determines, of course, the depth of the hole drilled. The screw *N* and shoe *K* provide convenient means for securely locking ring *B* to pinion shaft *L*. The stop-pin *P* determines the maximum adjustment of ring *B*.

This machine also has an automatic safety release in case of an overload, which operates as follows: Worm *F* is keyed to rotate with its shaft, but is free to slide longitudinally. Under a normal load this worm is held in the operative position with respect to worm-gear *R*, by means of a ring *C* and compression spring *D*. When overload occurs, the worm moves longitudinally against the tension of compression spring *D*, and as the worm is connected to latch *A* through the ring *C* and pin *H*, this longitudinal movement results in disengaging the feed. The tension of spring *D* can be varied for drills of different diameter, by cap *E* and the locking nut shown. The feed can be stopped at any time by throwing out latch *A*, and it is engaged by simply lifting the worm-shaft supporting arm *G*, which causes the latch to hook over stud *I*.

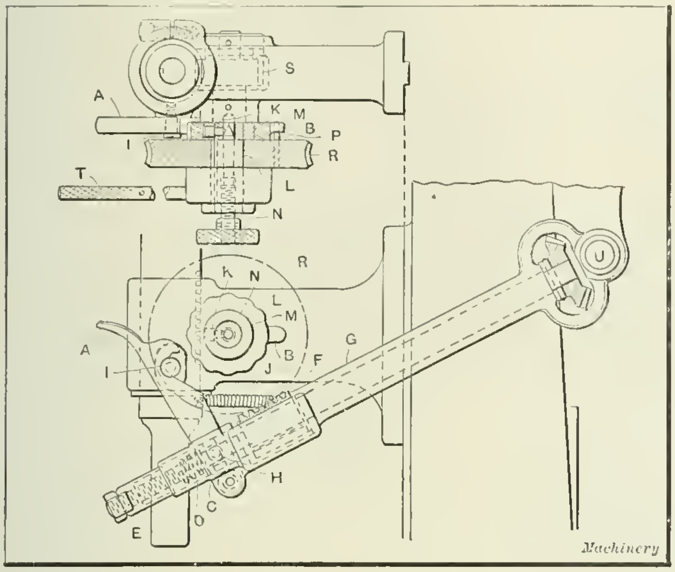
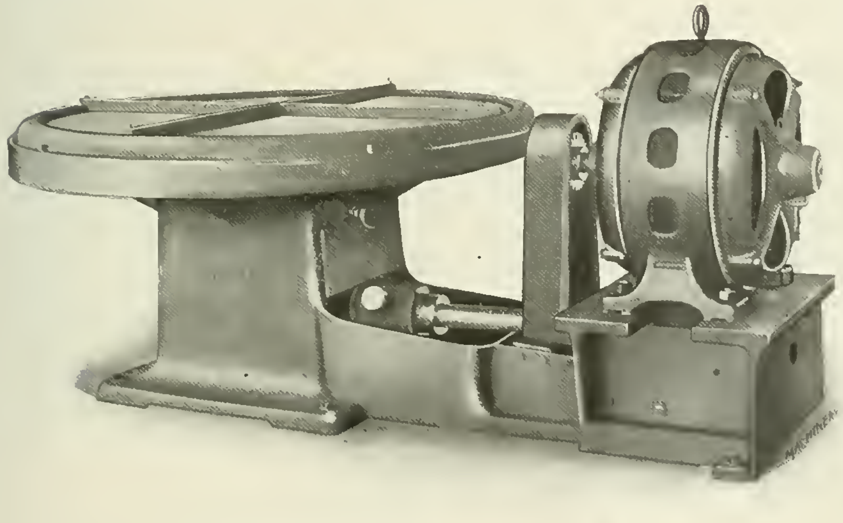


Fig. 5. Feed Mechanism of Machine illustrated in Fig. 4

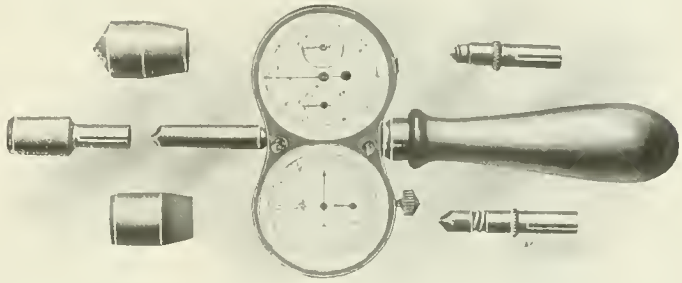
A multiple-spindle machine equipped with the worm feed, is recommended when the drilling is comparatively deep, and, especially, for work which cannot be quickly inserted in or removed from the jigs. On the other hand, the cam-feed machine is adapted to that class of work which is quickly drilled and easily jigged.



Gardner Vertical-spindle Motor-driven Disk Grinder

SCHUCHARDT & SCHUTTE TACHOSCOPE

The instrument shown herewith is known as a "Tachoscope" and consists of a revolution counter and a non-magnetic, precision stop-watch, which are so connected that they operate simultaneously the moment a slight pressure is applied to the center spindle. As soon as the pressure is released, both the revolution counter and watch stop at the same time, thus indicating on the dials shown, the number of revolutions made by whatever is being tested, and also the time elapsed. The small pointer on the watch dial records up to thirty minutes and then repeats, and the duration of the test is indicated in minutes, seconds and fractions thereof. The revolution counter has three pointers which indicate from 1 to 100, 100 to 1000 and 1000 to 10,000 revolutions per minute, respectively. This instrument can be used for right- or left-hand rotation and no adjustment or setting is required. The appearance of either a red or black disk on the counter dial, indicates whether right or left rotations are being counted, and the figures on the dials which correspond in color with this disk, are the proper ones to use. The counter and also the stop-watch, can be set back to the zero position instantly. The movements of the stop-watch and counter are said to equal in precision those used in high-grade time pieces. This instrument, which has been placed on the market by Schuchardt & Schutte, Cedar and West Sts., New York, is especially recommended for testing rapidly revolving parts and it can be used for speeds up to 30,000 revolutions per minute.



Combined Revolution Counter and Stop-watch

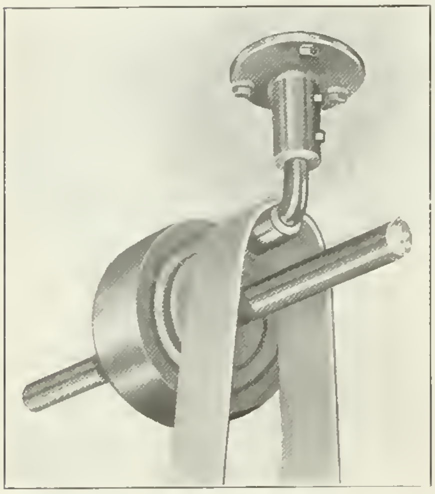
GARDNER MOTOR-DRIVEN DISK GRINDER

The large vertical spindle type of disk grinder which is built by the Gardner Machine Co. of Beloit, Wis., and was described in detail in the September, 1911, number of Machinery, is now equipped with a motor drive. The motor is mounted on an extension of the base and forms an integral part of the machine, as shown by the accompanying view. A 15-horsepower motor is used, and connection is made with the main shaft of the grinder by a silent chain. This main shaft, in turn, drives the disk wheel spindle through bevel gears which are fully enclosed and run immersed in oil. A guard covers the chain and gears as shown. The starting box for the motor is attached to the rear of the base and does not show in the illustration. The pedestal for the motor is made to accommodate any standard make that is specified.

When these machines are installed in plants having no dust exhaust system, an exhaust blower is furnished. The pulley for driving this blower is attached to the main driving shaft, midway between the shaft collar and the silent chain gear. The disk wheel is driven at 500 revolutions per minute, and is 53 inches in diameter. This type of grinder is also made for a belt drive, from either overhead or underneath. The motor-driven type is often more convenient when it is desired to place the machine under a hoist or crane-way. The complete weight of the machine is 4500 pounds.

SAFETY BELT-HANGER

The Universal Stamping Co., 47 Poultney St., Buffalo, N. Y., is now manufacturing a safety belt-hanger which is designed to prevent the accidents caused by belts winding up on the shaft when they are thrown on or off the pulleys. This hanger consists of a cast-iron bracket which is fastened to the ceiling or shaft-hanger support, by three lag-screws or bolts. The hanger proper is made of steel tubing bent at right angles on the lower end. The horizontal part thus formed carries a roller which is held in place by a small casting driven in the end of the tube. The hanger is located over the center of the shaft, and on whichever side of the pulley the belt is usually thrown off. The supporting roller should be about one-half inch below the rim of the pulley. The end of the roller should also be close to the side of the pulley. When a belt is thrown off it runs onto the roller, and, if the other end of the belt is also thrown off the driven pulley, the belt will hang free from the shaft, as shown in the illustration. When a belt is being placed on the revolving pulley, it is first engaged with the stationary driven pulley, after which it is slipped onto the driving pulley by using an ordinary belt pole. As the belt is held close to the pulley rim by this hanger, it can be put on easily. This belt-hanger is made in three sizes for belts up to 6 inches in width.


Safety Belt-hanger

CHAMPION MOTOR-DRIVEN LATHES

The method of applying a motor drive to the 12-, 14-, 16, and 18-inch lathes built by the Champion Tool Works Co., 2422 Spring Grove Ave., Cincinnati, Ohio, is shown in Figs. 1 and 2.

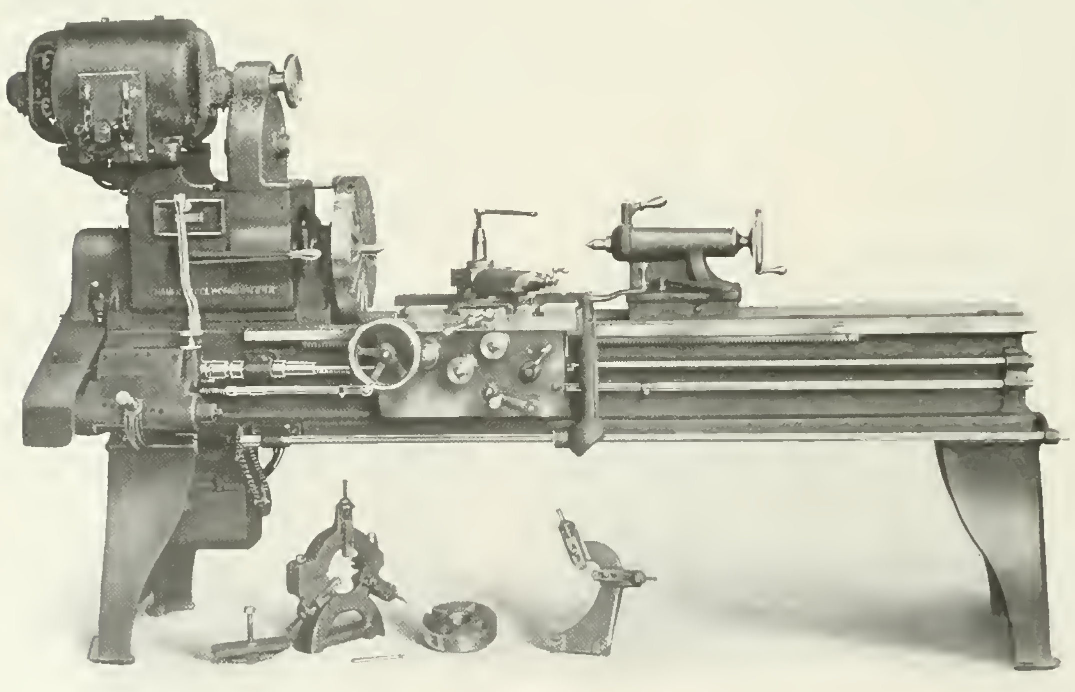


Fig. 1. Motor-driven Lathe built by the Champion Tool Works Co.

The power is transmitted from the motor to the lathe spindle as follows: A steel pinion mounted on the motor shaft, meshes with a raw-hide intermediate gear which makes the drive practically noiseless. This raw-hide gear drives a friction gear which runs freely on the spindle sleeve. Keyed to this sleeve there is a friction controlled by the horizontal lever seen in front of the headstock, and by means of this lever, the lathe can be stopped or started at will, independently of the motor. The drive from this point to the spindle is either direct through the face gear to which the friction can be connected by means of a locking pin, or through either one of the positive-clutch, double back-gears which are controlled by the vertical lever shown. These three mechanical changes in the headstock, in addition to those obtained by the three to one variable-speed direct-current motor, give a wide range of progressive spindle speeds. The spindle speeds vary (approximately) from 12 to 400 revolutions per minute, and the convenience of the control enables these changes to be obtained quickly and with little effort on the part of the operator.

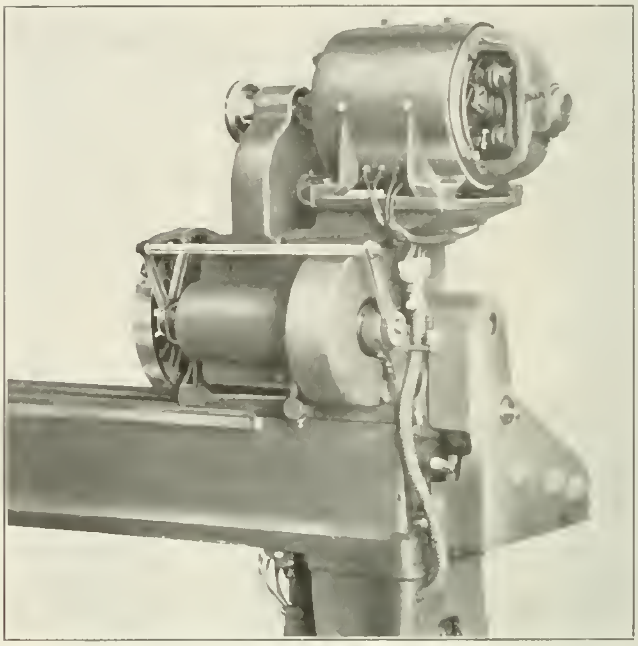


Fig. 2. Rear View showing Headstock End of Motor-driven Lathe

The speed of the motor is regulated by a drum-type controller located under the headstock end of the lathe. This controller is operated by the crank handle seen at the right of the apron. The connection between this handle and the controller is made through bevel gears, a splined rod and the chain and sprocket wheels shown. A handwheel on the outer end of the motor shaft, enables the operator to revolve the lathe spindle by hand, when this is necessary in connection with the chucking or inspection of work. Any standard make of motor having a speed variation of from 500 to 1500 R.P.M., can be used and the following sizes are recommended: For a 12-inch lathe, 1 horsepower; 14-inch lathe, 1 horsepower for medium duty, and 2 horsepower for heavy duty; 16-inch lathe, 2 horsepower; 18-inch lathe, 3 horsepower. These lathes can also be furnished for motors of the alternating current type.

The back-gears on this machine are so arranged that a change from the single to the double back-gear can be made without stopping the lathe. As previously stated, this change is effected by the vertical lever seen in front of the headstock. These gears have a positive internal key clutch, and the change from fast to slow or *vice versa*, can be made quickly without shock or jar. The feeding movement of the lathe can be reversed either from the apron or headstock, and the longitudinal feed can be disengaged at any predetermined point by automatic stops. There is a chasing dial for thread cutting and an interlocking device to prevent engaging the screw and rod feed simultaneously. The quick change gear box gives forty changes for feeding and threading without removing any gears. Eight of these changes are obtained by a single lever, and one movement of a push-pin varies the entire range. All the gears are carefully guarded as will be seen by referring to the rear view, Fig. 2.

The 16-inch lathe has a swing of 17⅛ inches over the bed and a swing of 11⅝ inches over the carriage bridge. It has a capacity for cutting screws having from 2 to 56 threads per inch, including 11½ pipe thread. The ratio of the double back-gears is 8 1/3 to 1 and 3 to 1, respectively. A double friction countershaft, large and small face-plates, steady- and follow-rests, wrenches, etc., are included in the equipment. A taper attachment, chucks, chuck-plates, a draw-in attachment, spring collets, oil pan, pump, turrets for the carriage or bed, and similar equipment, can be furnished extra if desired.

SLOCOMB INSIDE MICROMETER SETS

The J. T. Slocomb Co., Providence, R. I., has recently placed on the market inside micrometer calipers in sets, contained in morocco-covered velvet-lined cases. Some of these sets contain only inside micrometers, and others have, in addition, regular outside micrometers, as shown in the accompanying illustrations. The set seen in Fig. 1 contains two inside micrometer handles, with two points for each handle for measuring diameters from ½ to 2 inches by thousandths of an inch. The set shown in Fig. 2 has one inside micrometer handle with two points for measuring from ½ to 1 inch, and it also contains a 1-inch outside micrometer. There are six sets, in all, which differ in the combination and number of tools they contain.

The form of the inside micrometer permits it to be used for measuring throughout the depth of any hole within its capacity and it is adapted for either tool-room or general machine shop work. This micrometer is a direct-reading instrument and can be set to given dimensions without using an outside micrometer. The inside micrometer is made in two sizes and each size has two measuring screws which are fitted with individual nuts graduated to read to thousandths of an inch. Adjustments for different diameters are obtained by turning these graduated nuts and the caliper is locked in any position by simply turning the knurled handle. The adjusting screw is prevented from turning with the nut by V-grooves engaged by a V-pointed spindle at the side, which is tightened by the handle and forms the lock. The V-groove has 1/10 inch graduations, which appear above the nut after every fourth revolution, thus giving a direct and continuous reading in addition to that obtained by finer graduations on the periphery of the nut.

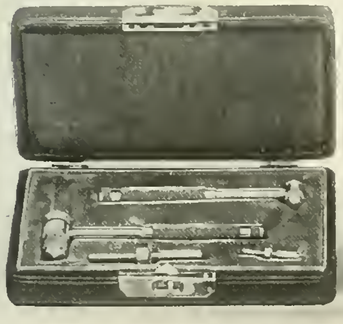


Fig. 1. Inside Micrometer Set with Capacity for measuring from 1-2 to 2 Inches

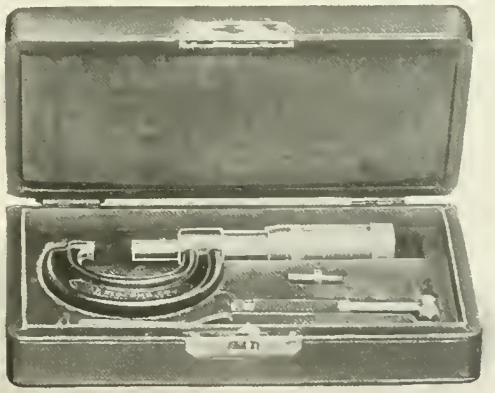
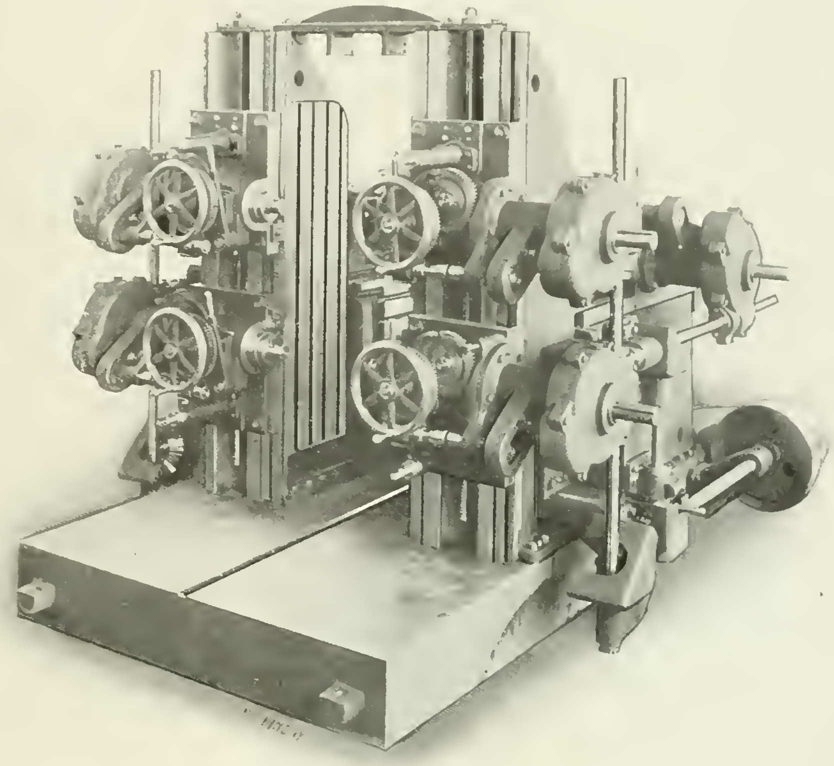


Fig. 2. Combination Set containing Inside and Outside Micrometer

BEAMAN & SMITH SIX-SPINDLE BORING MACHINE

The boring machine illustrated herewith is a special design built by the Beaman & Smith Co., Providence, R. I., for boring and reaming heater sections. This machine has a heavy base or platen upon which are mounted two uprights. On the front face of each upright, there are two adjustable saddles, each of which carries a horizontal spindle. At the rear of the upright, there are horizontal beds and each bed also has a saddle and horizontal spindle, making six spindles in all. The work is held in a jig and it is bored or reamed simultaneously from both sides, by the different spindles, thus giving a rapid production.



Beaman & Smith Special Six-spindle Boring and Reaming Machine

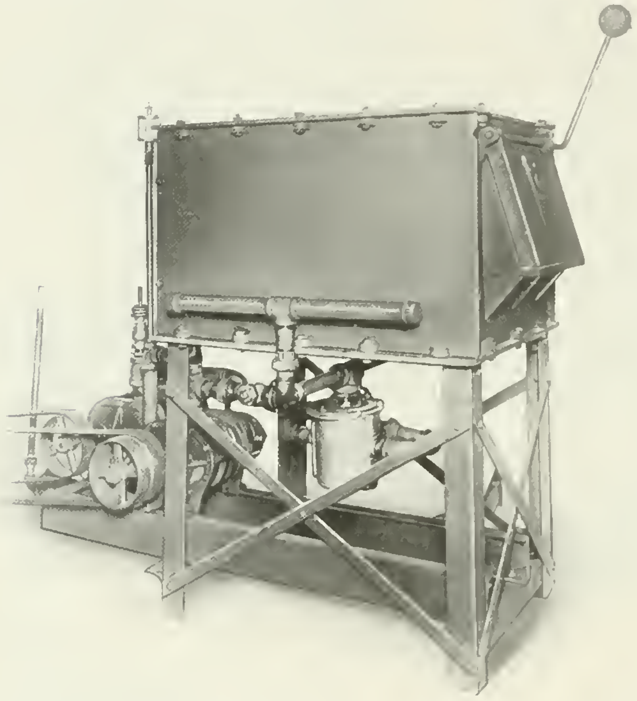
The platen is provided with a track on which a jig holding the work is rolled into position. Two jigs are required, so that one can be loaded or unloaded, while the other is in the machine. The spindles in each upright are driven in unison, and those on the beds at the rear are independent. All the spindles have a horizontal movement of 11 inches in their respective heads. There are four speeds ranging from 15½ to 32 revolutions per minute. The feeds for the spindles are automatic and vary from 1/64 to 1/16 inch per revolution. Variations of feed are obtained by change gears. Each side of the machine is driven independently by 5-inch belts which operate on four-step cone pulleys at the rear. The driving gears have a ratio of 14 to 1.

The spindles are all crucible steel and run in hard bronze boxes. The inner ends of the spindles are fitted to the particular form of cutter required. The platen of this machine is

6 feet wide and 10 feet long. The distance between the uprights is 23½ inches. The minimum distance between the centers of the front spindles is 18 inches and the maximum distance, 49 inches. The minimum and maximum distances between the ends of opposed spindles, are ¾ inch and 22¾ inches, respectively. The greatest distance between the front and rear spindles is 62 inches. The weight of this machine is approximately 31,000 pounds.

CASEHARDENING AND ANNEALING FURNACE

The casehardening and annealing furnace shown herewith is manufactured by the Wisconsin Foundry & Machine Co., Madison, Wis. The principal features claimed for this furnace are: high temperatures with a minimum amount of gas, ease of heat regulation for constant temperatures, and simplicity of operation. The furnace proper has a fire-brick heating chamber, 15 inches wide, 11 inches high, and 30 inches long. This chamber is thoroughly insulated from the iron shell by air spaces and asbestos board strips. The insulation is said to be so effective that the furnace chamber remains hot after the fire has been out about fifteen hours. The furnace door is easily opened or closed, owing to the ball counterweight provided. Each installation is supplied with two positive-pressure blowers of sufficient size to produce the best results. The air and gas enter, separately and under pressure, a mixer which is seen under the furnace. Here the gas and air are thoroughly mixed, and this mixture passes to the furnace through a single pipe. It is claimed that a temperature of 2500 degrees can be easily obtained. The installation illustrated is equipped with a gasoline priming system which is used to advantage in starting the furnace, or for enriching a poor quality of gas, in order to get the desired heat. This furnace can also be supplied in sizes varying from 15 by 15 inches to 15 by 36 inches.



Casehardening and Annealing Furnace

SHUSTER STOCK STRAIGHTENER AND CUTTER

The machine shown herewith is designed to automatically straighten and cut to accurate lengths either square, hexagon or flat stock. It has a capacity for ¾ inch squares or hexagons and it will also handle flat stock 1¼ inch wide by ¼ inch thick. A maximum length of 20 feet can be cut, but only part of the extension of the machine is shown in the illustration.

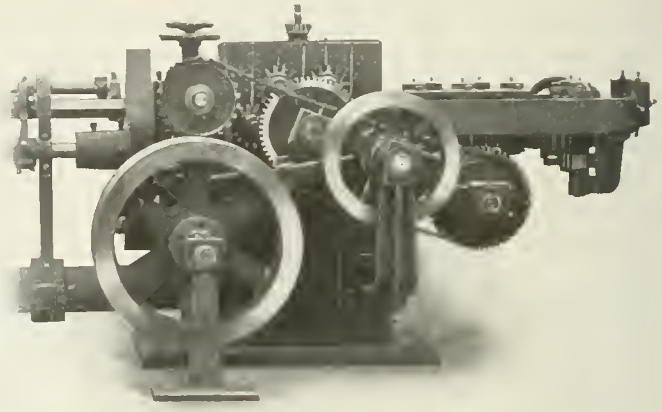


Fig. 1. Rear View of Shuster Stock Straightener

The machine is driven by a balance wheel (see Fig. 1), which connects with a train of gears operating the horizontal and vertical straightening rolls and feed rolls. There are five vertical and five horizontal rolls, all of which are gear driven. These rolls have grooves corresponding to the shape of the material they are to handle. The upper horizontal rolls and the rear vertical rolls are adjusted, by means of suitable screws, to suit the size of the material. The front feed rolls are adjusted by the handwheel shown above them, and they are driven in unison with the back feed rolls, by the chain and sprockets, seen in Fig. 1. The back feed rolls (at the left end of the machine) are also adjusted by a handwheel.

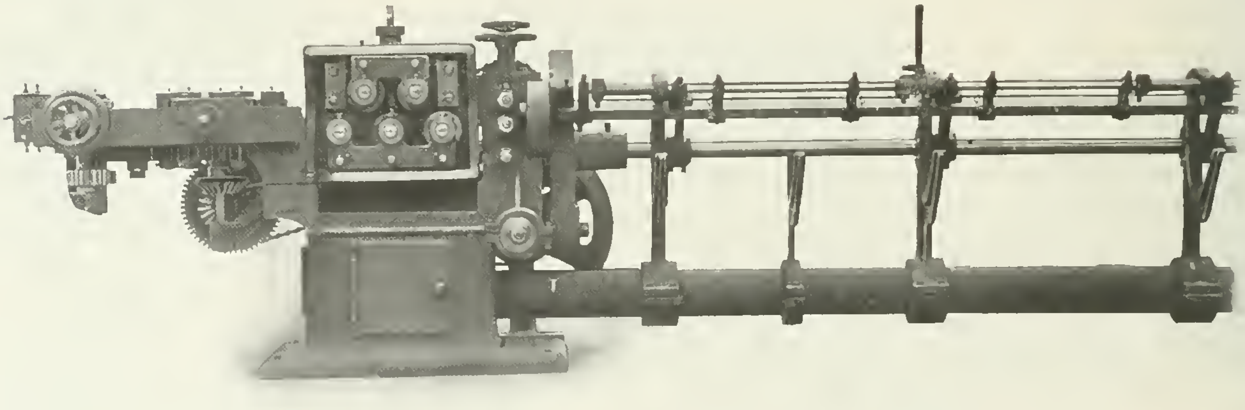
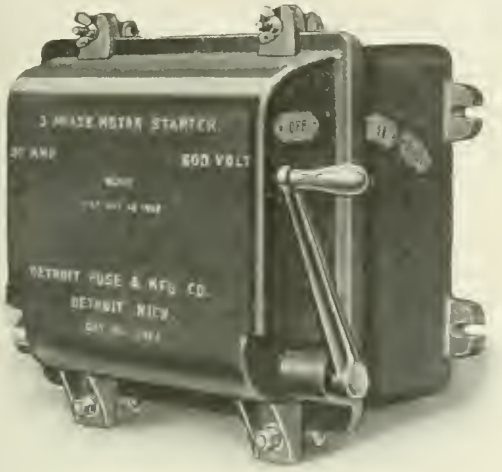


Fig. 2. Side View of Shuster Geared-roll Stock Straightener and Cutter

The extension consists of a guide-bar having a suitable groove for the shape of material being handled, and a cover or apron. There is an adjustable stop-gage which is set for the length to be cut. The coil of stock should be mounted on a suitable reel located at the end of the machine. The stock first passes through a guide and then enters the rear feed rolls. The straightening rolls are next encountered and then the front feed rolls. After passing the latter, the stock moves through a bush die, past the cutter knife and into the guide-bar until it strikes the stop gage previously referred to. Then the cutting mechanism is automatically set in motion and the knife severs the piece, after which the guide-bar cover is thrown open and the cut rod drops out into the forked holders or brackets shown. As soon as the stock strikes the stop-gage, a clutch mechanism is thrown in, which releases the feed rolls and causes them to remain stationary while the cutting operation takes place. This machine is built by the F. B. Shuster Co., New Haven, Conn.

DETROIT THREE-PHASE MOTOR STARTER

A new type of three-phase motor starter is now being manufactured by the Detroit Fuse & Mfg. Co., 1400 Rivard St., Detroit, Mich. This starter makes it unnecessary to "fuse" a three-phase motor for the starting current, and it automatically protects the motor from injury, as well as the operator. The size shown in the illustration, has a capacity of 30 amperes at 400 to 600 volts, and it is especially adapted for motor-driven machinery using alternating-current motors with any voltage above 250 and not exceeding 600.



Detroit Three-phase Motor Starter

The starter is of very substantial construction, and all the mechanical or moving parts are enclosed in a cast-iron box. The switch is operated by the hand lever seen at the side of the box. To start a three-phase motor, this lever is moved to the "start" position. This closes the circuit and places the fuses in the circuit, but "parallels" them with a solid copper bar which takes care of the starting load. It is necessary for the operator to hold the lever in the starting position until the motor reaches its normal speed; he then removes his hand from the lever and the parallel bars are thrown out of the circuit without opening it. This leaves the fuses completely protecting the motor at its running load, without at any time breaking the contact, as is done when a double-throw knife-switch is used for this purpose. There are no flimsy or complicated parts connected with this starter, and in its operation there is no possibility of accidental contact with "live" parts The three-phase starter is also made in a 200 to 250 volt size.

NEW MACHINERY AND TOOLS NOTES

Chuck Closer: Stark Tool Co., Waltham, Mass. Hand-operated chuck closer for bench lathes which enables the work to be released or clamped while the lathe is in motion. This chuck is operated by a lever at the left of the headstock.

Band Saw: Houghton & Richards, 26 N. Clinton St., Chicago, Ill. Tilting band saw designed for cutting metal. The saw is operated by gravity feed and the band wheels are mounted on a tilting arm which swings forward over the table and gives a continuous feeding movement.

Lathe Center: Stark Tool Co., Waltham, Mass. Self oiling lathe center which can be oiled without withdrawing it from the work. The hole through which the oil is inserted, is normally kept closed by an adjustable brass collar. This collar retains the lubricant and excludes dust or dirt.

Tapping Machine: Evans Stamping & Plating Co., Taunton, Mass. Vertical tapping machine having an automatic stop mechanism for tapping to any predetermined depth. This machine is built for either hand lever or foot lever operation. It has a capacity up to 1/4 inch, and the work table is 11 1/2 inches in diameter.

Drilling Machine: Richmond Stay-Bolt Drilling Machine Mfg. Co., 11 E. Broad St., Richmond, Va. Machine for drilling the tell-tale holes in boiler stay-bolts. The bolts are dropped into slots in a revolving carrier, and then all the operations are performed automatically. The carrier may be easily adjusted to accommodate bolts of different lengths.

Emery Wheel Guard: Challenge Machine Co., Inc., Philadelphia, Pa. Emery wheel protector and dust guard. The guard proper is made of four heavy steel bands which have great strength. At the ends of the guards in front, there are adjustable shields which deflect the grindings and protect the eyes of the workmen. The guard is attached to the machine by a heavy arm.

Pipe Threading Machine: The Loew Mfg. Co., Cleveland, Ohio. Pipe threading machine which will not only cut off and thread pipe, but also cut off and thread nipples without the use of a nipple chuck. This machine is a lathe bed type. The die-head is self-locking and self-releasing. There are two changes of speed obtained by shifting gears, and no countershaft is required, as tight and loose pulleys are provided on the machine itself.

Die-Sinking Machine: Newton Machine Tool Works, Inc., Philadelphia, Pa. Die-sinking machine designed to eliminate the use of special angular cutters by having a swiveling knee upon which the work table is mounted. By means of this angular adjustment of the work table, both internal and external clearances can be milled with straight cutters. The machine is equipped with both vertical and horizontal spindles and the latter is supported by an overhanging arm.

Speed Changing Mechanism: Burke Electric Co., Erie, Pa. Arrangement for changing the constant speed of alternating or direct-current motor, in connection with machine tool drives. It consists of a frame which supports a jack-shaft and the necessary pulleys for the speed adjustments. In the case of a lathe, the frame is attached to the headstock, and the jack-shaft is located above the main cone pulley, whereas the driving motor is mounted on an extension base at the rear.

Safety Device: J. H. Williams & Co., 61 Richards St., Brooklyn, N. Y. Safety device for drop-hammers, designed to automatically prevent accidents to the operator when inserting work by hand. The device is used in connection with work which has to be "restruck" after the "flash" or excess metal has been removed. A spring steel guard is clamped to the guide or upright, and when the ram descends, the guard swings outward, thus forcing the hand of the operator away from the danger zone.

Gear Testing Machine: Peerless Gear Tester Mfg. Co., 602 Schofield Bldg., Cleveland, O. Gear tester for determining the concentricity, pitch diameter and variation in the tooth thickness of spur and bevel gears. The machine consists of a horizontal base, having a stationary and a movable block carrying hardened and ground studs for holding the master gear and the gear to be tested. There is also the necessary mechanism for transmitting the motion caused by inaccuracy in the gear being tested to pointers swinging over graduated dials.

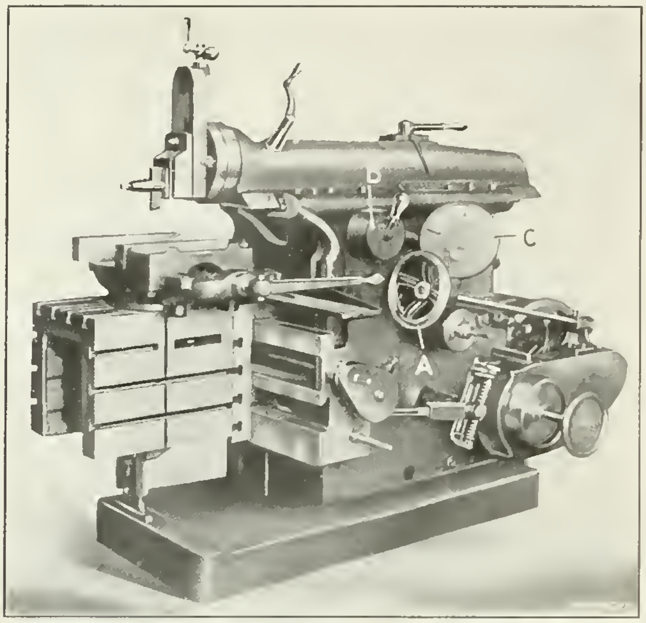
Surface Grinder: Northampton Emery Wheel Co., Leeds, Mass. Grinder for surfacing dies, chucks, straightedges, surface-plates, typewriter parts and all similar work within the capacity of the machine. This grinder is of the column-and-knee type and the table can be operated either by hand or automatically. The vertical feed is shown by a dial graduated in thousandths of an inch. Three sizes are built, the smallest of which has a table measuring 10 by 24 inches and the largest, 10 by 36 inches. A 12-inch wheel is used, and the side feed can be varied from 1/64 to 1/8 inch per stroke.

Motor Drive for Lathes: South Bend Machine Tool Co., South Bend, Ind. Double-belt reversible motor drive for lathes, consisting of a cast-iron bracket pivoted to a casting attached to the rear of the bed and carrying both the countershaft and motor. The motor is mounted on the lower end of this bracket and is connected to the countershaft at the upper end by open and cross belts. A cone pulley on the countershaft is belted to the headstock pulley, and the proper tension for this driving belt is obtained by simply adjusting the rear bracket by means of a screw in front of the lathe. The forward and reverse movements are controlled by a horizontal shifter rod which extends along the lathe bed and is within convenient reach.

The Periodograph: Gisholt Machine Co., Madison, Wis. Recorder for keeping accurate record of time required by workmen on various jobs. Each man is supplied with a card on which the recorder registers the time at which a piece of work is started. When the job is completed, the card is again placed in the recorder and the finishing time is automatically registered just above the starting time. By simply subtracting the lower figure from the upper, the net time is obtained. Spaces are provided on the card for several starts and stops, and by carrying the net periods to the right, it is easy to sum up the total time. The stamp automatically locates the card, so that the recorder can be operated by the workmen without chance of error.

SHAPER HAVING AUTOMATIC STARTING CONTROL AND SPEED DIAL

A motor-driven crank-shaper equipped with an automatic starting control and a speed dial for obtaining any desired cutting speed, is illustrated herewith. This is a Gould & Eberhardt machine and it is driven by a 5 horsepower Reliance adjustable-speed motor having a speed range of from 300 to 1500 revolutions per minute. The speed adjustments are obtained by mechanically shifting the motor armature by handwheel *A*. When the speed is properly set for a given operation, the motor can be stopped and started as often as desired, without further attention to the speed adjustment. This is due to the fact that the starting and stopping is entirely separate from the speed regulation and is controlled by an automatic starter through the drum switch *B*. This switch has three positions, namely, the "start," "off," and "brake" positions. To start the motor, it is simply necessary to throw the switch to the starting position. When the switch is moved to the "off" position, the power is shut off, and the time then required for the machine to stop will depend upon the time required for friction to overcome the momentum of the moving parts. When the switch is thrown to the "brake" position, the motor is automatically brought to a stop almost instantly. This simple method of stopping eliminates the necessity of a clutch, and the motor is never running idle, thus unnecessarily wasting power. The starter, which is mounted on a nearby post, is of the series control type and automatically takes care of all starting conditions. All wires are carried in a conduit which is tapped directly in the drum switch, so that there is no exposed wiring.



Motor-driven Crank Shaper equipped with Automatic Starting Control and Speed Dial

The speed dial *C* is a device used with the Reliance adjustable-speed motors to enable the motor speed to be quickly regulated for obtaining any required cutting speed of the tool. This device is in the nature of a circular slide rule, and, in the case of a shaper, it takes into account all the variable factors, such as the ratio of the drive and the length of the stroke. The method of using this dial was described in the March number of MACHINERY. It is the product of the Reliance Electric & Engineering Co., Cleveland, Ohio.

* * *

PERSONALS

Henry L. Gantt spoke on "Scientific Management" before the American Society of Swedish Engineers, Brooklyn, N. Y., Saturday evening, March 23.

William H. Holland, of the Sibley Machine Tool Co., South Bend, Ind., has succeeded Mr. Walter A. Sibley as president and general manager.

E. H. Pratt, Lansing, Mich., has been promoted from the position of toolroom foreman to that of tool engineer of the Olds Motor Works of Lansing.

Frank P. Judge, formerly head of the mechanical department of the Wells Bros. Co., Greenfield, Mass., has been appointed general superintendent of the company's bolt cutter and gage shops.

George V. Rottweiler has resigned as chief engineer and factory manager of the Falls Machine Co., Sheboygan Falls, Wis. Mr. Rottweiler designed the line of gasoline motors built by the motor department of the company.

E. E. Barney of Syracuse, N. Y., the present manager of the Smith Premier Typewriter Works of Syracuse, has been appointed manager of the Remington Typewriter Works of Ilion, N. Y., to succeed Mr. John Calder, whose resignation takes effect May 15.

Albert G. Lea, who for the past five years was president of the Lea Equipment Co., New York and Philadelphia, has disposed of his interest in the company to Philadelphia parties, and has resigned as president. Mr. Lea will not enter active business for the present.

John Calder, who for several years has been manager of the Remington Typewriter Works, Ilion, N. Y., has resigned his position, effective May 15, to take a position with the Cadillac Motor Car Co., Detroit, Mich., where he will be associated with the management.

D. De Vries, manager of the well-known firm of dealers, R. S. Stokvis & Zonen, Ltd., Rotterdam, Holland, is in this country, where he arrived February 20. Mr. De Vries expects to remain for about eight weeks, visiting the principal machine tool concerns throughout the country.

George Langen, works manager of the Cincinnati Planer Co., Cincinnati, Ohio, sailed March 18 for Europe, where he will make a trip covering the entire continent. Mr. Langen expects to be gone four or five months. The trip is taken principally in the interests of his company.

Walter B. Snow, publicity engineer, 170 Summer St., Boston, has increased his organization by the addition of Mr. Charles L. Mulligan, late of the editorial staff of the Brooklyn *Standard-Union*, and for a considerable period associated with the publicity department of the Western Electric Co.

Howard D. Penney, for several years foreman for the Knox Automobile Co., Springfield, Mass., and for the past two years with the Parker Transmission & Appliance Co., of the same city, has taken a foreman's position with the Hendee Mfg. Co., manufacturers of the Indian motorcycle, of Springfield.

C. F. Barker of the firm of Gilbert & Barker Mfg. Co., Hartford, Conn., retired from the firm on January 1, 1912, having reached the age where he felt that he had earned a well-deserved rest. Shortly before retiring, his associates in the office presented him with a clock as a token of their esteem and good wishes.

Frank D. Chase, associate member of the American Society of Civil Engineers and architect of the Western Electric Co., has opened offices in the Peoples Gas Bldg., Chicago, Ill., for the practice of architecture and industrial engineering. Mr. Chase will make a specialty of manufacturing plants and mercantile buildings.

Allen D. Risteen, who for the past twenty-three years has been assistant editor and editor of *The Locomotive*, Hartford, Conn., has resigned to become connected with the Travelers' Insurance Co., of the same city. Dr. Risteen has contributed many valuable articles on steam boiler inspection and practice to the technical press.

Arthur B. Tilton, assistant advertising manager of Hoskins Mfg. Co., Detroit, Mich., has been made advertising manager, succeeding Mr. H. Ralph Badger, resigned. Mr. Badger, who had been with the Hoskins Mfg. Co. for three years as publicity manager and assistant manager of sales, will for the present confine his attention to personal interests.

H. E. Harris has been appointed general superintendent of the Wells Bros. Co.'s tap and die plant. He was formerly the company's assistant superintendent and production engineer and came to them from the Western Electric Co., with which he had been master mechanic and methods engineer. Mr. Harris read the paper "Taps and Tapping," presented before the monthly meeting of the A. S. M. E., March 12.

George J. Henry, Jr., who has had eighteen years' experience with the Pelton Water Wheel Co., San Francisco and New York, ten years of which were spent as the company's chief engineer, and the past six years as chief engineer and sales manager, has resigned, and opened an engineering office at No. 737 Rialto Building, San Francisco, Cal. Mr. Henry will specialize on hydraulic machinery and hydraulic installations.

George H. Graves, treasurer, and George T. Coppins, secretary, of the Walworth Mfg. Co., Boston, Mass., were recently presented with loving cups by twenty employes of the company, only two of whom have been in the company's service less than twenty years. The average term of service of the givers of the cups is thirty-one years. Mr. Graves has been with the company forty-seven years, and Mr. Coppins thirty years.

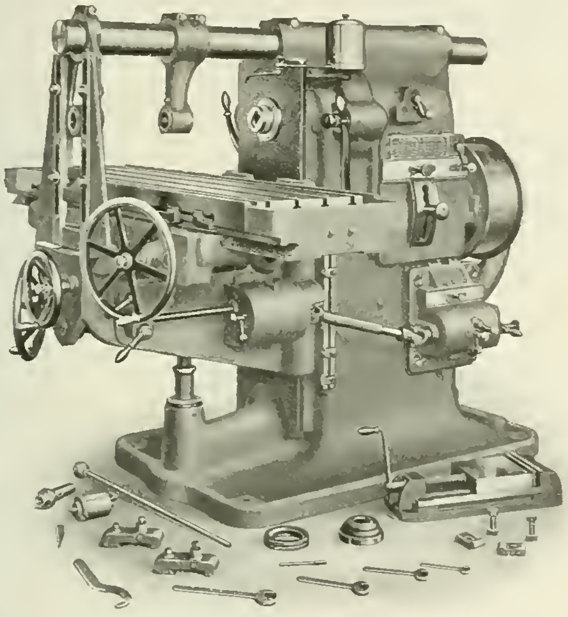
H. R. Setz, who has been chief engineer of the Struthers Wells Co., Warren, Pa., for the past two years, has taken the

Heavy Plain Milling Machines Offer Many Opportunities to Reduce Production Costs

Many heavy jobs in our shops that were formerly done on the planer are now put on a Heavy Plain Milling Machine.

A saving of at least one-half and sometimes considerably more of the time formerly required is effected in this way.

Consequently, the cost of work is likewise lowered.



No. 5B HEAVY PLAIN MILLING MACHINE

Such savings in time and cost are surely worthy of consideration.

Perhaps there are many jobs in your shop that can be done to distinct advantage on a heavy plain milling machine, and a study of the few points following may serve to open the way to a material saving in manufacturing costs.

All B. & S. Heavy Plain Milling Machines are exceptional examples of strong, rigid construction and are fully capable of taking continuous heavy cuts.

They are easily adjusted to accommodate different pieces of work, and are handy to operate.

The No. 5 B Heavy Plain Milling Machine shown is the largest size. Its table has both power and hand feeds—longitudinally, 50″, transversely, 12″, and vertically, 21″. The driving pulley is 20″ in diameter, takes 7″ belt, and runs at 320 R. P. M. Net weight 10,750 lbs.

This machine is designed particularly for the heavier work in machine tool, engine and railroad shops.

The constant speed type of drive embodied in these machines enables the full power delivered to be available at the spindle under all conditions of spindle speed.

It also permits of the speeds and feeds being independent of one another.

A friction clutch, operated by handles at each side of the machine, obviates the necessity of shifting a heavy belt to stop the machine.

Special circulars describe these and many other features more fully, and we shall be glad to send you copies free.

BROWN & SHARPE MFG. CO.
PROVIDENCE, R. I., U. S. A.

position of chief engineer with the Otto Gas Engine Works of Philadelphia. Mr. Setz was formerly connected with several of the leading European and American gas and oil engine manufacturers. His attention will be chiefly directed toward the development of a complete line of Otto-Diesel engines of the horizontal type.

C. C. Owens was recently placed in charge of the Detroit sales office of the Westinghouse Electric & Mfg. Co., with the title of district manager. Mr. Owens was born in 1877 and graduated from Columbian University, Washington, D. C. He entered the employ of the Westinghouse Electric & Mfg. Co. in 1896, taking the apprenticeship course for three years in the engineering department, specializing on switchboards and controllers. For the past eight years he has been connected with the New York sales office.

William R. Wherry, a Pennsylvania R. R. passenger conductor, was retired March 22, at the age of sixty-seven, after fifty years of active service. In this period he was never suspended or disciplined in any manner. Mr. Wherry was born in Cambria County, Pa., and when seventeen years old was employed by the Pennsylvania R. R. Co. as a freight brakeman. One promotion followed another until he was made a passenger conductor on the Pittsburg Division, where he is employed at the present time. The record of this passenger conductor, who is the type of man the company puts in charge of its trains, is given in a letter written by him to his superintendent: "I have now been running a passenger train for almost forty-six years and in that time have never had a serious accident, never had a passenger seriously injured or killed, have never been fined or suspended, always got along well with the traveling public, was never reported by a passenger that I heard of, and never was the cause of any lawsuits, which, when you consider the number of people of all kinds I have handled, is a wonder. It has always been my aim to do everything in my power to take my train over the division safely, and I have always held the company's interests first and have been loyal to it. I have never been seriously injured, but have had some very narrow escapes, having fallen between freight cars, and been knocked down by an engine and squeezed between cars."

* * *

OBITUARIES

Henry W. Spangler, Whitney professor of dynamical engineering, University of Pennsylvania, Pa., died March 17.

Alanson H. Merriman, a manufacturer of drop presses for the past forty years, died in Hartford, Conn., March 4, aged eighty-four years.

Frank E. Eggleton, superintendent of the molding department of the Waterbury Farrel Foundry & Machine Co., died March 5, at his home in Waterbury, of pneumonia, aged forty-six years.

John H. O'Donnell, regarded as an authority on wire drawing machinery, died at his home in Waterbury, Conn., February 27, aged forty-eight years. He was the inventor of the diamond wire-drawing die, and was prominently identified with various concerns in Waterbury and Seymour, Conn., and Worcester, Mass.

Charles Hart, president of the Hart Mfg. Co., Cleveland, Ohio, died February 9, aged sixty-two years. He was a lifelong resident of Cleveland and established the company of which he was president and treasurer, thirty years ago. He is survived by a widow, daughter and son, Mr. Louis F. Hart, vice-president and secretary of the company.

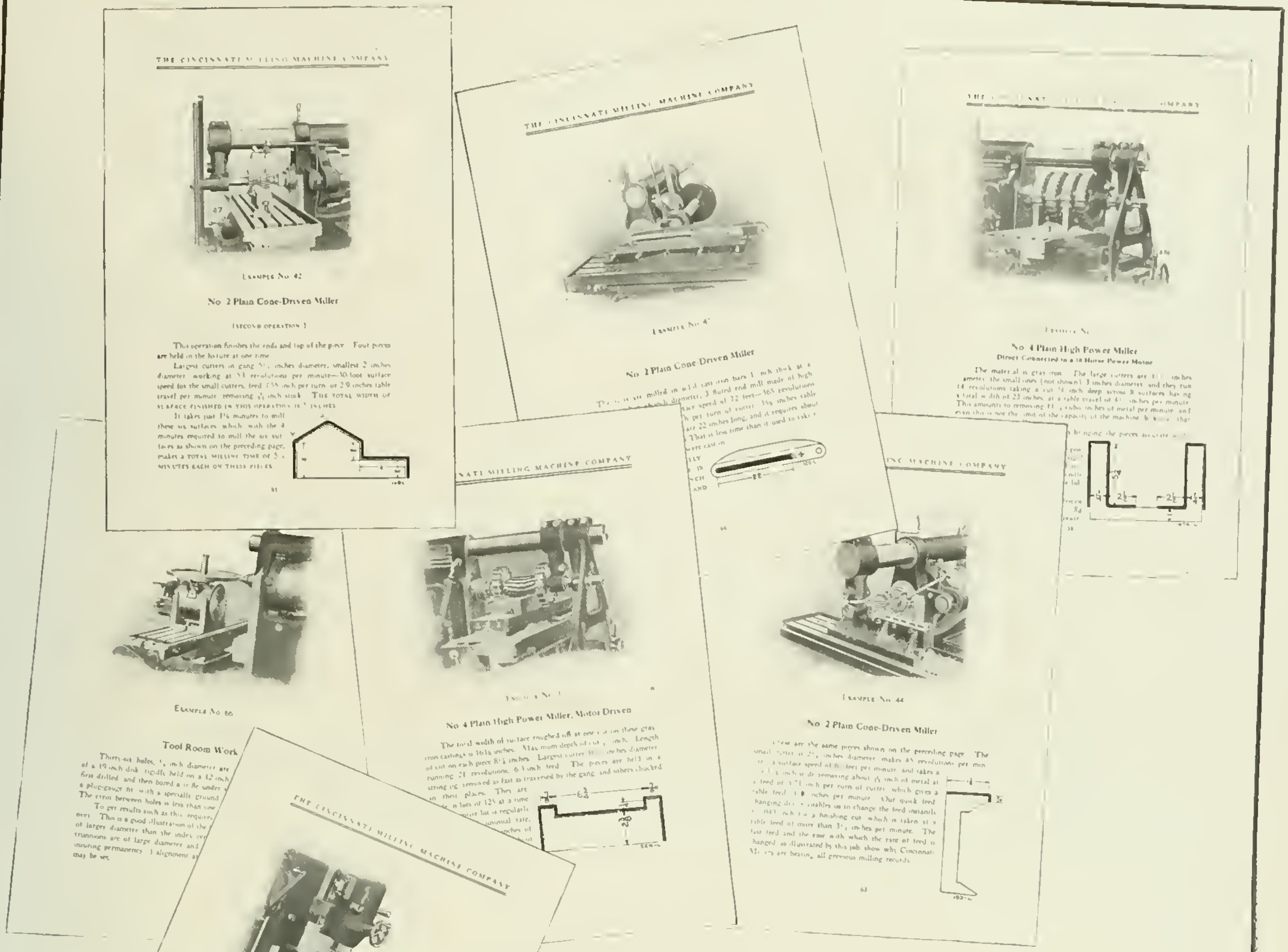
Elias G. Heller, president of the Heller Bros. Co., Newark, N. J., prominent steel and file makers, died at his home in the Forest Hill section of that city, March 22, of pneumonia, following apoplexy, in his seventy-fifth year. The firm of Heller Bros. was established in 1865 by the three brothers, Elias, Peter and Lewis, and a factory was built in the following year. The business soon outgrew the capacity of the building and a much larger plant was built in 1872. Lewis Heller withdrew from the firm in 1870 and Peter Heller in 1880, in which year the brothers George and John Heller were made members of the firm. Mr. Heller is survived by a widow and three sons, Paul E., Arnaud G., and R. Arthur Heller.

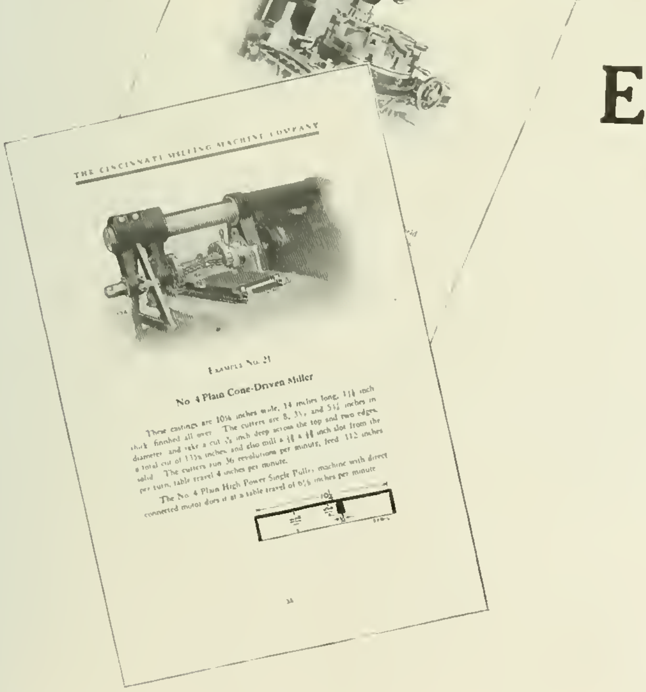
Rear-Admiral George W. Melville, formerly engineer-in-chief of the U. S. Navy, and world-famous as an engineer, inventor scientist and Arctic explorer, died at his home in Philadelphia, March 17 of paralysis, aged seventy-one years. At the outbreak of the Civil War, Melville, then twenty years old, entered the U. S. Navy and became an officer of the engineer corps. He saw much active service during the war and at its close was attached to the *Tacony*, with which vessel he served in the Gulf of Mexico during the occupation and evacuation of Mexico by the French. Melville's career as an Arctic explorer began with a trip to the North in 1873, when as assistant officer of the small sealing steamer *Tigress* he assisted in the search for the remaining members of the crew of the *Polaris*. Later he was the engineer officer of the ill-fated *Jeannette* expedition, and returned from this terrible experience in 1882. In the spring of 1884 he again went into the frozen North with the squadron dispatched to the relief of the Greeley expedition, the survivors of which were rescued in 1884. He was appointed engineer-in-chief of the Navy in 1887 for a term of four years and was reappointed four times successively, his retirement taking place in 1903. During this long period in the naval service one-hundred-and-twenty vessels were constructed, aggregating 700,000 horsepower. Rear-Admiral Melville was elected vice-president of the American Society of Mechanical Engineers 1895-97, president of the society in 1899, and in 1910 he was made an honorary member. Some years after his retirement from the Navy he and John Macalpine were associated in Philadelphia as a firm of consulting engineers and naval architects. During this association the Melville-Macalpine reducing gear was successfully developed for coupling steam turbines to marine propellers for the efficient propulsion of ships.

Milton Prince Higgins

MILTON PRINCE HIGGINS

Milton Prince Higgins, president of the Norton Co., and Norton Grinding Co., died Friday, March 8, at his home in Worcester, Mass., aged sixty-nine years. Mr. Higgins was born December 7, 1842 in Standish, Maine. He was the descendent of an old Cape Cod family which originally came from England in 1633. At the age of seventeen years he left home to serve an apprenticeship in the shops of the Amoskeag Mfg. Co., Manchester, N. H. While serving his time he studied evenings and saved enough money to enable him to go through Dartmouth College, from which he graduated in 1868. After his graduation he entered the employ of the Washburn & Moen Mfg. Co., under the late Mr. Charles Hill Morgan and later took a position as superintendent of the Washburn Shops of the then newly organized Worcester Polytechnic Institute, where he remained for twenty-eight years. In 1903 he was appointed a trustee of the Institute, which position he held until his death. Mr. Higgins took an active interest in the establishment of trade schools for mechanics, and his influence in industrial education has been wide-spread. During his association with the Worcester Polytechnic Institute he obtained a year's leave of absence to organize the shops of the Georgia School of Technology at Alabama. He also planned the shops of the Miller Manual Labor School of Virginia. In 1899, he presented a paper before the American Society of Mechanical Engineers on the education of machinists, foremen and mechanical engineers, thus being the first to introduce to the public the "half-time" school proposition. He was appointed a member of the state board of education by Governor Douglas of Massachusetts, and his vigorous efforts in this connection led to the establishment of the Worcester Trade School in 1908. While at the Washburn Shops, Mr. Higgins became interested in a small emery wheel business which he acquired in company with Prof. Alden. Under their management this business grew into the well-known firm of the Norton Emery Wheel Co., which later became the Norton Grinding Co. In 1896, the Worcester Polytechnic Institute sold its hydraulic elevator business to Mr. Higgins and Prof. Alden, who had been instrumental in building it up. Thus the Plunger Elevator Co. was established and carried on successfully until its absorption a few years ago by the Otis Elevator Co. In 1904, Mr. Higgins acquired an interest in the Worcester Ferrule & Mfg. Co., which in a few years greatly increased its business and was reorganized as the Worcester Pressed Steel Co. He was also president of the Manchester Supply Co., Manchester, N. H., and of the Sanford Riley Stoker Co., Providence, R. I. Mr. Higgins was a member and past vice-president of the American Society of Me-





Examples of Modern Milling Practice

Our new book "Examples" is now ready for distribution. It is a 96-page book, made up of live matter of the helpful sort, as indicated by these sample pages. Every one of the ninety-six contains information of value to you, if your job is in the Engineering, the Planning, or the Manufacturing Department.

We will send it anywhere, postage free, on request.

The Cincinnati Milling Machine Company
Milling Specialists
Cincinnati, Ohio, U. S. A.

chanical Engineers and a charter member of the Society for the Promotion of Engineering Education. He leaves a widow, two sons and two daughters. One of his sons, Alden C. Higgins, is with the Norton Co., and the other, John W. Higgins, is manager of the Worcester Pressed Steel Co.

* * *

COMING EVENTS

April 10-11.—Fourteenth annual convention of the National Metal Trades Association in New York, Hotel Astor headquarters. Robert Wuest, commissioner, New England Bldg., Cleveland.

May 13-15.—Triple convention of the American Supply and Machinery Manufacturers' Association, National Supply and Machinery Dealers' Association, and Southern Supply and Machinery Dealers' Association, at Norfolk, Va., Monticello Hotel, headquarters. F. D. Mitchell, secretary-treasurer, 309 Broadway, New York.

May 13-25.—Newark industrial exposition under the auspices of the Board of Trade of Newark, N. J., in the First Regiment Armory. It is claimed that one hundred thousand different articles are manufactured in the three thousand shops of the Newark industrial district, the diversity being proportionately greater than that of any other manufacturing district in the country. William G. Rose, manager, Newark, N. J.

May 14-17.—Sixth annual convention of the Master Boiler Makers' Association at the Fort Pitt Hotel, Pittsburg, Pa. J. R. Flannery, of the Flannery Bolt Co., Frick Building, Pittsburg, Pa., secretary and treasurer of the general committee of arrangements.

May 16-17.—Semi-annual convention of the National Machine Tool Builders' Association at Atlantic City, N. J., Hotel Chalfonte headquarters. E. P. Bullard, Jr., president, Bridgeport, Conn.; James H. Herron, secretary, Cleveland, Ohio.

May 20-22.—Railway Storekeepers Association's convention in Buffalo, N. Y. Hotel Statler, headquarters. Wm. E. Kelley, secretary-treasurer, 825 Wabash Ave., Chicago, Ill.

May 28-31.—Spring meeting of the American Society of Mechanical Engineers in Cleveland, Ohio. Hotel Hollenden, headquarters. Calvin W. Rice, secretary, 29 W. 39th St., New York.

June 12-14.—Annual convention of the American Railway Master Mechanics' Association at Atlantic City, N. J.

June 17-19.—Annual convention of the Master Car Builders' Association at Atlantic City, N. J.

July 9.—Annual convention of the American Railway Tool Foremen's Association in Chicago. H. L. Miller, secretary of the supply association, 835 Monadnock Bldg., Chicago, Ill.

August 20.—Annual convention of the International Railroad Master Blacksmith's Association at Hotel Sherman, Chicago, Ill. J. E. Carrigan, Rutland Railway, Rutland, Vt., chairman of the executive committee.

September 2-7.—Sixth congress of the International Association for Testing Materials at the Engineering Societies Building, 29 W. 39th St., New York. H. F. J. Porter, secretary, 1 Madison Ave., New York.

September 24-26.—Annual convention of the American Foundrymen's Association and allied bodies, in Buffalo, N. Y.; Hotel Statler, headquarters. Richard Moldenke, Watchung, N. J., secretary.

October 7-11.—Annual convention of the American Electric Railway Association and allied associations in Chicago, Ill. The exhibit will be at Dexter Pavilion, 43d and Halstead Sts. H. C. Donecker, secretary-treasurer, 29 W. 39th St., New York.

SOCIETIES, SCHOOLS AND COLLEGES

Manufacturers' Association of Hartford County, Hartford, Conn. Circular on a cooperative continuation course for shop boys offered by the Hartford Public Schools, which has been provided to fill the need of more efficient training for shop men, long felt by the manufacturers of Hartford. Charles B. Cook, manager of the Royal Typewriter Co., is chairman of the industrial educational committee of the Association.

Franklin Institute, acting through its Committee on Science and the Arts, recently awarded the Elliott Cresson gold medal, the highest in the gift of the Institute, to the following gentlemen: Alexander Graham Bell, of Washington, D. C.; Samuel Wesley Stratton, of Washington, D. C.; Albert A. Michelson, of Chicago, Ill.; Alfred Noble of New York City; Elihu Thomson, of Swampscott Mass.; Edward Williams Morley, of West Hartford, Conn.; Johann Friedrich Adolph von Baeyer, of Munich, Germany; Sir William Crookes of London, England, and Sir Henry Enfield Roscoe, of London, England.

Oscar E. Perrigo, 6 Beacon St., Boston, Mass., has made an advance in the methods of correspondence school work whereby the courses of instruction are reduced in average cost and made of greater practical value to students. A special course is arranged for each individual to fit individual needs, and the tuition rates are made proportional to the requirements of the individual. The student is not required to spend time necessary to go over matter already well known, and he pays only for those parts of the course in which he needs specific instruction. The advantages of the system are obvious. Theory, practice and system for clerks, mechanics, engineers, accountants, manufacturers and other men connected with industrial work are taught.

NEW BOOKS AND PAMPHLETS

Mechanical Stresses in Transmission Lines. By A. Guell. 31 pages, 6 by 9 inches. 10 illustrations. Price, 20 cents. 5 tables. Published by the University of Illinois, Urbana, Ill.

Inductance of Coils. By Morgan Brooks and H. M. Turner. 72 pages, 6 by 9 inches. 25 illustrations and charts and 12 tables. Price, 40 cents. Published by the University of Illinois, Urbana, Ill.

Bulletin of Syracuse University. Syracuse, N. Y. 509 pages, 5½ by 8½ inches. Contains general information on admission, courses, examinations, and list of students. Published by the University, Syracuse, N. Y.

Annual Report of the Directors of American Telephone and Telegraph Co. to the Stockholders, for the year ending December 31, 1911. 51 pages, 6 by 9 inches. Published by the American Telephone & Telegraph Co., New York.

Fifty Years of the Arkwright Mutual Fire Insurance Company. By Edward V. French. 123 pages, 6 by 9 inches. Numerous illustrations, maps and charts. Published by the Arkwright Mutual Fire Insurance Co., Boston, Mass.

This book contains a history of the development of, and work done by the Factory Mutual Fire Insurance Companies during the past seventy-five years, and deals especially with that part of the work done by the Arkwright company in inducing manufacturers to cooperate for the prevention of fires in their plants, and for obtaining insurance at cost. The book is distributed to engineers, architects, manufacturers and others connected with and interested in fire prevention engineering. It gives a great deal of technical information, and should be very valuable to any one on whom it devolves to take precautionary measures against fire.

Practical Problems for Vehicle Draftsmen and Mechanics. By R. B. Birge and Hugh M. Sargent. 80 pages, 12 by 9 inches. Published by Ware Bros. Co., Philadelphia, Pa. Price $2.00.

This work is the outgrowth of practical experience in the classroom. The authors state that while intimately connected with the vehicle industry, they, in 1909, conducted an evening class in carriage drafting, and that the results of the first year were so encouraging that the work was continued through another year; the many problems which came up for discussion and solution in relation to the highly technical work of carriage body drafting were collected, and have formed the basis of the present treatise. The work contains first a number of geometrical definitions, followed by specific problems of particular interest to the carriage-maker. It is profusely illustrated, and contains not less than thirty-one full page plates with problems, and drawings of carriage bodies. The typographical execution of the book and the paper on which it is printed are of the best, making the intricate drawings extremely sharp and clear, and leaving nothing to be desired as regards distinctness in the execution of the design.

Engineering as a Vocation. By Ernest McCullough. 201 pages, 5½ by 8 inches. Published by David Williams Co., New York. Price $1.00.

The subject matter of this work has been re-arranged from a number of addresses presented before technical schools, and is especially published for the information of parents in order that they may form a correct judgment in advising a career for their sons. In his preface the author states—certainly with considerable truth—that semi-technical periodicals and daily newspapers are the bureaus of information frequently consulted in matters of this kind, and perhaps more than one-half the students now in the technical schools are there because of the advice obtained from such sources. The book deals with the work of the engineer, the education of the engineer, and home study course. One chapter is entitled "How to Hunt and Hold a Job," and another, "Does it Pay to Study Engineering?" The work contains exact information on many subjects on which the prospective engineer should be informed, and will undoubtedly prove of value to anyone who is planning an engineering education for himself or for others.

Wood-working Safeguards. By David van Schaack. 217 pages, 6¾ by 9¾ inches. 320 illustrations. Published by Aetna Life Insurance Co., Hartford, Conn. Price $1.00.

This book offers a great number of practical suggestions for safeguarding workmen engaged in the lumbering and wood-working industries. It confines itself chiefly to machines, operations and conditions which are more or less common, but the suggestions contained should impress manufacturers with the possibilities in safeguarding, which, with some variation, will be applicable to many of the special machines used which it has not been possible to touch upon in a work of limited extent. The book is profusely illustrated, so as to clearly show the suggested safeguards. Different sections of the book are devoted to logging, saw mills, planing mills, circular saws, band saws, jointers, shapers, sanders, etc., and to the various wood-working industries. Special attention is also given to power generation and transmission, grinding wheels, and elevators. A carefully compiled index is an important feature of the book. It deserves a place on the desk of the executive of any industrial establishment employing wood-working machinery.

Marine Steam Turbines. By G. Bauer and O. Lasche, assisted by E. Ludwig and H. Vogel. Translated from the German and edited by M. G. S. Swallow. 214 pages, 6 by 9 inches. 103 illustrations. 18 tables. Published by Norman W. Henley & Son, New York. Price $3.50.

The use of steam turbines for the propulsion of naval vessels has increased to a considerable extent during the last few years. The present book will therefore be welcomed by many engineers who are especially interested in this subject. The book is the work of men engaged in practical pursuits, and while it contains the necessary theory, yet the theoretical discussions have been presented in such a way as to be useful to any engineer with enough fundamental training to enter successfully upon the subject of the theory of steam turbines. The book is divided into ten parts headed as follows: Introduction; General Remarks on the Design of a Turbine Installation; The Calculation of Steam Turbines; The Turbine Design; Shafting and Propellers; Condensing Plant; Arrangement of Turbines; General Remarks on the Arrangement of Steam Turbines in Steamers; Turbine-driven Auxiliaries; and Tables. Being partly the work of an author who has already made himself favorably known to the steam engineering profession by his "Marine Engines and Boilers," it is safe to predict that the present book will be well received by engineers.

Applied Methods of Scientific Management. By Frederic A. Parkhurst. 325 pages, 6 by 9 inches. 18 illustrations and 9 folding plates. Published by John Wiley & Sons, New York. Price, $2.00.

This book is based on a series of articles published by the author in *Industrial Engineering*, during 1911. A considerable amount of new matter, not contained in the original articles, is, however, included. The book does not deal with mere principles, but shows the actual application of these principles to every-day practice. As a concrete example, the history of the application of scientific management to the works of the Ferracute Machine Co., at Bridgeton, N. J., is recorded. The system adopted, closely follows the lines laid down by Fred W. Taylor, and is particularly suited to businesses employing one hundred people or more. The book is logically arranged, and commends itself particularly to the manager or superintendent on account of the practical, precise and detailed manner in which it has been written. The "glittering generalities" with which books and articles on scientific management have often been filled, are here reduced to distinct rules and descriptions of definite methods. The appendix, which contains most of the new matter not included in the original publication, and which covers over one hundred pages of the book, is especially profuse in definite information relating to the duties of the various officers and men in the shop, with instructions for each. The thoroughness of the treatment in this respect may be judged from the fact that instructions are included for the duties of the shop drawing boy, the night watchman, the janitor, the crane boss, etc. Altogether, it seems that this is the very kind of a book which persons who have looked for really practical and definite information on scientific management, will welcome.

NEW CATALOGUES AND CIRCULARS

General Electric Co., Schenectady, N. Y. Booklet No. 4930 on electrically driven refrigerating machinery.

Gisholt Machine Co., Madison, Wis. Leaf illustrating Gisholt 36-inch boring mill equipment for finishing flywheels in one chucking.

Max Ams Machine Co., Mt. Vernon, N. Y. Circular of the Ams power presses, showing a few of the recent designs and additions to the line.

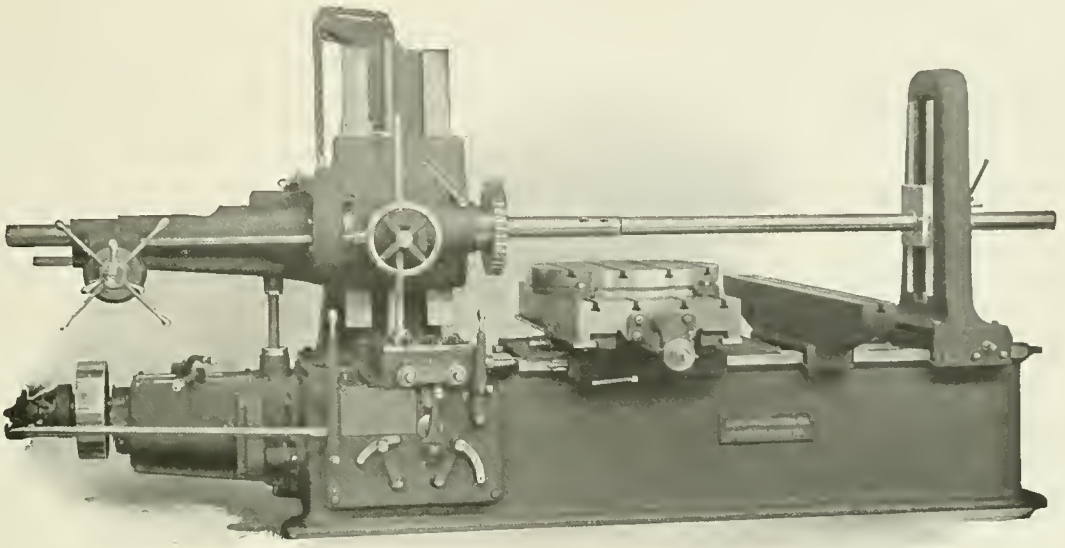
Challenge Machine Co., Inc., Philadelphia, Pa. Circular of the Challenge emery wheel protector and dust guard for the protection of workmen.

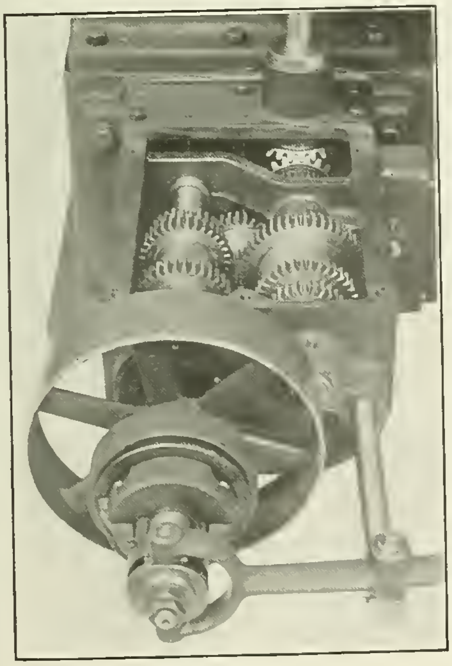
Blood Bros. Machine Co., Kalamazoo, Mich. Circular of universal

THIS IS THE

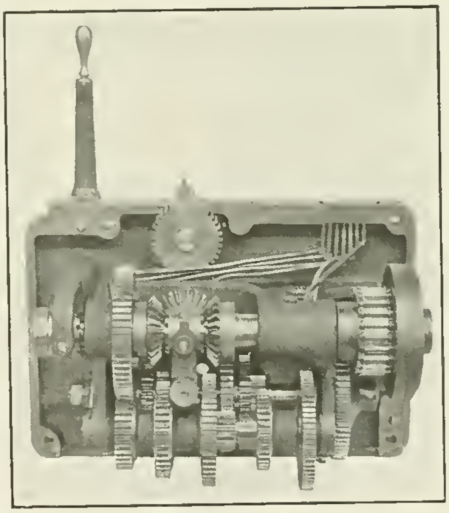
"PRECISION"

BORING, DRILLING AND MILLING MACHINE





THE SPEED BOX



THE FEED BOX

These boxes are shown approximately under the positions they occupy on the machine. Note that they are UNITS, each complete in itself, and involved in no way with each other, hence, **SIMPLICITY.**

Note also the **large size** of the boxes by comparing them with the bed, as shown in position on the machine, giving room for gears of **large diameter,** hence, **STRENGTH.**

These are two good things about the "PRECISION"—everything else about it has had the same careful attention in designing. The ACCURACY alone of the "PRECISION" would make it, as it is, the favorite of those who require something **RELIABLE.**

Lucas Machine Tool Co., NOW AND ALWAYS OF Cleveland, O., U.S.A.

AGENTS—C. W. Burton, Griffiths & Co., London. Alfred H. Schutte, Cologne, Berlin, Brussels, Paris, Milan, Barcelona, Bilbao. Donauwerk Ernst Krause & Co., Vienna, Budapest, Prague. Overall, McCray, Ltd., Sydney, Australia. Andrews & George, Yokohama, Japan. Williams & Wilson, Montreal, Can.

joints which are made in over one-hundred patterns, encased and open, single and double forms.

Fort Wayne Electric Works of the General Electric Co., 1616 Broadway, Fort Wayne, Ind. Catalogue of electric fans; and bulletin No. 1134 on direct-current electric motors.

S. A. Woods Machine Co., Boston, Mass. Booklet on inside wood molders, illustrating Nos. 107 and 107-B machines and details; also a universal side-head grinder and automatic knife grinder.

Brown Hoisting Machinery Co., Cleveland, Ohio. Circular on "Brownhoist" rapid freight handling equipment, showing freight handling trolleys, roller bearing freight trucks, lumber trolleys, etc.

Gilbert & Barker Mfg. Co., Springfield, Mass. Catalogue A on oil storage systems for factory store-rooms, paint stores hardware and commissary stores and mines, designed for handling heavy lubricating and non-lubricating "gummy" oils.

Holen-Dusha Co., 93d St., and First Ave., New York. Catalogue of button machinery, comprising cutting lathes, blank splitters thickness gages, emery stands, backing machines, button grinding machines, facing and turning lathes, drilling machines, etc.

Garwood Electric Co., Garwood N. J. Leaflet illustrating a 5-horsepower "C & C" motor which has been running twenty-two years, driving the presses of the Hartfield Telegraphic Code Publishing Co. The motor is still in good condition and is in daily use.

Cling-Surface Co., 1018 Niagara St., Buffalo, N. Y. has issued Bulletin No. 321, a neat folder showing eleven noteworthy installations in Pennsylvania where "Cling-Surface" is profitably used on belts. Each illustration is accompanied by data concerning the belts shown.

General Electric Co., Schenectady, N. Y. Booklet No. 4927 on feeder voltage regulators, illustrating the various processes of manufacture and showing the facilities possessed by the company at its Pittsfield works for the manufacture of this type of apparatus.

SKF Ball Bearing Co., 50 Church St., New York. Bulletin No. 2 on SKF single- and double-thrust ball bearings, illustrating the self-aligning feature provided for both types; also single-thrust bearings, without self-aligning seats, capacities and sizes of all forms are listed.

E. G. Smith Co., Columbia, Pa. Catalogue of "Columbia" beam calipers graduated in inches and metric measure, with and without verniers. The catalogue also lists and illustrates "Which Way" pocket levels, the "Columbia" spherometers, spring gages and other machinists' tools.

Superior Machine Tool Co., Kokomo, Ind. Leaflet on sensitive vertical drilling machine equipped with high-duty roller bearing bushings, and having the features of constant drive, constant power factor, geared speed change box, unit spindle construction, and front control of all speeds.

Fairbanks Co., 416-422 Broome St., New York. Circular of the Osgood oil-groove cutting machine which cuts continuous spiral grooves in interior bushings or on the exterior of shafts, journals or studs. The capacity of the machine is from ⅜ inch to 7¾ inches in diameter and from 1½ inch to 20 inches long.

Falls Machine Co., Sheboygan Falls, Wis. Catalogue of Falls gasoline motors of the tandem four-cylinder automobile type in three models of 40–45, 30–35 and 30–40 horsepower, respectively. The company also furnishes unit power plants in two models with or without foot pedals, control levers and transmission brake.

Veeder Mfg. Co., 39 Sargeant St., Hartford, Conn. Catalogue of Veeder products, comprising odometers for automobiles, tachodometer (a speed indicator or tacometer combined with an odometer) odometers for carriages, cyclometers, revolution counters, speed counters, mileage recorders for elevators, and die-castings.

National-Acme Mfg. Co., Cleveland, Ohio. Booklet on the adjustable screw-cutting spring dies which are carried in stock by the company. The advantages of spring dies are enumerated, as are also the special advantages of the "Namco" form, which are perfect rake and clearance for the teeth, ample chip room and correct temper.

Celfor Tool Co., Buchanan, Ill., Catalogue No. 11 on drills, reamers, flue-cutters, countersinks, chucks, sockets, tool-holders, tool-bits, and boring tools. The catalogue concludes with a table of feeds and speeds for cast iron, medium steel and hard or very tough steel, and a table of decimal equivalents comprising both English and metric measure up to 76 millimeters and 3 inches.

Permanent Manufacturers Exhibit Railway Supplies and Equipment, Karpen Bldg., 900 S. Michigan Blvd., Chicago. Pamphlet on scope and purpose, exhibition hall and equipment, division and allotment of space, power for working machinery, character of exhibits, and other matters of interest to manufacturers desiring to reach the buyers of railway supplies. The exhibition opened March 16.

Norton Co., Worcester, Mass. February number of *Grits and Grinds* containing an account of the award of the *Scientific American* medal to the Norton Co. for grinding-wheel protective devices, description of the American Museum of Safety, New York, and an article on the safety movement in America and abroad. The protection hoods for grinding wheels made by the Norton Co. are also illustrated and described.

Peerless Rubber Mfg. Co., 16 Warren St., New York. Catalogue No. 100 of mechanical rubber goods comprising "Rainbow" sheet packings, "Peerless" piston and valve rod packings, combination packing, gaskets, rubber belting, elevator and conveyor belts, water and steam hose, air-brake hose, pneumatic tool hose, acid hose, pump valves, car vestibule diaphragms, gas engine bags, rubber cement, rubber matting, sheet rubber tiling, etc.

United States Bureau of Mines has just issued Technical Paper No. 8, by Frederick M. Stanton and Arno C. Fieldner, in order to suppy the constantly increasing demands for information relating to the methods used by the Bureau of Mines in analyzing coal and coke. This technical paper describes the methods in use at the laboratories of the bureau for analyzing coal and coke and determining the heating value of these fuels. Copies may be obtained by writing to the Director of the Bureau of Mines, Washington, D. C.

Heald Machine Co., 20 New Bond St., Worcester, Mass. Booklet giving the personnel of the company and its history. The business of the Heald Machine Co. was established by Stephen Heald in the year 1830, in Barre, Mass. and at first comprised the making of woodworking machinery and agricultural implements. In 1903 Mr. James N. Heald bought out his father's interest and moved the plant to Worcester, where it was organized under the name of Heald Machine Co. The plant now covers 50,000 square feet and employs 160 persons.

Taft-Peirce Mfg. Co., Woonsocket, R. I. Illustrated booklet showing the various departments and equipment of the plant, which is one of the largest and finest in the world devoted exclusively to the handling of light high-grade machine work on the contract basis. The company specializes on making equipment for manufacturing, comprising jigs, fixtures, dies, tools, etc., required for the economical manufacture of interchangeable machine parts. The toolroom equipment illustrated is without parallel in the United States. The booklet will be found of unusual interest to all concerned with toolmaking and high-grade machine production.

Westinghouse Electric & Mfg. Co. E. Pittsburg, Pa. Special publication R. L. 57, entitled "Synchronous Motors for Power Factor Correction." This booklet, which has an art cover, contains some of the most valuable common-sense data on the phenomena of power factor and on the bad effects of low power factor and power factor correction with synchronous motors, that has been published. The publication gives much more specific data on synchronous motor installations, including curves and diagrams by means of which anyone can determine, with a few simple calculations, the capacity of a synchronous motor necessary to correct a given load from and to given power factors. The booklet is sent free to any address on request.

Lucas Machine Tool Co., Cleveland, Ohio. Circular of new model No. 33 precision horizontal boring, drilling and milling machine; and leaflet on the vertical milling attachment which is now furnished for the Nos. 32 and 33 machines. The No. 33 machine, like the intermediate model No. 32, has constant-speed quick power movements to all parts, having feeds so arranged that no matter what feed is used the quick return for that feed is obtained by simply moving the feed and quick-return lever in the reverse direction. The vertical milling attachment is of the bridge form of construction with both ends supported and rigidly tied by the uprights. The attachment can be quickly removed, leaving the machine unencumbered for use as a regular horizontal boring and milling machine.

J. T. Slocomb, Providence, R. I. Catalogue No. 13 of machinists' tools, comprising external micrometers up to 18 inches capacity, internal micrometers, standard end measures, standard reference disks, screw thread micrometers, special micrometers, centering tools, combination center drills, etc. The new catalogue is bound in a red waterproof cover, printed in black and gold. The size is 5⅞ by 7⅜ inches, which is more convenient for the pocket than the common catalogue size, 6 by 9 inches. The tools illustrated and listed are fully described, a feature that is appreciated by intending buyers. A number of valuable tables for machinists which apply particularly in the use of these tools is included. Copies of the new catalogue will be sent to any address upon receipt of request.

Geometric Tool Co., New Haven, Conn. Book entitled "Special Threading Tools," illustrating and describing the "Geometric" screw cutting die heads of the self-opening and adjustable type made in styles D, C, and DD; "Geometric" solid adjustable die head for use on automatic screw machines where the direction of rotation of the piece is reversed on the completion of the thread; "Geometric" adjustable collapsing taps; "Geometric" adjustable hollow milling tools; "Geometric" chaser or die grinder; "Geometric threading machine." The book is virtually a treatise on the special threading tools showing their form and component parts with fine halftone views, and giving valuable information for users of modern threading equipment. It contains several pages of valuable data useful to makers of bolts, screws, nuts and other threaded work.

Dodge Mfg. Co., Mishawaka, Ind. Catalogue C-12 containing 413 pages, beautifully illustrated and printed, is being distributed to the trade. The first pages are devoted to interior views of Dodge foundries, machine shops, power plant and branch houses; then follow tables for laying out shafting, horsepower of steel shafting, dimensions, etc. Every product of the company—a complete line of power transmission machinery and appliances, elevating and conveying equipment, rope driving system, and water softener apparatus—is completely described and listed. Considerable space is devoted to the Dodge friction clutch as an accident prevention device. The concluding pages give a little history of the transmission of power by Manila rope with illustrations of a number of striking installations, heavy engineering work, etc. The business was established in 1878 by Wallace H. Dodge, inventor of the split wood pulley with interchangeable bushings which effected a revolution in the pulley art. At that time, the plant occupied only a few acres of ground in Mishawaka. To-day there are 63 acres of ground space and over 21 acres of floor space.

TRADE NOTES

Doehler Die-Casting Co., Court & 9th Sts., Brooklyn N. Y., is about to erect a reinforced concrete addition to its present plant, consisting of seven floors, 50 by 100 feet.

Lansing Co., Lansing, Mich., recently purchased the entire hoist building plant of the Butcher & Gage Co., Jackson, Mich., and in the future will manufacture the Wolverine contractors' hoist in Lansing.

Favor, Ruhl & Co., 49 Barclay St., New York, have taken the sales agency for the "Tec" line of drafting-room supplies for New York City and vicinity, controlled by the Technical Supply Co., Scranton, Pa.

Edgar Allen & Co., Ltd., 86 John St., New York, agents for Allen's high-grade tool steel are now located at the foregoing address. A complete stock of steel is carried, and all requirements of customers can be promptly met.

Hauck Mfg. Co., 149 Livingston St., Brooklyn, N. Y., had a small fire in the office March 5. The fire destroyed some furniture, unimportant records and papers, but in no way affected the manufacturing facilities. There will be no delay in handling orders.

Metallic Shell & Tube Co., has removed from Pawtucket, R. I., to a large three-story building at 129 Valley St., East Providence, R. I. The change of quarters was made necessary by the rapidly increasing growth of the business. The company is installing new machines and equipment, and will be in a better position than ever to take care of seamless tube wants.

Blood Bros. Machine Co., Kalamazoo, Mich., manufacturer of universal joints, is running its factory with full force night and day. Although new buildings and equipment have been added during the past four months, nearly doubling the original capacity, the company is still barely able to keep up with orders. The entire factory is at present devoted to the manufacture of universal joints.

Parker Transmission & Appliance Co., has moved from Springfield, Mass., to Fulton, N. Y., where it will continue the manufacture of the Parker "all-in-mesh" transmission gears for automobiles. The company will also develop several of Mr. Parker's inventions. The capitalization was recently increased from $250,000 to $1,000,000, and plans have been made for pushing the business aggressively.

E. L. Essley Machinery Co., Chicago, Ill., had a fire in its store at 555-557 Washington Blvd., March 7, which completely destroyed its office records. The large warehouse, 817 Washington Blvd., containing 10 000 square feet of floor space was untouched by the fire however, and the company's offices are temporarily located at this address. The warehouse is filled with new and second-hand machinery, and the fire will not seriously interrupt the business.

Joseph Dixon Crucible Co., Jersey City, N. J., has just put on the market a new chain graphite, especially intended for lubricating the chains of motor trucks and pleasure cars. This preparation is put up in cylindrical sticks, 2 by 8 inches, encased in a neat cardboard carton and weighing about one pound each. This convenient chain lubricant can be carried ready for use at any time, and is simply applied by rubbing the bar against the sprocket side of the chain. Unlike oils and greases, graphite does not rapidly collect dust and dirt.

Supplement to

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Tables for Articles in this number entitled "The

SPRING CALCULATIONS—CUBES OF NUMBERS—I

No.	Cube	No.	Cube	No.	Cube	No.	Cube
1/16	0.000244	3 7/16	40.618896	6 13/16	316.169189	10 3/16	1057.311279
1/8	0.001953	3 1/2	42.875000	6 7/8	324.951172	10 1/4	1076.890625
3/16	0.006592	3 9/16	45.213135	6 15/16	333.894287	10 5/16	1096.710205
1/4	0.015625	3 5/8	47.634766	7	343.000000	10 3/8	1116.771484
5/16	0.030518	3 11/16	50.141357	7 1/16	352.269775	10 7/16	1137.075928
3/8	0.052734	3 3/4	52.734375	7 1/8	361.705078	10 1/2	1157.625000
7/16	0.083740	3 13/16	55.415283	7 3/16	371.307373	10 9/16	1178.201660
1/2	0.125000	3 7/8	58.185547	7 1/4	381.078125	10 5/8	1199.462891
9/16	0.177979	3 15/16	61.046631	7 5/16	391.018799	10 11/16	1220.754639
5/8	0.244141	4	64.000000	7 3/8	401.130859	10 3/4	1242.306641
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3/4	0.421875	4 1/8	70.189453	7 1/2	421.875000	10 7/8	1286.138672
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1	1.000000	4 3/8	83.740234	7 3/4	465.484375	11 1/8	1376.892578
1 1/16	1.199463	4 7/16	87.380615	7 13/16	476.837158	11 3/16	1400.229248
1 1/8	1.423828	4 1/2	91.125000	7 7/8	488.373047	11 1/4	1423.828125
1 3/16	1.674561	4 9/16	94.974854	7 15/16	500.093506	11 5/16	1447.690673
1 1/4	1.953125	4 5/8	98.931641	8	512.000000	11 3/8	1471.818359
1 5/16	2.260986	4 11/16	102.996826	8 1/16	524.093994	11 7/16	1496.212646
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1 1/2	3.375000	4 7/8	115.857422	8 1/4	561.515625	11 5/8	1571.009766
1 9/16	3.814697	4 15/16	120.370850	8 5/16	574.374268	11 11/16	1596.485107
1 5/8	4.291016	5	125.000000	8 3/8	587.427734	11 3/4	1622.234375
1 11/16	4.805420	5 1/16	129.746338	8 7/16	600.677490	11 13/16	1648.259033
1 3/4	5.359375	5 1/8	134.611328	8 1/2	614.125000	11 7/8	1674.560547
1 13/16	5.954346	5 3/16	139.596436	8 9/16	627.771729	11 15/16	1701.140381
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2	8.000000	5 3/8	155.287109	8 3/4	669.921875	12 1/8	1782.564453
2 1/16	8.773682	5 7/16	160.767334	8 13/16	684.380127	12 3/16	1810.272217
2 1/8	9.595703	5 1/2	166.375000	8 7/8	699.044922	12 1/4	1838.265625
2 3/16	10.467529	5 9/16	172.111572	8 15/16	713.917725	12 5/16	1866.546143
2 1/4	11.390625	5 5/8	177.978516	9	729.000000	12 3/8	1895.115234
2 5/16	12.366455	5 11/16	183.977295	9 1/16	744.293213	12 7/16	1923.964600
2 3/8	13.396484	5 3/4	190.109375	9 1/8	759.798828	12 1/2	1953.125000
2 7/16	14.482178	5 13/16	196.376221	9 3/16	775.518311	12 9/16	1982.568604
2 1/2	15.625000	5 7/8	202.779297	9 1/4	791.453125	12 5/8	2012.806641
2 9/16	16.826416	5 15/16	209.320068	9 5/16	807.604736	12 11/16	2042.340576
2 5/8	18.087891	6	216.000000	9 3/8	823.974609	12 3/4	2072.671875
2 11/16	19.410889	6 1/16	222.820557	9 7/16	840.564209	12 13/16	2103.302002
2 3/4	20.796875	6 1/8	229.783203	9 1/2	857.375000	12 7/8	2134.232422
2 13/16	22.247314	6 3/16	236.889404	9 9/16	874.408447	12 15/16	2165.464600
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3	27.000000	6 3/8	259.083984	9 3/4	926.859375	13 1/8	2260.986328
3 1/16	28.722900	6 7/16	266.779053	9 13/16	944.798096	13 3/16	2293.440180
3 1/8	30.517578	6 1/2	274.625000	9 7/8	962.966797	13 1/4	2326.203125
3 3/16	32.385498	6 9/16	282.623291	9 15/16	981.366943	13 5/16	2359.276611
3 1/4	34.328125	6 5/8	290.775391	10	1000.000000	13 3/8	2392.662109
3 5/16	36.346924	6 11/16	299.082764	10 1/16	1018.867432	13 7/16	2426.361084
3 3/8	38.443359	6 3/4	307.546875	10 1/8	1037.970703	13 1/2	2460.375000

Contributed by E. R. Morrison

No. 154, Data Sheet, MACHINERY, May, 1912

SPRING CALCULATIONS—FOURTH POWERS OF NUMBERS—II

No.	Fourth Power	No.	Fourth Power	No.	Fourth Power	No.	Fourth Power
1/16	0.000015	3 7/16	139.62745	6 13/16	2153.90261	10 3/16	10771.35887
1/8	0.000024	3 1/2	150.06250	6 7/8	2234.03929	10 1/4	11038.12865
3/16	0.000124	3 9/16	161.07176	6 15/16	2316.39164	10 5/16	11309.82394
1/4	0.003906	3 5/8	172.67603	7	2401.00000	10 3/8	11586.50431
5/16	0.009537	3 11/16	184.89625	7 1/16	2487.90532	10 7/16	11868.22971
3/8	0.019776	3 3/4	197.75391	7 1/8	2577.14869	10 1/2	12155.06250
7/16	0.036636	3 13/16	211.27077	7 3/16	2668.77172	10 9/16	12444.75546
1/2	0.062500	3 7/8	225.46899	7 1/4	2762.81644	10 5/8	12744.29331
9/16	0.100113	3 15/16	240.37111	7 5/16	2859.32497	10 11/16	13046.81479
5/8	0.152588	4	256.00000	7 3/8	2958.34009	10 3/4	13355.79595
11/16	0.223404	4 1/16	272.37892	7 7/16	3059.90479	10 13/16	13667.98502
3/4	0.316406	4 1/8	289.53149	7 1/2	3164.06250	10 7/8	13986.75836
13/16	0.435806	4 3/16	307.48171	7 9/16	3270.85695	10 15/16	14311.02750
7/8	0.586182	4 1/4	326.25391	7 5/8	3380.33231	11	14641.00000
15/16	0.772477	4 5/16	345.87282	7 11/16	3492.52296	11 1/16	14976.59724
1	1.000000	4 3/8	366.30352	7 3/4	3607.50394	11 1/8	15317.93017
1 1/16	1.274429	4 7/16	387.75148	7 13/16	3725.29031	11 3/16	15665.06417
1 1/8	1.601806	4 1/2	410.06250	7 7/8	3845.93777	11 1/4	16018.06612
1 3/16	1.988541	4 9/16	433.32277	7 15/16	3969.49224	11 5/16	16377.00104
1 1/4	2.441406	4 5/8	457.55884	8	4096.00000	11 3/8	16741.93430
1 5/16	2.967544	4 11/16	482.79762	8 1/16	4225.50779	11 7/16	17112.93161
1 3/8	3.574462	4 3/4	509.06641	8 1/8	4358.06272	11 1/2	17490.06250
1 7/16	4.270035	4 13/16	536.39284	8 3/16	4493.71216	11 9/16	17873.39228
1 1/2	5.062500	4 7/8	564.80493	8 1/4	4632.50395	11 5/8	18262.98892
1 9/16	5.960464	4 15/16	594.33107	8 5/16	4774.48612	11 11/16	18658.91961
1 5/8	6.972901	5	625.00000	8 3/8	4919.70724	11 3/4	19061.25420
1 11/16	8.109146	5 1/16	656.84084	8 7/16	5068.21632	11 13/16	19470.05944
1 3/4	9.378906	5 1/8	689.88306	8 1/2	5220.06250	11 7/8	19885.40594
1 13/16	10.792252	5 3/16	724.15651	8 9/16	5375.29544	11 15/16	20307.36352
1 7/8	12.359618	5 1/4	759.69141	8 5/8	5533.96508	12	20736.00000
1 15/16	14.091811	5 5/16	796.51832	8 11/16	5782.99683	12 1/16	21171.38711
2	16.000000	5 3/8	834.66821	8 3/4	5861.81645	12 1/8	21613.59335
2 1/16	18.095719	5 7/16	874.17238	8 13/16	6031.09990	12 3/16	22062.69244
2 1/8	20.390869	5 1/2	915.06250	8 7/8	6204.02366	12 1/4	22518.75360
2 3/16	22.897720	5 9/16	957.37062	8 15/16	6380.63971	12 5/16	22981.84886
2 1/4	25.628906	5 5/8	1001.12917	9	6561.00000	12 3/8	23452.05060
2 5/16	28.597427	5 11/16	1046.37089	9 1/16	6745.15722	12 7/16	23929.30971
2 3/8	31.816650	5 3/4	1093.12893	9 1/8	6933.16432	12 1/2	24414.06250
2 7/16	35.300309	5 13/16	1141.43678	9 3/16	7125.07447	12 9/16	24906.00804
2 1/2	39.062500	5 7/8	1191.32839	9 1/4	7320.94145	12 5/8	25405.37082
2 9/16	43.117691	5 15/16	1242.83792	9 5/16	7520.81914	12 11/16	25912.19509
2 5/8	47.480714	6	1296.00000	9 3/8	7724.76197	12 3/4	26426.56672
2 11/16	52.166764	6 1/16	1350.84964	9 7/16	7932.82473	12 13/16	26948.55687
2 3/4	57.191406	6 1/8	1407.42210	9 1/2	8145.06250	12 7/8	27478.24215
2 13/16	62.570571	6 3/16	1465.75316	9 9/16	8361.53080	12 15/16	28015.69826
2 7/8	68.061807	6 1/4	1525.87894	9 5/8	8582.28544	13	28561.00000
2 15/16	74.458023	6 5/16	1587.83571	9 11/16	8807.88258	13 1/16	29114.22381
3	81.000000	6 3/8	1651.66037	9 3/4	9036.87895	13 1/8	29675.44519
3 1/16	87.985319	6 7/16	1717.39013	9 13/16	9270.83136	13 3/16	30244.74264
3 1/8	95.367431	6 1/2	1785.06250	9 7/8	9509.29715	13 1/4	30822.19107
3 3/16	103.228775	6 9/16	1854.71534	9 15/16	9752.33397	13 5/16	31407.86974
3 1/4	111.566406	6 5/8	1926.38696	10	10000.00000	13 3/8	32001.85559
3 5/16	120.39919	6 11/16	2000.11596	10 1/16	10252.35321	13 7/16	32604.22728
3 3/8	129.74634	6 3/4	2075.94137	10 1/8	10509.45334	13 1/2	33215.06250

Contributed by E. R. Morrison

No. 154, Data Sheet, MACHINERY, May, 1912

DETERMINATION OF HELIX ANGLES

Ratio of Lead to Diameter	Helix Angle		Ratio of Lead to Diameter	Helix Angle		Ratio of Lead to Diameter	Helix Angle		Ratio of Lead to Diameter	Helix Angle	
	Deg.	Min.		Deg.	Min.		Deg.	Min.		Deg.	Min.
0.10	88	11	5.50	29	44	11.80	14	54	26.50	6	46
0.20	86	21	5.60	29	18	12.00	14	40	27.00	6	38
0.30	84	32	5.70	28	52	12.20	14	27	27.50	6	30
0.40	82	45	5.80	28	27	12.40	14	14	28.00	6	23
0.50	80	57	5.90	28	2	12.60	14	2	28.50	6	16
0.60	79	11	6.00	27	38	12.80	13	50	29.00	6	10
0.70	77	26	6.10	27	15	13.00	13	38	29.50	6	4
0.80	75	43	6.20	26	52	13.20	13	26	30.00	5	59
0.90	74	1	6.30	26	30	13.40	13	14	31.00	5	48
1.00	72	21	6.40	26	9	13.60	13	2	32.00	5	38
1.10	70	42	6.50	25	48	13.80	12	50	33.00	5	28
1.20	69	7	6.60	25	27	14.00	12	39	34.00	5	18
1.30	67	33	6.70	25	7	14.20	12	29	35.00	5	8
1.40	65	0	6.80	24	48	14.40	12	19	36.00	5	0
1.50	64	32	6.90	24	29	14.60	12	9	37.00	4	52
1.60	63	4	7.00	24	10	14.80	11	59	38.00	4	44
1.70	61	37	7.10	23	52	15.00	11	50	39.00	4	36
1.80	60	12	7.20	23	34	15.20	11	41	40.00	4	29
1.90	58	51	7.30	23	17	15.40	11	32	42.00	4	17
2.00	57	31	7.40	23	0	15.60	11	23	44.00	4	5
2.10	56	15	7.50	22	44	15.80	11	14	46.00	3	55
2.20	55	0	7.60	22	28	16.00	11	6	48.00	3	45
2.30	53	48	7.70	22	12	16.20	10	58	50.00	3	30
2.40	52	37	7.80	21	56	16.40	10	50	55.00	3	18
2.50	51	30	7.90	21	41	16.60	10	42	60.00	3	0
2.60	50	23	8.00	21	26	16.80	10	35	65.00	2	46
2.70	49	19	8.10	21	12	17.00	10	28	70.00	2	34
2.80	48	16	8.20	20	58	17.20	10	21	75.00	2	24
2.90	47	17	8.30	20	44	17.40	10	14	80.00	2	15
3.00	46	19	8.40	20	30	17.60	10	7	85.00	2	7
3.10	45	23	8.50	20	17	17.80	10	0	90.00	2	0
3.20	44	28	8.60	20	4	18.00	9	54	95.00	1	54
3.30	43	36	8.70	19	52	18.20	9	47	100.00	1	48
3.40	42	44	8.80	19	40	18.40	9	41	105.00	1	43
3.50	41	55	8.90	19	27	18.60	9	35	110.00	1	38
3.60	41	7	9.00	19	15	18.80	9	29	115.00	1	34
3.70	40	21	9.10	19	2	19.00	9	23	120.00	1	30
3.80	39	35	9.20	18	50	19.20	9	17	125.00	1	26
3.90	38	52	9.30	18	39	19.40	9	11	130.00	1	23
4.00	38	10	9.40	18	28	19.60	9	6	135.00	1	20
4.10	37	29	9.50	18	18	19.80	9	1	140.00	1	17
4.20	36	48	9.60	18	7	20.00	8	56	145.00	1	14
4.30	36	9	9.70	17	57	20.50	8	44	150.00	1	12
4.40	35	30	9.80	17	47	21.00	8	32	155.00	1	9
4.50	34	54	9.90	17	37	21.50	8	20	160.00	1	7
4.60	34	19	10.00	17	27	22.00	8	9	165.00	1	5
4.70	33	45	10.20	17	6	22.50	7	58	170.00	1	3
4.80	33	12	10.40	16	47	23.00	7	47	175.00	1	1
4.90	32	40	10.60	16	29	23.50	7	37	180.00	1	0
5.00	32	8	10.80	16	12	24.00	7	28	190.00	0	57
5.10	31	38	11.00	15	56	24.50	7	19	200.00	0	54
5.20	31	8	11.20	15	40	25.00	7	10	300.00	0	36
5.30	30	39	11.40	15	24	25.50	7	2	400.00	0	27
5.40	30	11	11.60	15	9	26.00	6	54	500.00	0	22

Contributed by George W. Burley

No. 154, Data Sheet, MACHINERY, May, 1912

SPRING CALCULATIONS—FIFTH POWERS OF NUMBERS—III

No.	Fifth Power	No.	Fifth Power	No.	Fifth Power	No.	Fifth Power
$\frac{1}{16}$	0.000000953674	$\frac{9}{16}$	0.056313	$1\frac{1}{16}$	1.35408	$1\frac{9}{16}$	9.3132
$\frac{1}{8}$	0.0000305176	$\frac{5}{8}$	0.095367	$1\frac{1}{8}$	1.80203	$1\frac{5}{8}$	11.3310
$\frac{3}{16}$	0.000231743	$\frac{11}{16}$	0.153590	$1\frac{3}{16}$	2.36139	$1\frac{11}{16}$	13.6842
$\frac{1}{4}$	0.000976562	$\frac{3}{4}$	0.237305	$1\frac{1}{4}$	3.05176	$1\frac{3}{4}$	16.4131
$\frac{5}{16}$	0.00298023	$\frac{13}{16}$	0.354093	$1\frac{5}{16}$	3.89490	$1\frac{13}{16}$	19 5610
$\frac{3}{8}$	0.00741577	$\frac{7}{8}$	0.512909	$1\frac{3}{8}$	4.91489	$1\frac{7}{8}$	23.1743
$\frac{7}{16}$	0 0160284	$\frac{15}{16}$	0.724196	$1\frac{7}{16}$	6.13818	$1\frac{15}{16}$	27.3029
$\frac{1}{2}$	0.0312500	1	1.000000	$1\frac{1}{2}$	7.59375	2	32.0000

FORMULAS FOR CONICAL SPRINGS

(Dimensions in inches, weights in pounds)

f = deflection, under load P,
D_1 = mean diameter of largest coil,
D_2 = mean diameter of smallest coil,
p = average horizontal pitch of coils,
d = diameter of bar or wire from which coil is made,
P = capacity of spring,
l = length of bar in spring,
W = weight of spring,
h = solid height of spring, assumed to equal $d \times$ number of coils.

In the following formulas the allowable stress is assumed as 80,000 pounds per square inch, and the modulus of torsional elasticity as 12,600,000.

Extension conical springs:

$$f = 0.002493\,\frac{D_1^4 - D_2^4}{p\,d\,D_1} \qquad P = 31{,}416\,\frac{d^3}{D_1}$$

Compression conical springs:

$$f = 0.003324\,\frac{D_1^3 - D_2^3}{p\,d} \qquad P = 31{,}416\,\frac{d^3}{D_2}$$

For all conical springs:

$$l = 1.571\,\frac{h}{d}\,(D_1 + D_2) \qquad W = 0.35\,d\,h\,(D_1 + D_2)$$

Contributed by E. R. Morrison

No. 154, Data Sheet, MACHINERY, May, 1912

MACHINERY

May, 1912

WATCH MOVEMENT MANUFACTURE[*]—1

METHODS EMPLOYED BY THE SOUTH BEND WATCH CO.

By DOUGLAS T. HAMILTON[†]

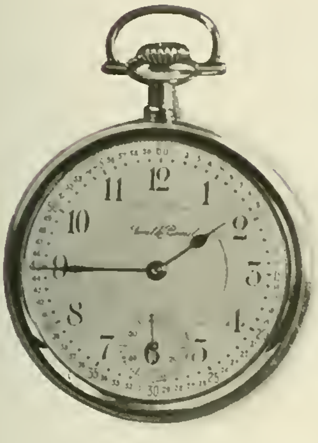

Fig. 1. Dial View of South Bend "Studebaker" Railroad Watch

A WATCH movement, when we consider its dimensions, the usage to which it is subjected, and the exacting requirements of its performance, is one of the most wonderful pieces of mechanism that man has devised. It may truthfully be called an automatic counting machine, which, with unerring regularity, counts every one-fifth second, day and night, and registers the count in larger units of seconds, minutes and hours on the dial. This is done without human aid, and without the pressing of buttons and the pulling of levers. All that is necessary is to wind up the main spring once in every twenty-four or thirty-six hours.

The South Bend 16 size watch movement shown in Fig. 3, the manufacture of which is to be described in the following, is made in the three-story brick building shown in Fig. 2. The main building is 402 feet long by 33 feet wide. This has several wings and extensions, the entire floor space being 55,220 square feet. All of the movements are made, assembled and tested in this building. The dials are made in a smaller two-story building at the rear. This company employs 500 men and women—most of them experts—and turns out 200 movements per day, quality and not quantity being the main consideration. The cases for the movements are produced by a well-known maker of watch cases, and as a watch is of little value as a timepiece without a case to protect it, some of the methods employed in their manufacture will be described in a future article.

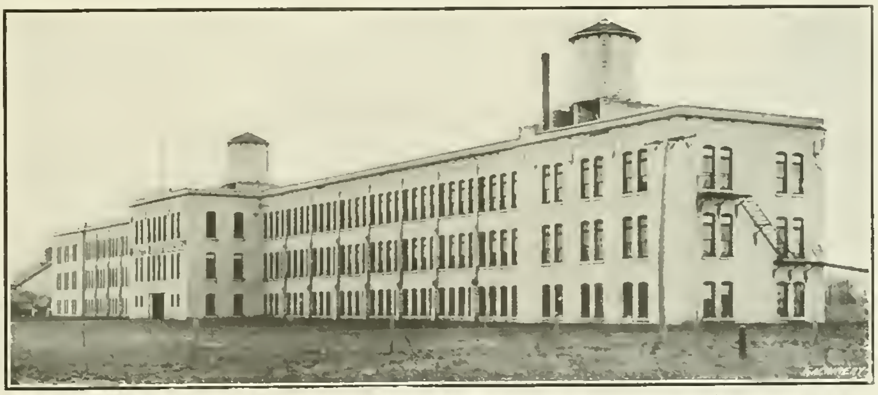

Fig. 2. Factory of the South Bend Watch Co., South Bend, Ind.

Through the courtesy of Mr. C. T. Higginbotham, consulting superintendent of the South Bend Watch Co., South Bend, Ind., the writer is enabled to give a general outline of the methods employed by this company in the manufacture of watch movements. It is not intended that this article shall deal with the construction of a watch, except so far as is necessary to make clear the description of the methods employed in its manufacture. The illustration Fig. 4 is presented for this purpose. With this in view, a description will be given of the various steps followed in designing a new model; that is, a watch which differs in construction from that previously manufactured.

Designing and Making Watch Movements

The first step that is taken in designing a new model is to make all the mathematical calculations for the complete watch movement. These calculations embrace the size and strength of the main spring, the strength and dimensions of the hair spring, and also the balance. Calculations are also worked out to determine the pitch diameters of the wheels and pinions, the number of teeth and leaves and the center distances in the plates and bridges.

After all the calculations pertaining to the various parts of the movement have been completed, an artist's drawing similar to that indicated in Fig. 3 is made. This of no practical value in the manufacturing, except that it gives an idea of what the completed watch will look like. Profile and assembled drawings, plan and developed elevations are then drawn to an enlarged scale. An assembled plan and elevation drawing of the 16 size watch is shown in Fig. 5. The elevations of the complete watch are made in two different scales on the profile drawing—the second drawing made, the first working drawing being a plan view. The developed length is made 10 to 1, and height 50 to 1, which facilitates the laying out of the movement. For the plan views the scale is 10 to 1. The plan and elevation views of the assembled drawing shown in Fig. 5 are made 10 to 1. The developed length of a watch is laid out in the order in which the power is transmitted from the main spring to the escapement, as illustrated in Fig. 4 by the zig-zag dot-and-dash line joining the wheel centers.

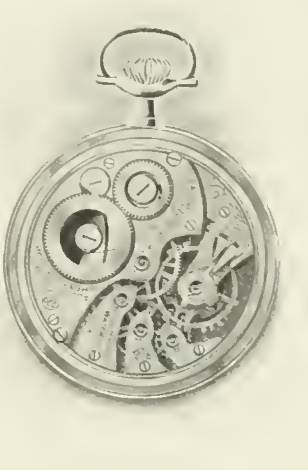

Fig. 3. Movement of the South Bend "Studebaker" Railroad Watch

From the profile and enlarged drawings the various details are taken and separate sketches of each part are made, giving the number of operations required and the dimensions of the piece after each operation. Upon the completion of all the detail drawings, prints are sent to the model-maker, who, by the use of a transfer chuck, which will be described later, makes a complete model watch. The model maker also makes the master plates, which are steel disks, 1.9 inch in diameter by 0.22 inch thick. In these, are carefully bored holes, exactly 0.1 inch in diameter. The location of every hole, the center of every turning, every curve center, milling, etc., is determined by these holes. The master plates are then used to determine the forms, and relative positions required in all dies, chucks, jigs, and other tools used in the manufacture of the watch. All the curves in watch plates and bridges are made true arcs of circles—no irregular curves being used—so that there is not one part of a watch plate which cannot be produced on the transfer chuck. In order to enable the model-maker to reproduce the form on a greatly reduced scale, the holes in the plates and bridges are laid out in their relation to what are called north, south, east, and west lines, radiating from the center of the watch. These lines are drawn in relation to the pendant which is always north; the position of the east and west in relation to right or left depends on whether the dial is facing up or down. This is illustrated clearly in Fig. 5.

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[*] For further information on watch making and allied subjects, see the following articles previously published in MACHINERY, "Watch Crowns, Dies and Methods," December, 1909, engineering edition; "Some Machinery and Methods of Watch Making," July, 1909, engineering edition; "Making Watch Parts in the Commercial Automatic Screw Machine," June, 1908; "Split Die for Watch Regulator," August, 1907; "Watch Dials, Process of Making," February, 1907, page 36, advertising section; "The Watchman's Watch," March, 1904, engineering edition.

[†] Associate Editor of MACHINERY.

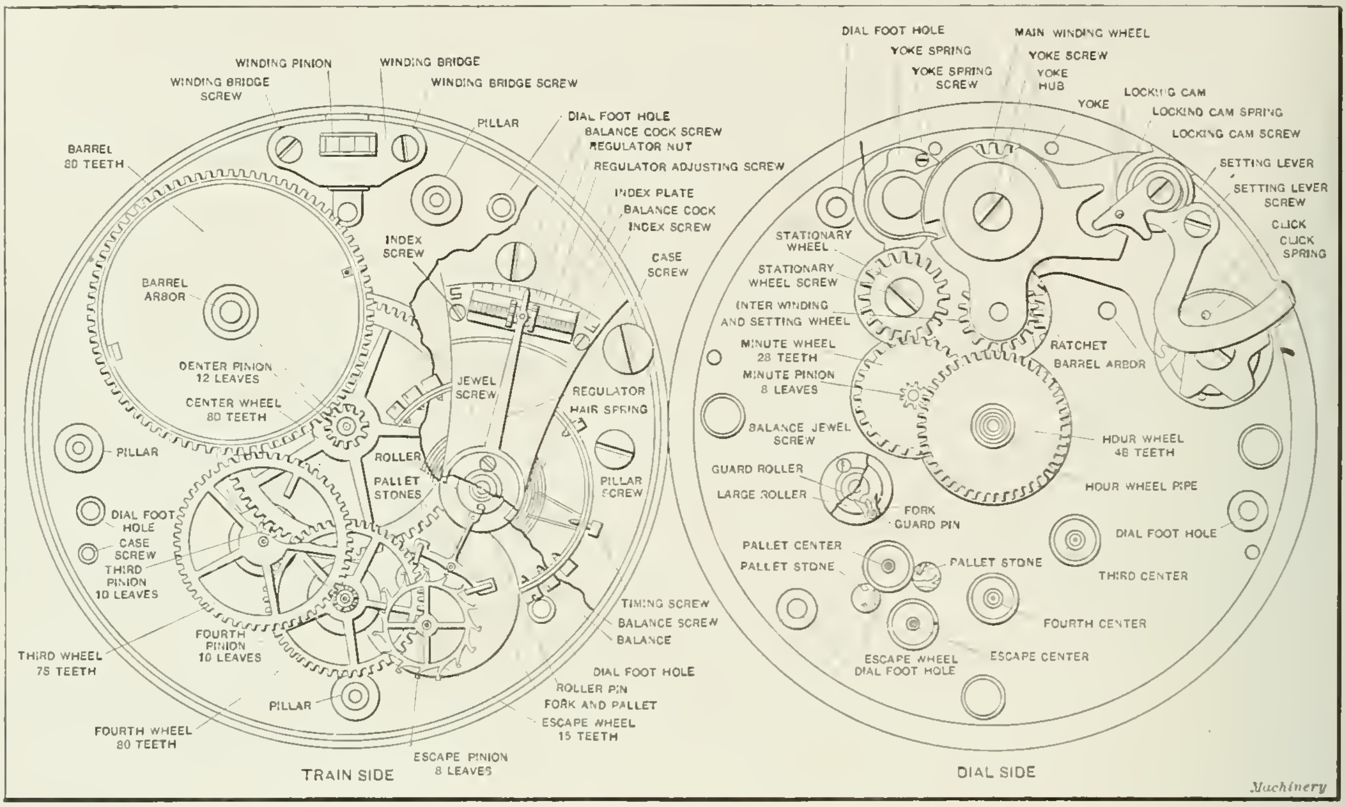

Fig. 4. Dial and Train Side Views giving the Names of the Parts of an 18-size South Bend "Studebaker" Railroad Watch

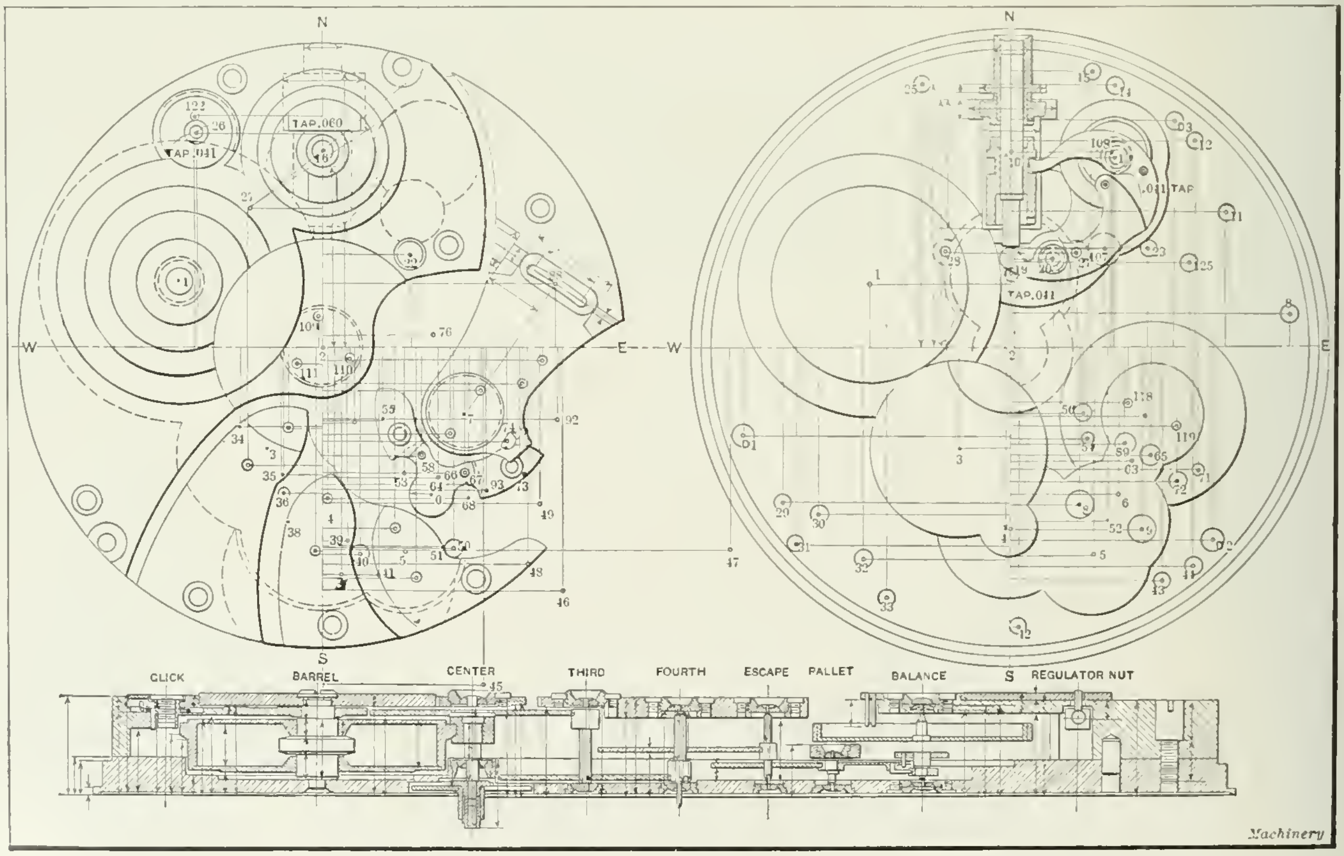

Fig. 5. Plan and Developed Elevation Views of the 16-size South Bend Watch, Enlarged

Fig. 6 shows the upper section of a chart of the 16 size, L model watch, open face, which gives the numbers of the holes and the numbers of the master plates in which they may be found. Any hole determining a certain position in a watch always bears the same number, and is frequently placed in two or more master plates. The numbers in the columns are the numbers by which these different master plates are designated. This system enables the model-maker and toolmakers to produce the parts exactly as called for on the drawings.

The model-maker, by means of the transfer chuck, produces a complete watch which is thoroughly tested. If found to be all that is required as a time-piece of accuracy, the tools for making the various parts are then designed and made. These are sent out into the factory to the various departments in which they are to be used, and the work of making watch movements in quantities on a commercial basis is begun.

Watch Gearing

The calculation for watch gears or wheels, as they are called, is carried out in a slightly different manner from that pursued in the design of gears for other mechanical work. The pitch diameter, and the diametral pitch are calculated in just the same manner, of course, as for any other gear, but the shapes of the teeth of the wheels and the leaves of the pinions differ. The addendum or working face of the tooth is an epicycloid curve starting at the pitch circle and extending to the point of the tooth.

Hole No.		Name of Hole	Numbers Designating Master Plates											
....	D 1	Dial feet. To left of pendant, dial down.	5464	5470	5471	6879	6886	6891	....	6974	....	7244	5460	5465
....	D 2	Dial feet, E.	5464	5470	5471	6879	....	....	6892	6974	....	7244	5460	5465
....	D 3	Dial feet, S. E.	5464	5470	5471	6879	6886	6891	6892	6974	....	7244	5460	5465
....	1	Barrel, N. E.	5464	5470	....	6879	....	....	....	....	....	7244	....	....
....	2	Center	5464	5470	5471	6879	6886	6891	6892	6974	6981	....	....	....
....	3	Third, S. W.	5464	....	....	....	....	....	....	....	....	....	....	....
....	4	Fourth, S.	5464	5470	5471	....	6886	6891	6892	6974	....	....	....	....
....	5	Escape, S. E.	5464	....	....	....	....	....	....	....	....	....	....	....
....	6	Pallet, S. E.	5464	....	....	....	....	....	....	....	....	....	....	....
....	7	Balance, S. E.	5464	....	....	....	....	....	....	....	6981	....	....	....
Other pin No. 12....	125–8	Balance cock steady pins, S. E.	....	5470	....	....	....	....	....	....	....	....	....	....
....	9	S. E.	....	....	....	....	....	....	....	....	....	....	....	....
....	10	....	....	....	....	....	....	....	....	....	....	....	....	....
....	11	Balance cock plate screw, N. E.	....	5470	....	....	....	....	....	....	....	....	....	....
Other pins No. 125–8	12	Balance cock steady pin	....	....	....	....	....	....	6892	....	....	....	....	....
....	13	Clutch lever screw pendant set, N. E.	....	5470	....	....	....	....	....	....	....	....	....	....
Other pin No. 30.....	14	Barrel bridge steady pin. N. E.	....	....	....	....	6886	....	....	....	....	....	....	....
Other screw No. 31.	15	Case screw, N. E.	....	....	....	6879	....	....	....	....	....	....	....	....
....	16	Winding wheel, N.	....	5470	....	6879	6886	6891	6892	6974	....	....	....	....
....	17	....	....	....	....	....	....	....	....	....	....	....	....	....
....	18	....	....	....	....	....	....	....	....	....	....	....	....	....

Fig. 6. Chart of Master-plate Holes for the 16-size Model L, Open Face South Bend Watch

Where the wheel is the driver and the pinion the driven member, the face of the wheel tooth and the flank of the pinion leaves only come in contact. The tops of the pinion leaves are circular for convenience in finishing. These tops never come into action. The wheel tooth and pinion leaf should come into contact on the line of centers to give the best results. To accomplish this, the flanks of the teeth and leaves in the wheel and pinion are made radial with the center. The proper diameter of circle to use for generating the epicycloid curve of a watch wheel tooth is half the diameter of the pitch circle of the pinion with which the wheel is intended to mesh. The addendum is made 2.25 of the diametral pitch for the driver, and 1.0 of the diametral pitch for the driven pinion.

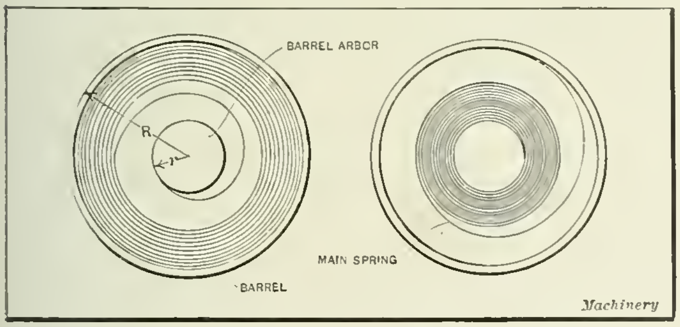

Fig. 7. The Main Spring wound and unwound—Note Space between Arbor and Inside of Chamber

In determining the width of the teeth in the wheel, nine-twentieths of the circular pitch is allowed, and seven-twentieths of the circular pitch for the width of the leaves of the pinion, leaving four-twentieths of the circular pitch for play, which is necessary in watch gearing to obviate dirt stopping the watch. There is no back-lash in watch gearing, because the drive is at all times in one direction.

Watch Train Computations

In laying out a watch train there are certain requirements which must be met. The essentials are, in this watch, that 18,000 vibrations per hour be imparted to the balance wheel, which gives 129,600 vibrations to 7 1/5 turns of the barrel which contains the main spring, and that the intermediate wheels driving the hour, minute and second hands rotate in the correct relation to each other. Another requirement in a railroad watch is that the main spring take 48 hours to unwind.

To proceed with the computation, refer to Fig. 4, which shows the gear train of an 18 size South Bend "Studebaker" railroad watch. The numbers of the leaves in the pinion are first considered, and as practice has determined different sets, we select those most suitable for the case in hand. For instance, the center pinion can have 10, 12 or 14 leaves; the third and fourth pinions 8, 10 or 12 leaves; and the fifth or escape pinion 6, 7 or 8 leaves. The main spring barrel is constructed to make 7 1/5 turns in 48 hours. In this case we select 12 leaves for the center pinion; 10 leaves for the third pinion; 10 leaves for the fourth pinion; and 8 leaves for the escape pinion.

Having decided on the number of leaves in the pinions, the next problem is to find the number of teeth in the barrel and intermediate wheels. The number of teeth in the barrel is:

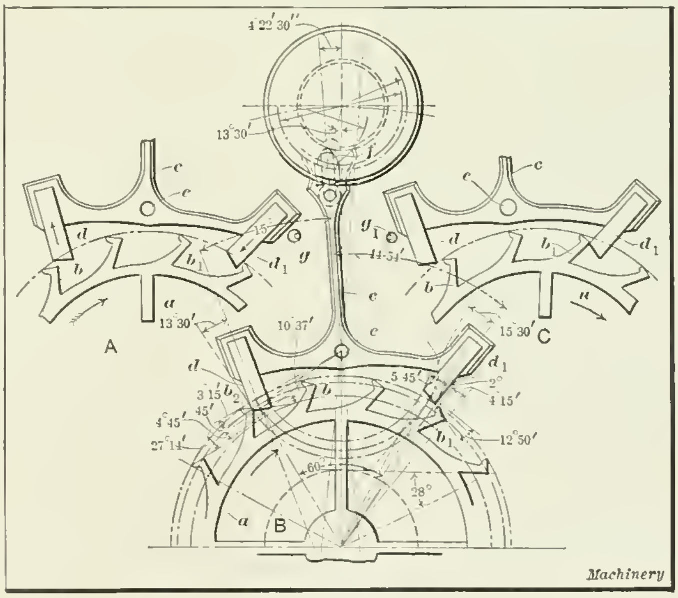

Fig. 8. Diagram Illustrating Function and Action of the Detached Lever Escapement

$$\frac{48 \times 12}{7\ 1/5} = 80 \text{ teeth}$$

As the balance wheel is to make 18,000 oscillations to one revolution of the center wheel, and as two oscillations of the balance wheel correspond to one tooth of the escape wheel, the latter having fifteen teeth, it follows, that the escape wheel will make:

$$\frac{18{,}000}{15 \times 2} = 600 \text{ revolutions per hour.}$$

The fourth wheel which is attached to the second hand must make 60 revolutions per hour, and as the escape pinion has 8 leaves, and makes 600 revolutions per hour, the number of teeth in the fourth wheel equals:

$$\frac{600 \times 8}{60} = 80 \text{ teeth.}$$

The numbers of teeth in the intermediate or third and the center wheels, are in a certain ratio to the number of leaves in the pinions with which they mesh, the product of which ratios must equal 60. The ratio in this case between the fourth pinion and third wheel is 1 to 7½, and between the third pinion and center wheel, 1 to 8. This multiplied by 10 give us, 7½ × 10, or 75 teeth in the third wheel, and 8 × 10, or 80 teeth in the center wheel; the ratio between the fourth wheel and escape pinion is 10. These ratios give the desired relation between the center wheel and escape wheel, the ratio between which is 1 to 600.

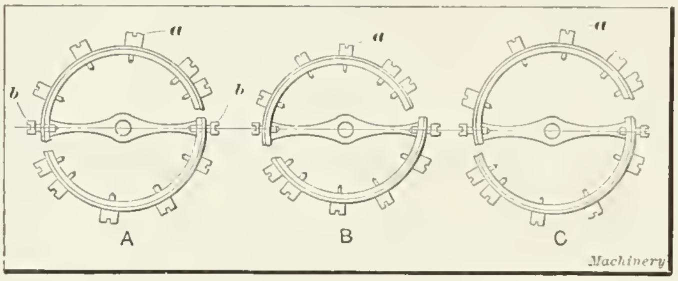

Fig. 9. The Compensating Balance in its Normal Condition and affected by Heat and Cold

The dial train wheels and pinions are now worked out so that the hour and minute hands will be revolved in their proper relation to each other. The dial train is driven by the cannon pinion, which is frictionally held on the center staff. In this case the cannon pinion has 14 leaves, the minute wheel 28 teeth, the minute pinion 8 leaves, and the hour wheel 48 teeth. As the cannon pinion makes one revolution per hour and drives the minute hand direct, it follows that the hour hand will make $\frac{14}{28} \times \frac{8}{48} = \frac{112}{1344} = \frac{1}{12}$ revolution per hour.

The Main Spring

The main spring furnishes the power for driving the entire mechanism of a watch, and is made from the best steel obtainable, carefully hardened and tempered. To give the best action, the main spring has to be made in certain proportions to the barrel or chamber which contains it. The radius r of the barrel arbor, see Fig. 7, is made equal to one-third the radius R of the chamber, the space outside the barrel arbor being divided into two equal areas.* The main spring occupies half this area irrespective of whether it is wound or unwound. Owing to one of the laws governing the action of the main spring, it will give the greatest number of turns when made to these proportions.

The number of turns of the main spring which is necessary to carry the watch a given number of hours is found by the following formula:

$$N = \frac{H \times n_1}{n}$$

in which, N = number of turns of main spring,
H = number of hours the watch is to run,
n = number of teeth in barrel,
n_1 = number of leaves in center pinion.

Applying this formula to the watch shown in Fig. 4, we have:

$$N = \frac{48 \times 12}{80} = 7.2 \text{ or } 7\ 1/5 \text{ turns.}$$

The calculations involved in determining the strength and torque of a main spring are too complicated to be presented here; suffice it to say that if the main spring is made to conform to the requirements previously given, thinner or thicker material can be used until a main spring having the proper strength is obtained.

The Detached Lever Escapement

The escapement of a watch movement transforms the rotary motion of the train of wheels into the vibratory motion of the balance. It also acts as a break to prevent the watch mechanism from "running away," retarding the motion of the train, and imparting the proper movement to the hands on the dial. To properly design an escapement, requires considerable study and is considered the most difficult problem in watch movement design. Ideal conditions are impossible to arrive at, so that compromises must always be made if an escapement to suit all requirements is to be obtained.

In action, the escape wheel a, Fig. 8, receives its motion from the wheel train, and by means of its peculiarly shaped teeth b coming in contact with the jewel pallets d and d_1 oscillates the fork c. To illustrate how this action takes place, we will assume that the fork c and escape wheel a are in the positions shown at A.

Now as the escape wheel a revolves, tooth b glides across the face of the pallet d lifting the latter up and forcing the upper portion of fork c, which is fulcrumed at e, to the right. This action lowers pallet d_1, bringing it in contact with the locking face of tooth b_1, as shown at C, and consequently stops the rotation of escape wheel a.

As the upper end of fork c is forced to the right, its forked end carries jewel pin f around, rotating the balance wheel, and putting the hair spring under tension. The hair spring, in unwinding, reverses the rotation of the balance and unlocks the tooth b_1 from the pallet d_1. The instant that this unlocking action takes place, the passage of the tooth b_1 across the inclined face of the pallet d_1 gives another impulse to the balance. This brings the fork and escape wheel into the positions shown at B, which happens as the fork c is returning to the banking g. Tooth b_2 now imparts an impulse to pallet d, and the order of actions is continued. The bankings g and g_1 stop the motion of the fork c in its oscillation from side to side.

The Compensating Balance

The balance wheel, or compensating balance, as it is called, is the heart of the watch. It regulates and controls the movement of the gear train from which it receives its motion. The motion of the gear train is intermittent, while that of the balance is practically continuous. Five times every second the train starts up from a dead rest, and for a brief space of time moves forward, again coming to rest. In this same time the balance reverses its direction of rotation, stopping for such a brief period of time that the cessation of movement is almost impossible to detect.

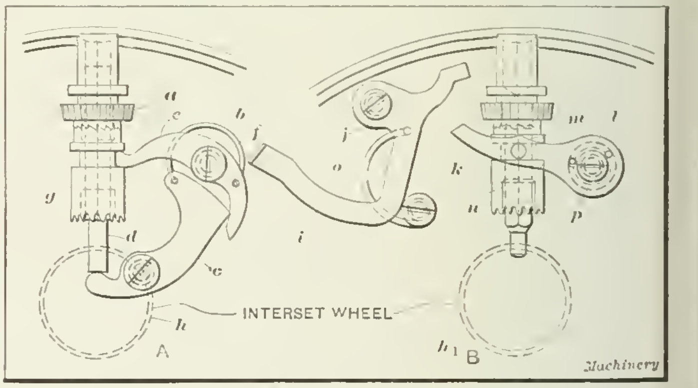

Fig. 10. Watch Setting Mechanisms

A compensating balance is composed of a steel center arm and rim made from one piece of metal, to which a brass ring is fused. The brass ring has twice the coefficient of expansion of the steel rim, and the proportion between the thickness of the rims is approximately two-fifths steel to three-fifths brass. The construction of a compensating balance is clearly shown in Fig. 9. At A it is in its normal position; at B it is affected by heat; and at C by cold. The conditions of the balance are exaggerated here to make the changes in its shape more perceptible. Located around the rim of the balance are what are called "balance" screws a. These are made from either brass or gold, and are employed for regulating, poising and altering the weight of the balance wheel in relation to the strength of the hair spring. The two screws *b* at each end of the arm are what are known as "timing" screws. These are employed to bring the watch to time without disturbing the regulator, which is always set at zero when it leaves the factory.

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* For further information regarding flat spiral springs, see the article entitled, "The Design of Flat Spiral Springs," which appeared in the July, 1910, number of MACHINERY, engineering edition.

When a watch movement is subjected to heat, the tension of the hair spring is decreased and thereby weakened, and the balance arms are lengthened, thus increasing the diameter of the balance which adds to the load on the hair spring. The effect of this action, if not counteracted, would be to cause the watch to lose time. To compensate for this, the brass rim expands more than the steel rim and center, which effect causes the balance to become smaller in diameter tending to throw the mass of its weight more toward the axis, as shown at *B*. When a watch movement is subjected to cold, the hair spring contracts and becomes stronger. The steel rim and center of the balance contract, as does also the brass rim, but as the brass rim contracts more than the steel rim, it has the effect of straightening the rim, thus increasing the diameter of the balance wheel, and carrying the mass of its weight further away from the axis, which has a retarding effect. This condition is shown exaggerated at *C*.

The rim of the balance is provided with more holes than it has screws, so that more screws can be added, or their positions changed as conditions may warrant, when poising and subjecting the movement to temperature tests. These screws add to the weight of the balance and change its radius of gyration, thus compensating for changes in temperature and positions. All first-class watches are regulated for five positions, *viz.*, dial up, dial down, pendant up, and pendant to right and left.

Many ingenious devices have been developed for setting the hands and winding the main spring of a watch. They can, however, be divided into two main classes, *viz.*, pendant and lever sets. A simple pendant and lever set which is used in the South Bend watch is illustrated at *A* and *B* in Fig. 10. At *A* is shown a pendant set mechanism in the position which it occupies when acted upon normally by the stem fastened to the crown, which is used for operating the mechanism. In this position, if the crown were rotated, the main spring would be wound up by means of the winding pinion *a* and intermediate wheels, not shown.

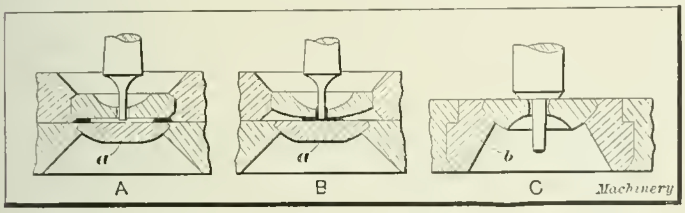

Fig. 11. Jewels, Settings and Pivots

When the crown is pulled out, the stem is withdrawn, releasing the tension on spring *b* and allowing it, through the setting lever *c*, to force up the stem *d*. The spring and lever *c* also act on clutch lever *e*, raising its rear end, and as it is fulcrumed on screw *f*, the forward end is lowered thus carrying down the setting clutch *g*. This clutch, in lowering, meshes with the teeth in an interset wheel *h*, which operates the wheels and pinions connected to the hands on the dial.

The setting mechanism shown at *B* is what is known as a lever set, and is used principally in railroad watches. It is shown in the position that it occupies when the main spring can be wound up by rotating the crown. When setting lever *i*, which is fulcrumed on screw *j*, is withdrawn from the case, its forward end is rotated downward coming in contact with the end of the clutch lever *k*, which is fulcrumed at *l* and connected by a pin *m* to the clutch sleeve *n*. It is evident that this action disconnects the clutch *n* and brings the teeth in its lower end in mesh with the interset wheel h_1, which in turn, operates the hands on the dial. As setting lever *i* is pushed in again, it is returned to its normal position by spring *o*, and as it is released from clutch lever *k*, spring *p* returns this lever to its normal position connecting the clutch with the winding mechanism. With this mechanism it is impossible to set the hands without first pulling out the lever *i*; this is not the case with the mechanism shown at *A*, which is likely to be operated by simply removing the watch from the pocket by the crown, thus making the latter an objectionable mechanism for use in railroad watches.

Jewels

Jewels are introduced into a watch movement to reduce friction as much as possible and also to increase the life of the watch. The shape of the hole in the jewel has a considerable bearing on the reduction of friction and in obtaining the best results. At *A* and *B* in Fig. 11 is shown the incorrect and correct method of finishing the holes in a jewel. The hole in the jewel at *A* is called a "straight hole," having parallel sides and a flat bottom. This type of jewel allows the oil to be drawn between the settings, leaving the jewels dry and keeping the oil at the outer rim, as is clearly shown in the illustration.

At *B* is shown what is called the "olive hole." This reduces the retarding effect of the thickening of oil to a minimum. The face of the jewel has a hemispherical oil cup, and the back is well rounded. The hole is also rounded and is made slightly larger than the diameter of the balance pivot. Having a jewel shaped in this manner increases capillary attraction toward the center, the pivot acting as a piston to keep the supply of oil at this point until the last particle is exhausted. The distance between the hole jewel and its end stone *a* should be just sufficient to allow the interception of a thin oil film. At *C* is shown a common type of jewel for the wheel pivots. This, as shown, is held in a setting *b* and is provided with the olive hole previously mentioned.

* * *

WHY ARE OUR FOUNDRIES NEGLECTED?

In the September, 1911, number of MACHINERY, an editorial appeared, entitled, "Why are our Foundries Neglected?" As an answer to this question we may appropriately quote a few paragraphs from an address by Mr. H. M. Ramp, superintendent of the Modern Foundry Co., before the Superintendents' and Foremen's Club, Oakley, Cincinnati, Ohio. Mr. Ramp says:

"While the foundry deserves much criticism and correction, it has never had the attention, the brains, the research work, or the finances poured in upon it that the machine end of the iron industry has had to elevate and develop its possibilities. It has been considered more as a necessary evil than as a branch of the business that could be mastered and developed and controlled. The foundry, until the last few years, has been the last place to receive improvements and advice, and it is not as yet burdened with a load of either.

"The individual who entered the foundry as a life's business was always regarded as sinking his intellectual or mechanical abilities, if he had any. The foundry has been demeaned and often referred to as a place where the qualifications are 'a strong back and a weak mind,' and yet there is no business under the canopy of heaven that requires greater judgment and a more thorough knowledge of fundamental principles than the art of molding. When properly done it most certainly deserves to be classed as an art, and yet this is the atmosphere in which the foundries of our country were developed and the foundrymen of our country were made until the past few years, while the machine shop was commanding the gray matter and finances of the brightest men in our land. This prejudice against the foundry in the past, as a place of dirt and grime fit only for occupation by hewers of wood and haulers of water, has done much to retard the development of the foundry business and to keep the bright, ambitious and energetic men from mastering its science. But these are not the only reasons why the foundry fails to give the machine shop what it asks.

"When the machine shop seeks to improve its tools or methods, it does not put blacksmiths or candy makers on the job—it uses the best educated brains and experience in the machine business that money can buy. Yet too often the pattern, the very foundation of the foundry's work, is constructed as the designer, the pattern foreman, the engineer directs, without even consulting the experience and preference of the foundry, and in as great a measure as this prevails just as great is the handicap placed upon the foundry."

* * *

The prize of $5000 for an aerial engine, which has been offered by Mr. P. Y. Alexander through the three British aeronautical associations, the Aerial Society, The Aero Club, and the Aerial League of the British Empire, has been awarded to the Green Engine Co., the engine of which developed, during the competition, 61.6 H. P. at 1150 R. P. M. during two non-stop runs of twelve hours each.

RE-CUTTING MILLING CUTTERS WITHOUT ANNEALING

By F. B. JACOBS*

In an article published in the December, 1911, number of MACHINERY the writer outlined the method used in re-cutting ordinary milling cutters without annealing them. In this article the re-cutting of thin milling saws, and of the end teeth of large end-mills will be explained. Great numbers of milling cutters find their way to the scrap box before their days of usefulness are over. These could, at slight expense, be re-cut and put in service again. The saving is especially marked with the high-priced, high-speed steel cutters in common use.

To re-cut milling cutters without annealing them does not call for special skill, or the services of a high-priced toolmaker. All that is required is the ordinary cutter grinding machines found in nearly every tool-room, wheels of the proper materials in the correct grits, grades and bonds, and an operator possessed of a little originality and ordinary mechanical skill. In fact, when re-cutting worn out milling cutters about the same methods are used as when cutting new cutters, except that grinding machinery and abrasive wheels are used in place of the milling machine and milling cutters.

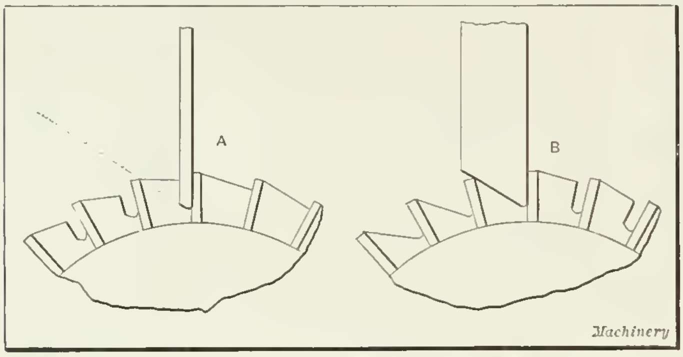

Fig. 1. The Two Steps taken in Re-cutting Milling Cutters by Grinding

The method followed can be readily understood from Fig. 1. This method applies to both peripheral and side teeth. The teeth are first gashed out as shown at *A*, with a thin vulcanite wheel, the object of this gashing being to preserve the corner of the wheel used in the re-cutting operation. At *B* is shown the re-cutting operation, the face of the wheel being trued to the proper angle. To re-cut milling cutters in one operation is not practical, as a hard and, therefore, slow cutting wheel would have to be used to preserve the corner of the wheel. With a thin elastic wheel of just the proper grain and texture for the gashing operation, and a fast cutting vitrified wheel to cut away the superfluous stock between the bottoms of the gashes and the points of the teeth, very economical and satisfactory results can be obtained with a little practice.

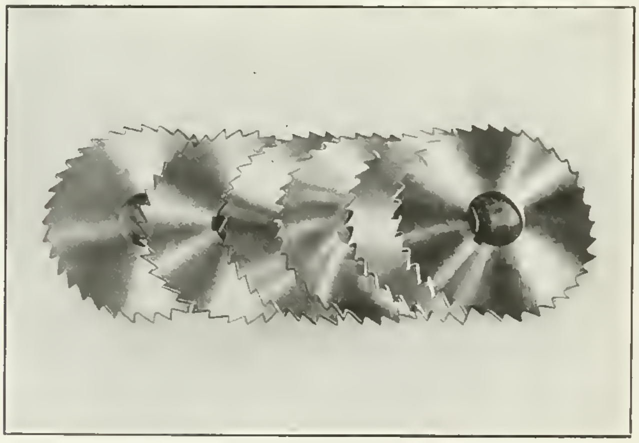

Fig. 2. A Number of Re-cut Slotting Saws

In Fig. 2 are shown six milling saws that for all practical purposes are now as good as new. These, however, were taken from the scrap box; four of them being 4 inches in diameter and 1-16 inch thick, and two of them, 5 inches in diameter and ⅛ inch thick. They were first located on an ordinary work arbor such as used in turning up thin collars, etc., paper washers being placed between the cutters to compensate for the side taper. They were then ground on a Walker grinder to a diameter of 3 9/16 inches. This work was done dry with an aloxite wheel 6 inches in diameter, ½ inch face, 1¼ inch hole, 50 grit, M grade, D496 bond. This operation ground all of the old teeth away from the large saws, and nearly so from the smaller ones.

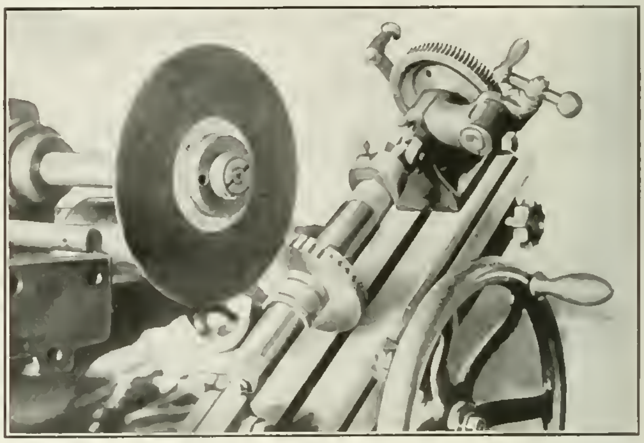

Fig. 3. The Gashing Operation

The work was then placed between the centers of the form cutter attachment of a Brown & Sharpe No. 3 cutter grinder, and the teeth gashed out to the required depth. This operation is shown in Fig. 3. The wheel used for this purpose was aloxite (vulcanite), 7 inches in diameter, ⅛ inch face, 1¼ inch hole, 30 grit, V-K-9 bond, run at a speed of about 4200 R. P. M. In this operation the wheel loss was very slight—only 0.008 inch. The depth of cut was 0.003 inch for each stroke, the graduations on the cross-feed screw being relied on for the correct depth. The work was fed under the wheel with a fairly rapid motion, one tooth being gashed to its full depth at a time.

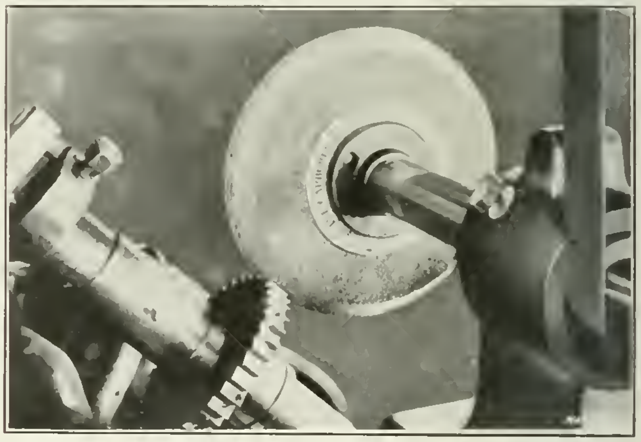

Fig. 4. Cutting the New Teeth

The next operation, which consists of cutting the new teeth, is shown in Fig. 4. This operation is practically the same as the gashing operation, the difference being that a wide wheel is used, its face being trued to the correct angle, as shown at *B* in Fig. 1. The wheel used for this purpose is aloxite, 6 inches in diameter, ¾ inch face, 1¼ inch hole, 40 grit, 0 grade, D497 bond, run at a speed of about 4200 R. P. M. The teeth were fed one at a time under the wheel, taking a cut of 0.002 inch at each stroke until the land of the tooth was of the correct thickness, or about 1/32 inch. The wheel loss in this operation was 1/64 inch. The teeth were then backed off as shown in Fig. 5. For this purpose an aloxite wheel 5 inches in diameter, ⅜ inch face, 1¼ inch hole, 50 grit, 0 grade, D496 bond, was used, the speed being 3650 R. P. M.

The total time consumed in re-cutting these cutters was divided as follows:

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* Address: Care of The Carborundum Co., Niagara Falls, N. Y.

Getting ready and setting up for first operation	10 minutes
Grinding time on Walker grinder	30 minutes
Setting up cutter grinder for gashing operation	15 minutes
Gashing out teeth	60 minutes
Setting up for re-cutting operation	5 minutes
Re-cutting teeth	50 minutes
Setting up for backing off teeth	10 minutes
Backing off teeth	13 minutes
Time consumed in trning wheels, etc	10 minutes
Total time	3 hours 23 minutes

In Fig. 6 are shown five high-speed steel end-mills, 3 inches long, 2⅜ inches in diameter, having sixteen teeth each; *A* shows a mill the end teeth of which are practically worn out, *B* illustrates a mill after the gashing operation, and *C*, *D* and *E* give a good idea of how the mills looked after the second or re-cutting operation.

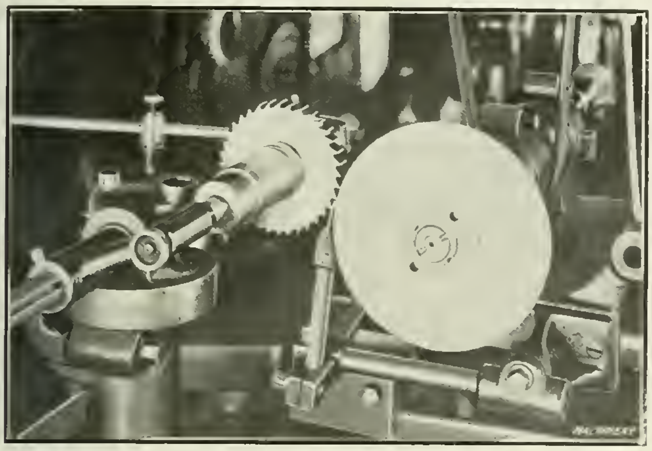
Fig. 5. Grinding the Clearance

Before re-cutting, the operator should first decide on the correct angle for the teeth, and then true the face of both wheels to this angle. For this purpose the writer has always used a carborundum stick 9 by ¾ by ¾ inches, 20 grit, H grade. With the wheels in question this will be found more satisfactory than a diamond. In the gashing operation the cut should be carried to a depth where a line drawn parallel to the face of the wheel comes nearly to the edge of the tooth. (See *A* in Fig. 1.) In re-cutting end teeth it is necessary to use a machine equipped with a head that can be set at any angle in order to bring the lands of the teeth parallel. The writer used a Brown & Sharpe No. 3 cutter grinder, equipped with an end-mill grinding attachment, as shown in Figs. 7 and 8. In setting the head to the correct angle the cut-and-try method can be used, or the angle can be figured out when the operator has decided on the angle for the wheel face and knows the number of teeth to be cut.[*]

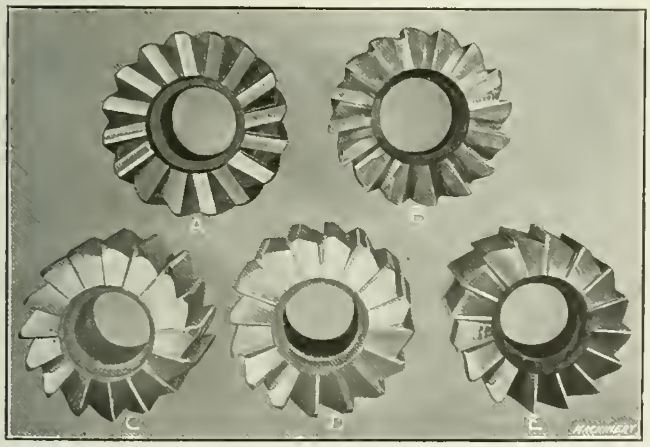

Fig. 6. Various Stages in the Re-cutting of End-mill Teeth

The gashing operation is shown in Fig. 7, the teeth being fed one at a time under the wheel with a cut of 0.002 inch, until the correct depth is reached. This is easily determined for all of the teeth by the graduations on the cross-slide screw, after the proper depth for the first tooth is decided on. In re-cutting four mills having sixteen teeth each the loss of the gashing wheel was only 1/64 inch. The re-cutting operation is shown in Fig. 8, the teeth being fed under the wheel until the lands were of the correct dimension, or 1/32 inch. The wheel loss in this operation was ⅛ inch for re-cutting four mills having sixteen teeth each. As the width of the land is relied on in this case to determine the proper depth of the cut, the wheel loss is of no consideration, provided the wheel wears true, thus preserving approximately the correct angle. In this operation the most satisfactory results were attained with a soft coarse wheel, run at a comparatively high speed. When finer wheels in harder grades were used the tendency was to cut slow and burn.

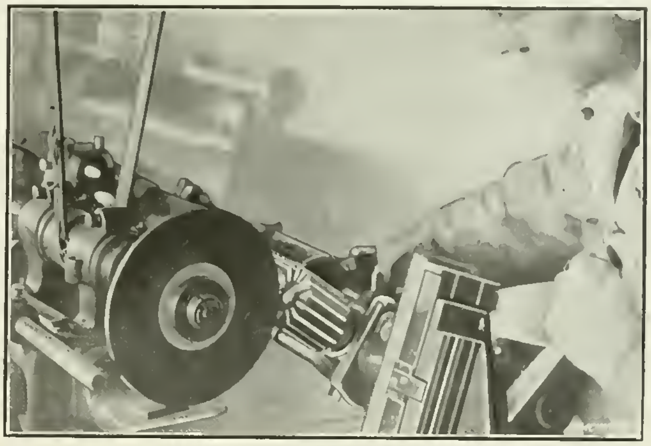
Fig. 7. Gashing the End-mill Teeth

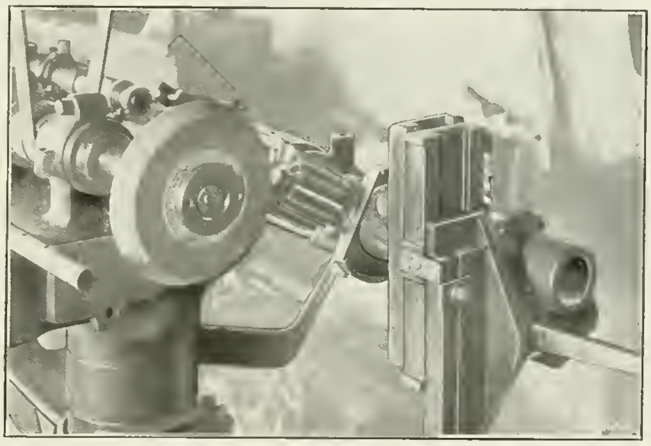
Fig. 8. Cutting the End-mill Teeth

After re-cutting, the teeth were backed off as shown in Fig. 9, this work being done on a Walker grinder equipped with a universal cutter grinding head. The wheel used for this operation was aloxite (cup), 5½ inches in diameter, 2 inches face, 1¼ inch hole, ¾ inch back, ⅜ inch wall, 50

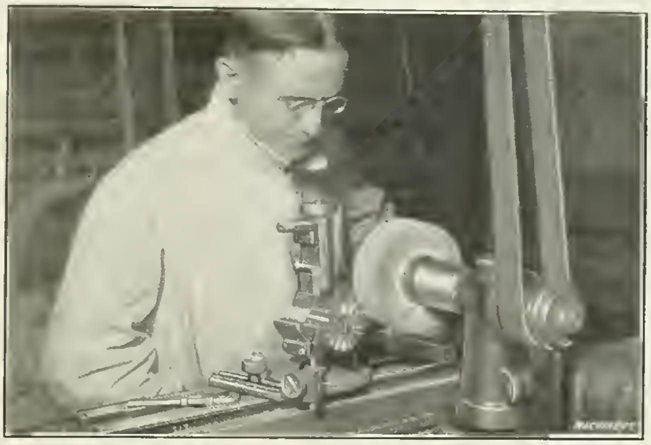
Fig. 9. Grinding the Clearance on the End-mill Teeth

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[*] See MACHINERY, engineering edition, November and December, 1911, "Milling Radial Teeth in Cutter Blanks," and the Data Sheet Supplements accompanying these articles. Also see MACHINERY, April, 1904, "To Calculate the Setting of the Dividing Head when Cutting the Teeth of End-mills"; MACHINERY'S Data Sheet No. 32, "Tables of Angles for Headstock of Milling Machine when Cutting End Teeth in Mills, etc."; and MACHINERY'S Data Sheet Book No. 4, "Reamers, Sockets, Drills and Milling Cutters," page 32.

grit, 0 grade, D496 bond, run at a speed of about 3650 R. P. M.

The total time consumed in re-cutting four end-mills of the dimensions mentioned above was divided as follows:

Setting up cutter grinder for gashing operation and cutting and trying to determine the correct angle	30 minutes
Gashing out teeth	120 minutes
Re-cutting teeth	120 minutes
Setting up Walker grinder for backing off teeth	15 minutes
Backing off teeth	30 minutes
Time consumed in truing wheels, etc	15 minutes
Total time	5 hours, 30 minutes

As the work as explained was wholly of an experimental nature, it is fair to assume that any machinist of ordinary intelligence could, with a little practice, do the same work in much shorter time. However, for the sake of argument we will suppose that a machinist at thirty cents per hour consumed 8 hours 43 minutes in re-cutting the cutters described in this article. After figuring his time, adding a certain amount for fixed overhead charges, and noting the value of similar cutters as bought on the open market, it will readily be seen that it is more profitable to re-cut them by the method described than it is to sell them as scrap.

* * *

AUTOMATIC BOTTLE BLOWING MACHINES

Automatic machinery for some classes of manufacture has reached a remarkable stage of development. The Owen Bottle Blowing Machine Co., Toledo, Ohio, has glass bottle blowing machines in operation that automatically blow twenty-three ketchup bottles a minute, twenty-four hours a day, seven days a week and fifty-two weeks a year, neglecting the short shut-downs necessary to change the bottle molds. The machine consists of a large turntable carrying two sets of molds, one set being "gathering" molds and the other "bottle" molds. The molds are carried over a hearth filled with molten glass, and as a gathering mold passes over the hearth, a rod of hot glass is drawn into it by suction. The gathering mold opens, leaving a rod of hot glass standing vertically. The bottle mold closes over the gathered glass and air pressure forces the molten glass out to fill the die the same as a glass blower would blow it.

The blown bottle is automatically deposited in a cast-iron bar containing thirty holes in a line. The bar shifts one place for each bottle until it is filled, and then it is taken up by a traveling chain conveyor and carried sideways through an annealing oven. At the far end of the annealing oven two men stand who inspect the bottles and pack them into cases. The cast-iron bars are returned by the chain conveyor to the bottle blowing machine to pass through the same cycle as before.

The bottle molds are made of cast iron and a mold is good for 12,000 to 15,000 gross of bottles before it requires scaling. Compressed air plays an important part in actuating the dies, and natural gas is used for melting the glass. The batch is automatically mixed and fed to the furnace, thus reducing the manual labor required for the operation of a machine and furnace to three men, two of whom are packers. The machine tender regulates the furnace also and looks after the general operation of the apparatus.

* * *

There are more telephones in proportion to population in the United States than in any other country in the world. Canada ranges second in this respect, and Sweden third. It is interesting to note that in New York City alone there are as many telephones as in Germany. In Ohio there are as many as in Great Britain; and Boston has double the number of telephones of Paris. Apparently, most of the European countries have been much slower to appreciate the advantages of the telephone than has the United States. One reason for the slow introduction of the telephone in Berlin, however, is stated to be that the postal system, with its tube post, is so perfected that for less than one cent one can send a message through the mails within the city, receiving a reply within an hour or less.

JIG-BORING AT THE UNITED SHOE MACHINERY CO.'S FACTORY

By CHESTER L. LUCAS[*]

The illustration Fig. 1 does more to give a general idea of the appearance of the plant of the United Shoe Machinery Co., at Beverly, Mass., than paragraphs of reading matter could do, and as nine-tenths of the employes are machinists, it will be realized that the output of the factory is very large. As a matter of fact, over 20,000 machines for the manufacture of shoes are shipped annually. The plant consists of sixteen buildings of reinforced concrete construction, having twenty-five acres of floor space. Over sixty tons of steel are used each week in the manufacture of machines, and the drop-forging department alone turns out 60,000 forgings per week.

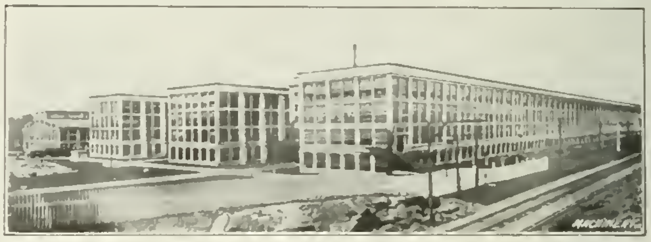

Fig. 1. Plant of the United Shoe Machinery Co., at Beverly, Mass.

The toolmaking department of this factory is one of the best equipped in the country. The principal work of the toolmaking department is the building of jigs and fixtures, in addition to maintaining the thousands of jigs which are in daily use in the factory. The important part of the work of jig- and fixture-making is the proper location and boring of the holes for bushings, studs, etc. Fig. 2 shows one of the toolmakers engaged in locating the position of a hole to be bored in the jig shown on the machine. Boring machines made by the Universal Boring Machine Co., Hudson, Mass., are used almost exclusively for boring jigs and fixtures in this factory. As indicated in the illustration, the machines are used without the left-hand supports for the boring-bars. In setting up the work, all measurements are taken either from the table or from an angle-iron that is permanently mounted on the rear part of the table of the machine. This angle-iron, a rear view of which is shown in Fig. 3 (on the floor), is somewhat unusual in type. The ribs at the back are spaced very closely, and the angle-iron is clamped to the machine by means of four slots placed between the ribs. The angle-iron shown has been rough-planed, and is now left to "season," before being finished and put into use.

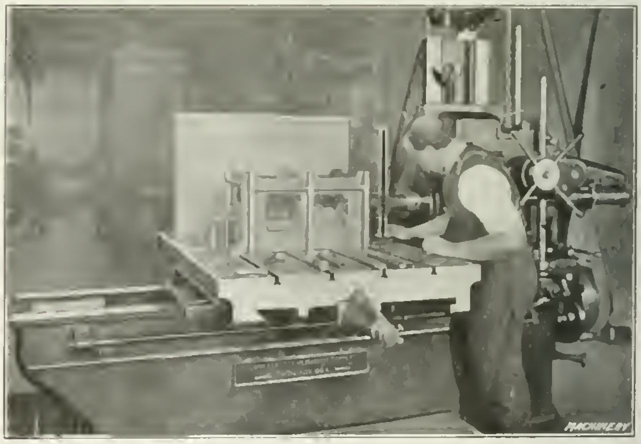

Fig. 2. Locating the Spindle in Position vertically for Boring a Hole in a Jig

In locating a jig in its proper position on the table of the boring machine, special height-gages are employed. In the toolmaking department there are about twenty-five of these special tools, which are made by the Brown & Sharpe Mfg. Co. These tools have extra wide and heavy bases. The jig is first placed against two stops that may be seen in the left-hand T-slot in the table in Fig. 2. With the height-gage, the jig is placed parallel with the angle-iron on the table, which, of course, is parallel with the spindle of the boring machine. In locating the spindle of the machine for boring a hole, measurements are taken vertically from the table, either to the spindle itself, or to a plug which is fitted in the end of the spindle. Needless to say, the spindle must be absolutely without shake or play, and this condition is insured by a "take-up" at the head of the machine. After locating the spindle for the vertical dimension, the horizontal measurement is taken, as shown in Fig. 3, from the angle-iron to the plug or spindle, as the case may be. After the spindle is properly located, the hole is bored for the bushing, and then attention is given to the next hole. Should there be two holes in line, with each other on opposite ends or sides of the jig, they are not bored at one setting, as might be supposed, but the jig is reversed on the table of the machine and re-located for the second hole. This method is considered to be the best practice, because long boring-bars are not required, and it is not necessary to use the left-hand boring-bar support. Fig. 4 shows the toolmaker boring the hole in a fixture. The type of machine used is particularly well adapted for jig-boring, because the operator can run the machine with his right hand, and at the same time watch the work of the cutter. It also has an added advantage over machines in which the head is at the opposite end, in that the operator can caliper holes without being obliged to use his left hand in so doing. This same advantage applies, of course, when trying size plugs.

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[*] Associate Editor of MACHINERY.

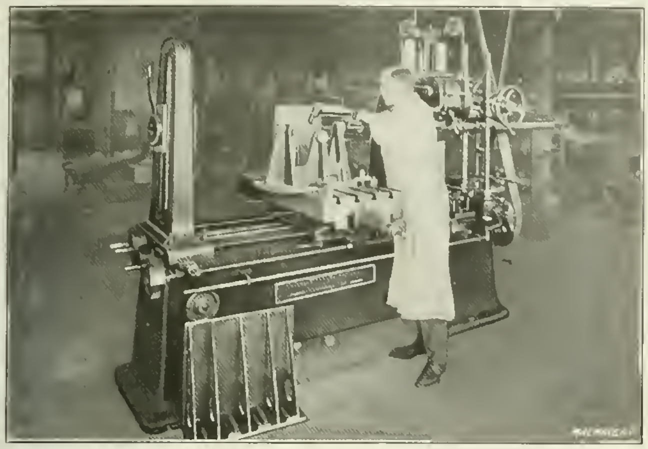


Fig. 3. Locating the Spindle laterally for Boring a Fixture

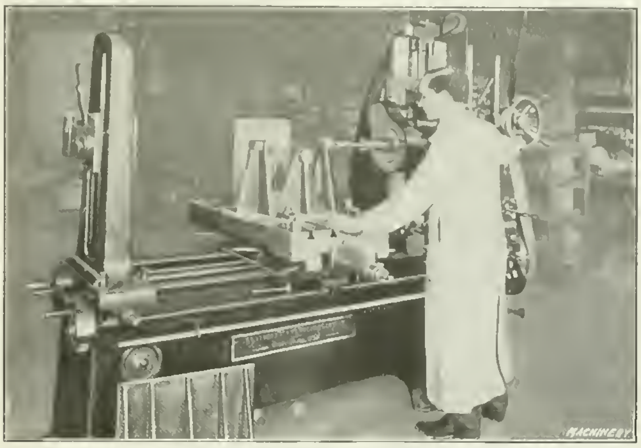


Fig. 4. Drilling one of the Holes in a Fixture

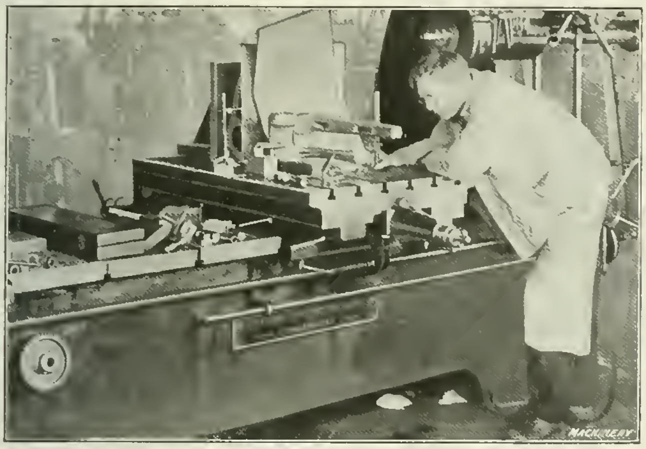


Fig. 5. Setting-up and Locating Experimental Work on Boring Machine

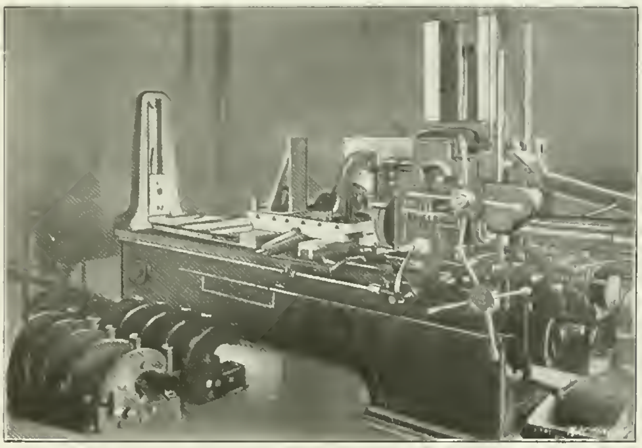


Fig. 6. Boring the Heads for Monogram-embossing Machines

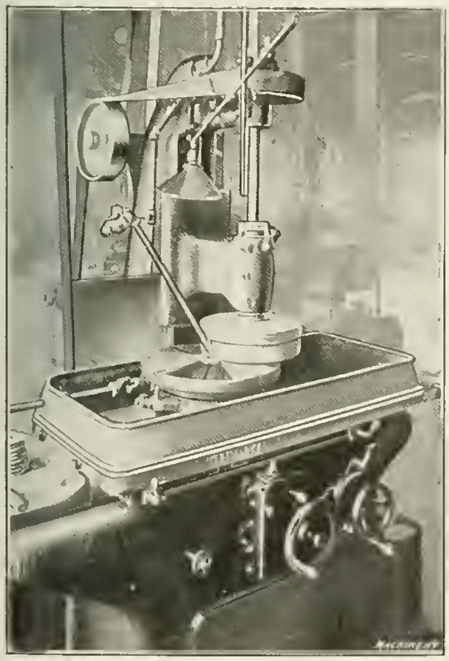


Fig. 7. Face-grinding the Drop-forgings

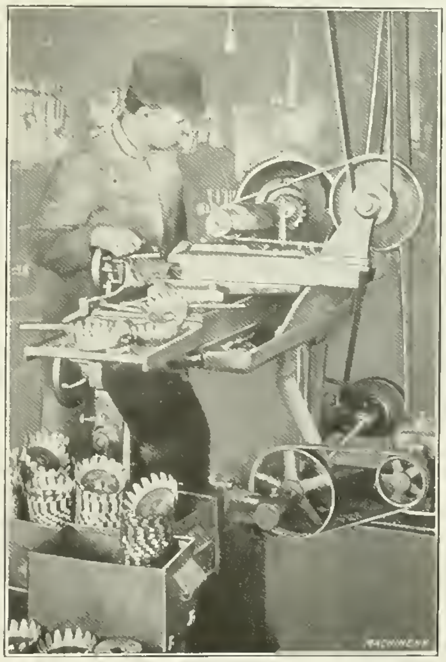


Fig. 8. Grinding Shoe-trimming Cutters

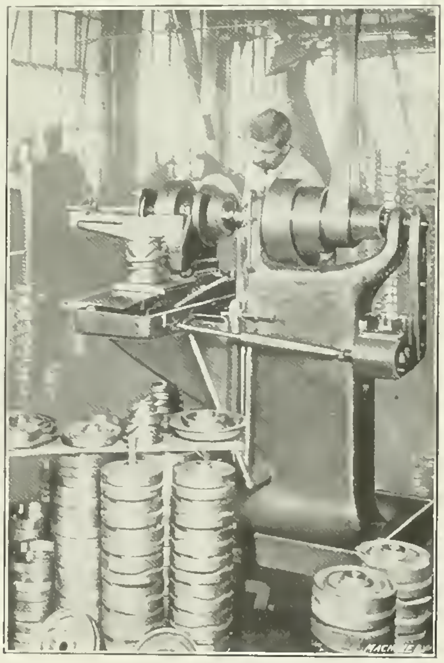


Fig. 9. One of the Cam-cutting Machines

Fig. 5 illustrates the method used in boring work in the experimental department, where trial machines for shoe manufacturing are built in small lots before the work has been jigged for regular production. The piece shown on the machine is one of the parts of a shoe-leveling machine, and the machinist is setting up the piece and locating each hole to be bored, in accordance with the drawing which he has before him. On a job of this kind it takes a great deal longer to set up the work properly and lay out the positions of the holes than it does to do the actual machining which follows.

The machine in Fig. 6 is shown working on the heads of monogram-embossing machines, a group of which appears on the floor near the base of the boring machine. From the foremost of this group it will be seen that there are numerous small holes to be located and bored for the various shafts and rocker-arms. This work is essentially the same as in the jig-boring operations, a small angle-iron being used as shown. In this instance, however, the angle-iron is at the side of the table, instead of at the rear.

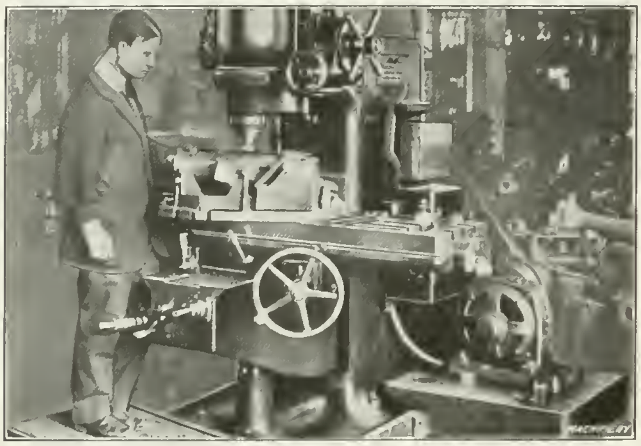


Fig. 10. Milling Fixture for Use on the Vertical Miller

The Pratt & Whitney Co.'s face grinder shown in Fig. 7 is used extensively in the grinding department for facing small drop forgings, some of which are shown on the machine. The surfaces of these forgings must be parallel within limits of 0.0005 inch. In order to show this machine to better advantage, the water-guard is removed, thus exposing the table to view. The drop forgings, which have central holes, are located by placing them over a stud at the center of the table; a magnetic chuck is not required, for the pressure of the wheel is sufficient to keep the piece flat against the faceplate while it is being ground.

Another interesting grinding job is shown in Fig. 8, where the knives for shoe trimming machines are ground internally and externally on Heald No. 70 internal grinders. Two machines are used on the work, one being set up for grinding the inside and one for the outside. The machine shown is working on the insides of the cutters, and the same operator, running two machines, turns out two hundred finished cutters per day. The cutters are located by being slipped over a stud that engages the central holes, and are held in place by a nut and washer.

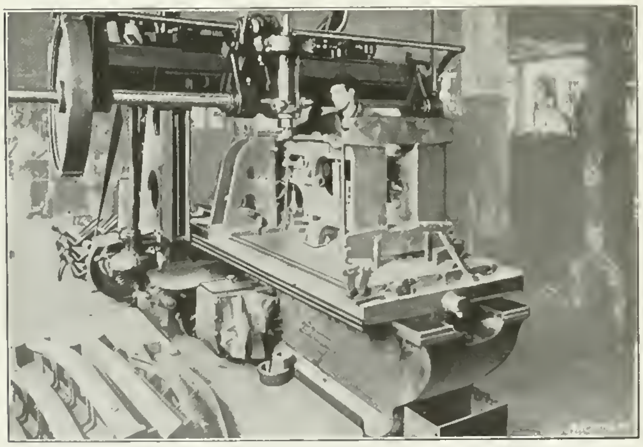


Fig. 11. Milling the Seats and Recesses on a Nailing Machine Column

Cams are cut in large numbers and great variety in the United Shoe Machinery Co.'s plant, and a special department is maintained for the sole purpose of turning out the cams used on the various machines. While several makes of cam-cutting machines are employed, the favorite seems to be the machine made by the Kearney & Trecker Co., Milwaukee, Wis. One of these machines is shown in Fig. 9, and some of the various cams which have been cut on it are shown piled up about the machine. Special attention is called to those resting upon the board on the top of the piles in the foreground. This machine, like most other cam-cutting machines, must be provided with a master cam that governs the movements of the work in relation to the cutter.

The Cincinnati miller shown in Fig. 10 is working on tack-puller heads, one of which is shown in the fixture on the table of the machine. As will be noticed, provision is made on the base of the fixture for clamping it in various positions to facilitate the milling of the different parts of the work. It is obvious that it would be impracticable to shift the fixture around in this manner, if the milling being done were other than that of facing off parts in which the relative height is the only consideration.

On the Ingersoll upright type of milling machine shown in Fig. 11 the large columns for nailing-machines are milled to receive the different parts of the machine attached to it. One of these columns is shown at the right of the illustration. This particular job is well suited to this type of machine, because the short cuts that are required can be easily taken with a milling cutter, whereas, if the work were planed, the machine used would necessarily have to be out of all proportion to the amount of cutting to be done, on account of the difficulty of accommodating the extremely large casting.

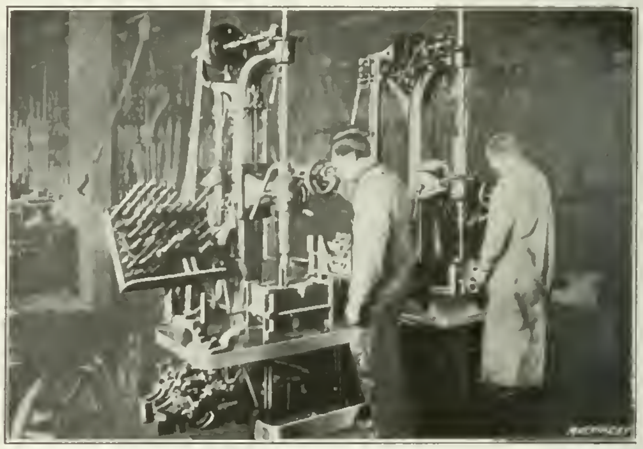


Fig. 12. Racks for Holding Tools used in Drilling Machines

Drilling operations are everywhere to be seen in this large factory, there being hardly a department that does not employ several hundred spindles. The manufacturing work, of course, is all jigged, and to facilitate the many changes which must be made in drills, reamers and counterbores, the large drill presses are fitted with tool-holding racks. In these the different tools used on the job are kept in regular order, so that they may be quickly gotten when wanted. At the same time, they are protected from being injured or mislaid, so that altogether the idea seems to be a good one. Fig. 12 shows a drill press with a rack.

Aside from the work done in the factory, much might be written on the conveniences installed in the factory for the workmen, in the form of metal lockers, washrooms, restaurant, etc. In addition there is a fully equipped emergency hospital. Here a trained attendant is in charge, who is qualified to administer first aid to the injured.

* * *

It appears from an article in *Zeitschrift des Osterreichischen Ingenieur und Architekten-Vereines*, that the water power available for industrial purposes in Switzerland is equivalent to 90 horsepower per square mile. The available water power in Sweden and Norway is about 45 horsepower per square mile of area. In Switzerland, nearly one-quarter of this available water power has already been made use of, while in Sweden and Norway but a small fraction, probably not more than one-fiftieth of the available water power has as yet been harnessed.

DRAWING A DEEP STEEL SHELL*

By JOSEPH V. WOODWORTH†

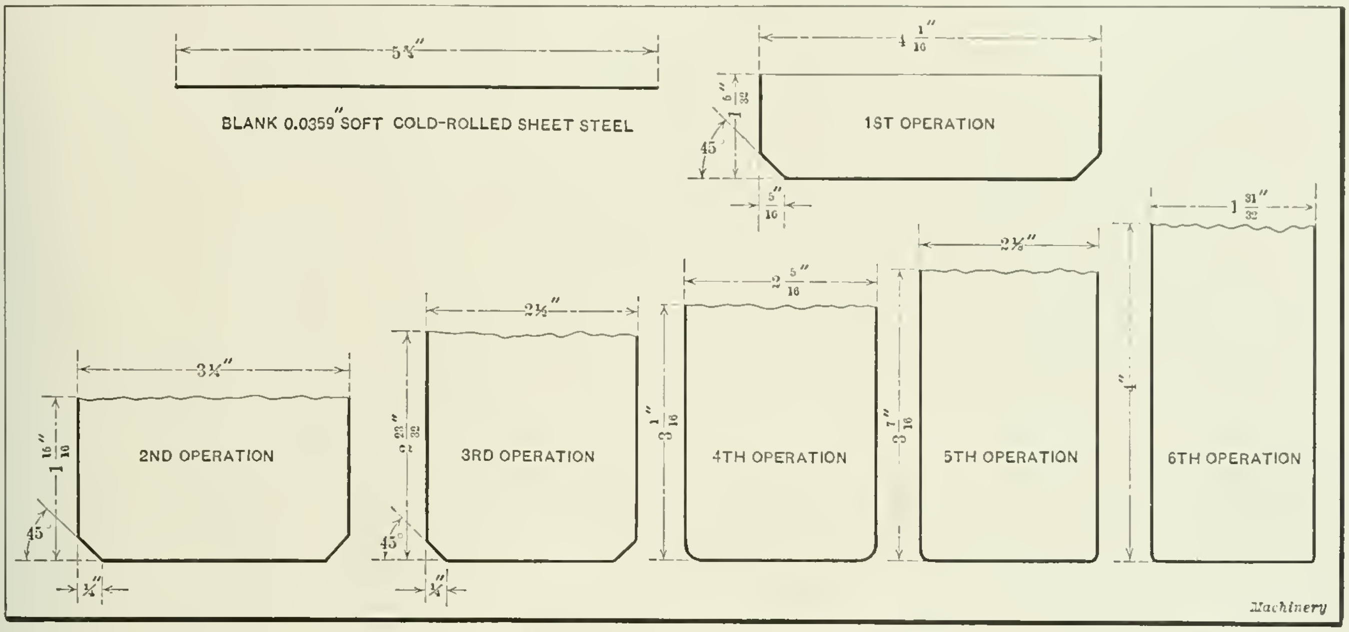
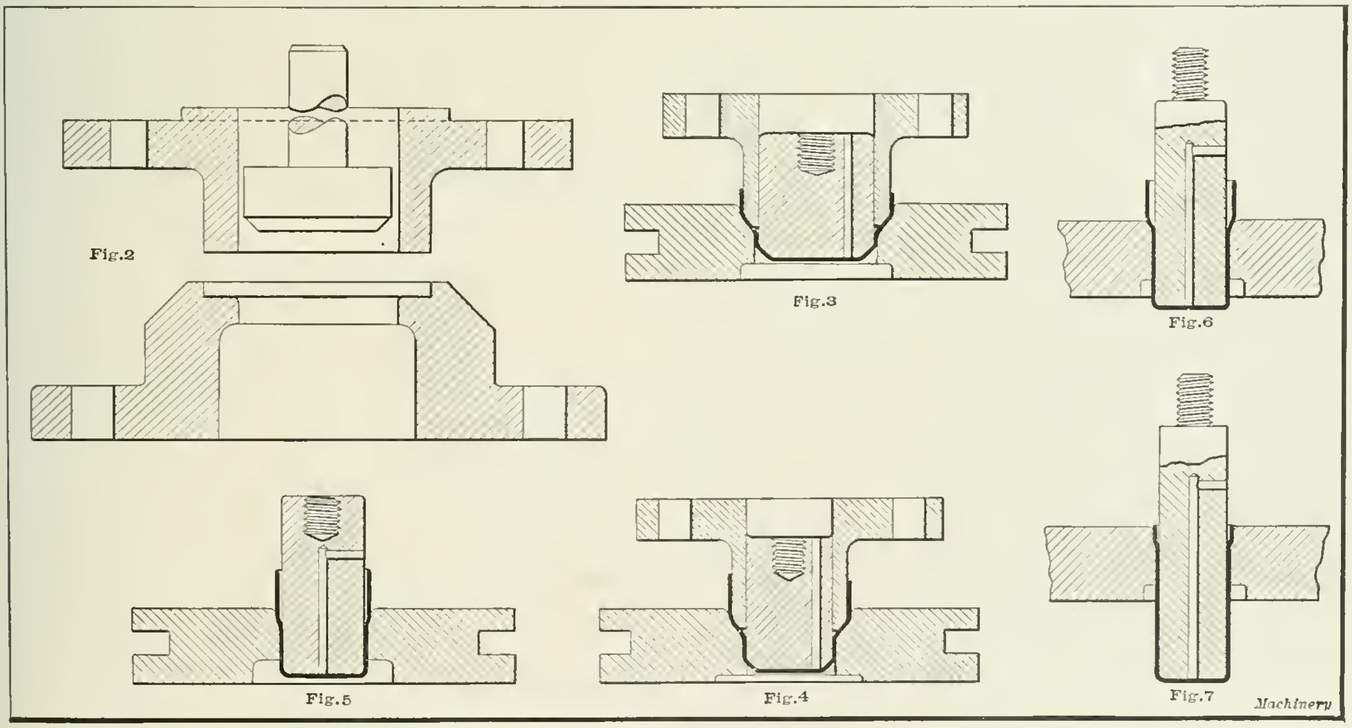


Fig. 1. Successive Operations in the Drawing of a Deep Shell

Fig. 1 shows the six successive operations required to produce the shell shown in Fig. 10, indicating clearly the evolution, proportions and dimensions. The material for which the tools were designed was 0.0359 inch dead soft cold-rolled drawing steel. The shell had to be true to size in diameter and height, smooth inside and out, and a strictly first-class product in every way.

Fig. 2 shows the double-action blanking and drawing die for the first operation; Fig. 3 shows the tools for the second operation; Fig. 4, the double-action dies for the third operation; Fig. 5, the single-action reducing die for the fourth operation; Fig. 6, tools of the same construction for the fifth operation; and Fig. 7, the punch and die for the sizing and finishing operation. The illustrations show clearly the design, construction and operation of the tools. The shell was annealed four times and trimmed but once—after the last redrawing. A thin mixture of lard oil and white lead was used to lubricate while reducing.



Figs. 2 to 7. Tools for the Operations shown in Fig. 1

Fig. 8 is a plan view of the single-action combination piercing, blanking and drawing die used for producing the drawn and perforated cover shown in Fig. 9, made of the same material as that for the shell. This cover was welded into the shell as shown in Fig. 10, the whole serving as a can receptacle for parts of an electrical device. Fig. 11 is a cross-sectional view of the complete punch and die designed for the cover, and Fig. 12 is a plan of the punch. A brief description will make plain the construction and action of the tools.

In the die, Figs. 8 and 11, *A* is the cast-iron die bolster; *E* are the interchangeable piercing die bushings of Blue Chip steel; *B*, the blanking die of the same material; *C*, the drawing pad; *D*, the pilot holes for pilots *P* in punch; *F*, the stripper of cold-rolled stock; *H*, the gage plates; *G*, the gage plate and stripper locating dowels; *I*, the eight blank-holder pressure pins; *J*, the blank holder ring; *K*, the spring barrel stud; *S*, the spring barrel washers; and *L*, the rubber spring barrel. In the punch, *M* is a tool steel forging machined to the shape shown; *R* is the blanking punch; *O*, the drawing die; *N*, the ejector pad with pilots at *P*; and *Q* the three piercing punches forced into slightly tapered holes in the punch proper.

Cold-rolled strips of the proper width are used for the stampings, the metal being fed in at *H*, Fig. 11. The end is trimmed and the three holes punched, and then the strip is moved forward against stop pin *T*. The punch descending again, pilots *P* engage the pierced holes, and before the blanking punch touches the metal, locate the strip accurately. By laying out the operations and the evolution of shape as here shown, and making the drawings so as to show clearly the operation of the tools upon the metal to be worked, the expense of designing is reduced to a minimum, the tools can be put through the shop with few "cut and try" troubles, their cost will be reasonable, and their efficiency assured.

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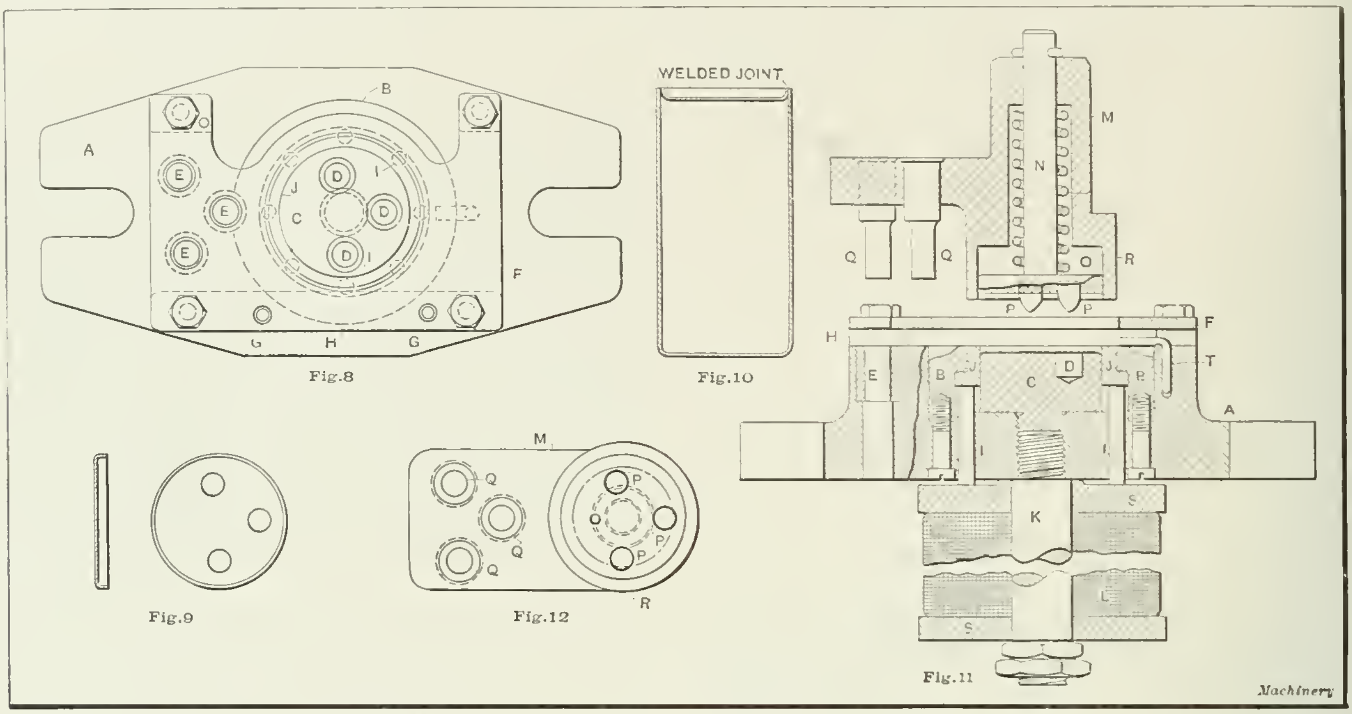
* See also MACHINERY, March, 1912, "Drawing a Flanged and Tapered Cylindrical Shell," and the articles there referred to.

† Consulting engineer, 165 Broadway, New York City.



Figs. 8 to 12. Completed Can and Cover and Tools for the Latter

* * *

In an address on "Comparison between Industrial Conditions in the United States and Europe," read before the American Society of Swedish Engineers, Mr. A. L. Valentine, superintendent of the small tool department of the Pratt & Whitney Co., Hartford, Conn., quoted some figures which show how far the United States is behind Europe in the matter of safeguarding the workers. Figures show, said Mr. Valentine, that in this country 100 men are killed every day as a result of industrial accidents. Two million in a year are injured. For 1908 very reliable figures are obtainable, and these show that there were between 30,000 and 35,000 fatal accidents that year. Of the deaths of male workers between the ages of 15 and 44, 15 per cent are due to accidental causes, and of these, at least half, or 7½ per cent, are incurred in the act of making a living. If such a proportion were lost in battle, it would be considered a disaster. Figures also show that the loss of life per thousand in the mines in the United States is greater than in France, Belgium and Great Britain combined. Manufacturers in Germany, which country has been at work preventing accidents for a quarter of a century, are compelled to be members of protective associations. These associations employ inspectors whose duty it is to inspect factories, nearly always, semi-yearly, especially those where women are employed. Seventy-five per cent of our accidents could be avoided by precaution. Better light and ventilation and better spacing of machinery should be insisted upon. It is better to build right, than to furnish safeguards after things are done wrong. Laws which this country has relating to employers' liability should at least be enforced, and those responsible would give a little more thought to the value of human life.

* * *

The aerial navy of France is assuming large proportions. Increases have been made in former appropriations and according to the latest decisions of the French war department, the French army will, during the present year, have 322 aeroplanes and 15 dirigibles at its disposal.

DRILLING AND COUNTERBORING FROM CROSS-SLIDE IN THE AUTOMATIC

By S. NEVIN BACON

Hand screw machine operations are frequently performed on work partly made in the automatic machines, because in order to complete the work in the automatic machine it would require seven tools, which it is not possible to hold in the turret of a Brown & Sharpe automatic screw machine. At *A*, in Fig. 1, is shown a piece of work knurled on one end, which was made in a No. 2 Brown & Sharpe automatic screw machine. Now unless we wish to use a combination counterbore, the list of turret tools required will be a stop, center, drill, reamer, two counterbores and a knurl.

The method used in holding the extra counterbore is shown at *A* in Fig. 2. The counterbore is held in a holder placed on the cross-slide, and when the counterbore is in line with the hole in the work it is fed forward by means of the stop in the turret coming against the rear end *a* of the counterbore. The counterbore is made a good sliding fit in the hole in the boss, and is prevented from turning by the headless screw *b*. A pin driven into the shank of the counterbore and a helical spring assist in keeping the counterbore in the "back" position. The order of operations for producing the piece shown at *A* in Fig. 1, is as follows:

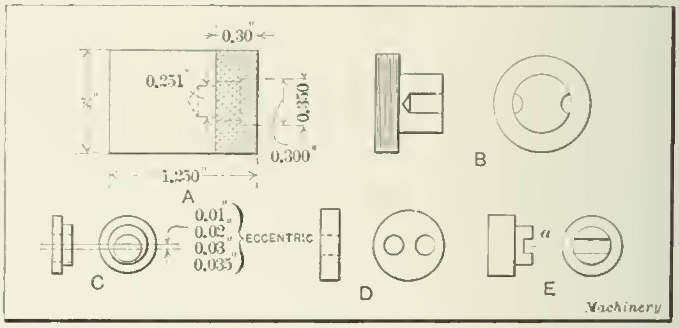


Fig. 1. Samples of Work Operated on by Counterbores and Drills held on the Cross-slide

Order of Operations	Revolutions	Hundredths
Clearance	19.6	2
Feed stock to stop	19.6	2
Revolve turret	19.6	2
Center, 0.125 inch rise at 0.0063 inch feed	19.6	2
Revolve turret	29.4	3
Drill, 0.500 inch rise at 0.0056 inch feed	88.2	9
Revolve turret	29.4	3
Ream, 0.500 inch rise at 0.0072 inch feed	137.2	14
Revolve turret	29.4	3
Counterbore, 0.150 inch rise at 0.0014 inch feed	107.8	11

Revolve turret	29.4	3
Knurl on, 0.300 inch rise at 0.0102 inch feed.	29.4	3
Knurl off, 0.300 inch rise at 0.0153 inch feed.	19.6	2
Revolve turret	29.4	3
Advance front slide and dwell	88.2	9
Counterbore from cross-slide, 0.125 inch rise at 0.0021 inch feed	(58.8)	(6)
Clearance	(19.6)	(2)
Cut off, 0.477 inch rise at 0.00167 inch feed	284.2	29
Total	980.0	100

The cams for producing the piece shown at *A* in Fig. 1 are shown in Fig. 3, where the various functions of the lobes are clearly indicated. The most interesting lobe on this set of cams is the lobe on the cross-slide cam from 63 to 71, which brings the special counterbore shown at *A* in Fig. 2 in line with the hole in the work. The stop in the turret used for feeding in this counterbore, and which is also used for gaging the stock to length is operated by the lobe from 63 to 69 on the lead cam. It will be noticed that this lobe is much lower than the lobe from 2 to 4 gaging the stock to length, the reason, of course, being that the counterbore projects much further from the chuck than does the stock when fed out.

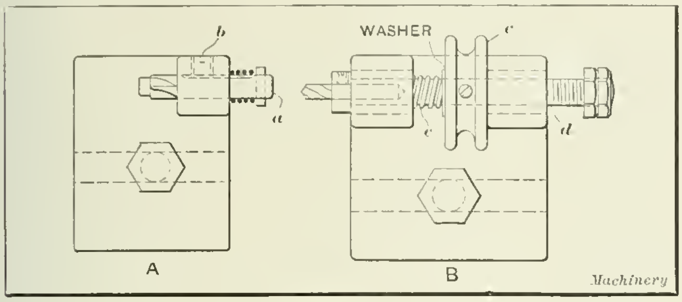


Fig. 2. Holders for Carrying Drills and Counterbores in the Cross-slide

Another simple method of holding an extra tool on the cross-slide is illustrated at *B* in Fig. 2. Here the holder is made so that it will take either a drill or a counterbore, as the case may be, which is held in it by means of a headless screw. The tool is rotated by means of the grooved pulley *c*, which is fastened to the spindle *d* as shown. This pulley is driven from the overhead works by a round belt, which is left sufficiently slack to allow the front cross-slide to advance to a position in line with the work. The drill is fed forward by a stop held in the turret, and is withdrawn by the coil spring *e*.

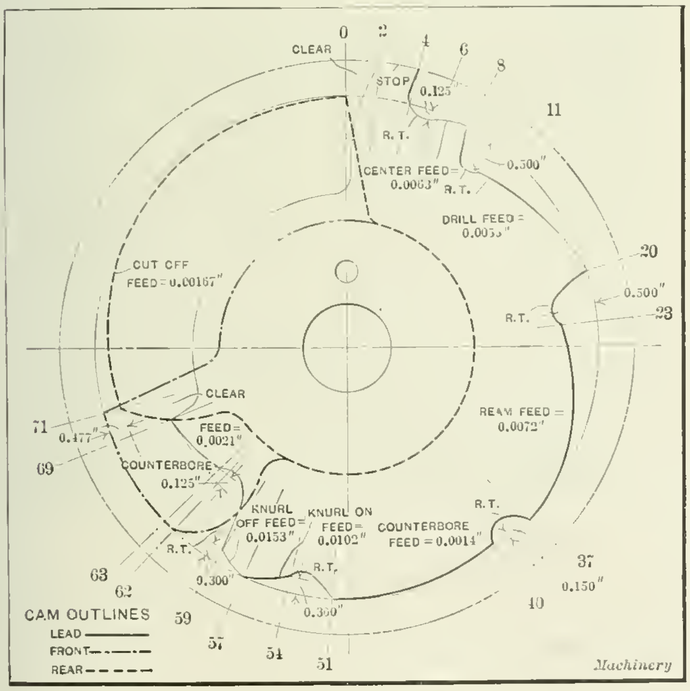


Fig. 3. Came used in Producing the Piece shown at A in Fig. 1

Other operations performed with drills and counterbores held on the cross-slide are shown in Fig. 1 at *B*, *C*, *D* and *E*, respectively. At *C* is shown a piece made with an eccentric hole. This is easily produced by means of a drill held in a holder fastened to the cross-slide. Of course it is necessary to lock the spindle when the hole is being drilled. A drill holder similar in construction to that shown at *B* in Fig. 2 is used. It will be noticed that the piece shown at *C* is made with holes having different degrees of eccentricity; otherwise the pieces made with an eccentric hole are of the same size and shape.

It is interesting to compare this method of drilling with the old method, which consisted in holding the stock in an eccentric chuck or in drilling each piece in a drill jig. The method last mentioned is expensive, and the eccentric chuck method is very destructive to the cut-off tools owing to the pounding of the stock against the cutting edge.

At *B* is shown how wrench slots were produced in a special nut. The holes were first drilled, after which the shank was turned down by means of a box-tool, leaving only one-half of the drilled holes in each side. To produce this piece, the cross-slide cam moves the drill and holder forward part way, then dwells while the first hole is being drilled, by means of a stop in the turret forcing the drill into the work. After the first hole is drilled, the cam advances into position for the second hole, when the same operation is repeated. At *D* is shown a washer provided with two holes which were also drilled in this manner. At *E* in Fig. 1 is shown a piece which requires a different movement. The lead cam is not used at all, and the groove *a* is cut with a reamer instead of a drill. After the machine spindle is locked in position by means of the brake, the reamer starts at one side and is fed across by the cross-slide cam operating the slide upon which the reamer is mounted. These special operations give little trouble especially on brass work, the material from which the parts described were made.

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BRITISH VIEW OF BRITISH CONDITIONS

The following editorial from the *Mechanical World* gives an interesting view of some industrial conditions in Great Britain that are very different from the conditions here. That it should be considered remarkable that a firm should pay wages to its engineering apprentices, and that a business career should be considered "undignified," is strange to us, and while we have seen frequent allusions to the latter subject in stories and novels, yet we were hardly prepared to accept it as a plain fact with a practical bearing on the administration of engineering undertakings in Great Britain at the present day.

"A remarkable offer has just been made by an electrical company in order to attract into the shops and offices men of superior education and some social standing. Instead of asking a premium of three hundred pounds or more for the training of young men in electrical engineering, the company is prepared to receive a number of promising university men and make them a reasonable remuneration. The men are required for good positions and salaries in an administrative capacity later on, and it will be of some interest at some future time to learn the result of the offer. At present it is possible to obtain the best brains and experience in the world for the purely technical side of the industry on paying suitably for them, but for the administrative side the best material, we are told, is represented by the British office boy. It is strange that before making an appeal to those of university education an effort has not been made to secure suitable candidates from the technical colleges and schools; or has sufficient experience already been obtained with the material turned out by these institutions? If so, is it hoped to be more successful with university men, who have been taught to regard business as undignified or as representing a fall in the social scale? There may, however, be exceptions, and the hope may be expressed that they will be discovered, so that the experiment may be afforded a practical test."

* * *

The latest statistics relating to the exports and imports of machine tools in Germany show that the exports increased from 59,100 metric tons in 1910 to 71,500 tons in 1911. Austria-Hungary and Italy imported more German machine tools than any other country, but France and Russia also proved themselves to be good customers. The imports amounted to 7400 tons of which 4500 tons was from the United States, and 960 tons from Great Britain. The total value of the machine tools exported in 1911 was in round numbers $19,000,000, while the total value of the imports was $2,300,000.

INTERNAL GRINDING PRACTICE IN THE HARDINGE BROS. SHOP

By EDWARD K. HAMMOND[*]

In developing methods of internal grinding—noteworthy on account of the low speeds used to meet the most exacting specifications for accuracy and finish—Hardinge Bros., Inc., of Chicago, Ill., have approached the problem from the opposite side to that taken by most manufacturers. Instead of taking the standard products of the grinding wheel manufacturers and driving them at the excessively high speeds for which they are suited, special wheels have been obtained for the different grinding operations in the Hardinge factory. These wheels are bonded in a manner which adapts them for their work when running at speeds ranging from 4500 to 10,000 revolutions per minute.

It is a generally recognized principle of grinding that a well-defined balance exists between the grade and grain of a wheel and the speed which makes it suitable for a specific grinding operation. Soft wheels part readily with their abrasive material and must be driven at high speeds in order to reduce the resistance between the wheel and the work; hard wheels have the abrasive material more firmly secured in the bond, and such wheels are driven at lower speeds in order that the resistance may be great enough to break away the abrasive material and maintain a good cutting surface. This relation between the grade of a wheel and the speed which adapts it to a given grinding operation presents two courses of action in preparing the equipment. The speed of the most suitable type of standard wheel may be adjusted to enable it to handle the work, or, after deciding upon a practical range of speeds, a special wheel may be developed to work at such speeds. The latter method is, of course, limited by the possibility of producing a wheel that will give satisfactory results when operating within the selected speed range.

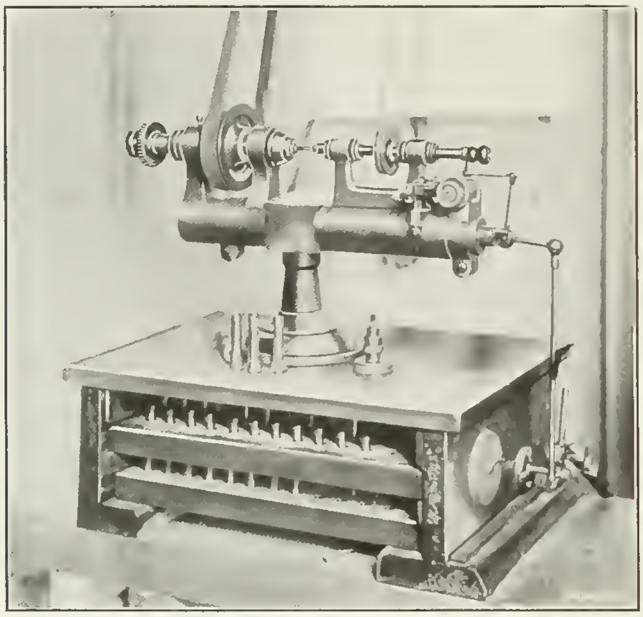

Fig. 1. Lapping a 0.125-inch Chuck at a Speed of 4500 R. P. M.

Grinding Wheels of Small Diameter

The general tendency in internal grinding has been to accept the standard wheels offered by the manufacturers, and, after selecting the type of wheel most nearly suited to the requirements of the work, to adjust the machine to drive the wheels at the proper speed. In grinding small holes, the wheels are necessarily limited in size, and with standard wheels, it has been necessary to adopt excessively high angular speeds. This has given rise to the assumption that it is necessary to drive small wheels at high speeds in order to give the abrasive the ability to cut, and as a result, internal grinding machines have been built along lines enabling them to run at speeds as high as 100,000 R.P.M. It cannot be denied, however, that such speeds have great disadvantages owing to the effect upon the machines, and the limited control which the mechanic has over his work when operating under such conditions.

With the view of obviating these objectionable features, the Hardinge firm entered into a consultation with the Eagle Emery & Corundum Wheel Co., of Chicago, which resulted in the undertaking of experimental work with different bonding materials. These experiments showed that it was possible to produce hard wheels in which the abrasive material was held firmly enough to allow them to run at greatly reduced speeds. Further work was then carried on which resulted in the production of different types of wheels that were especially suited to the individual internal grinding operations in the Hardinge shops. The abrasive materials used were emery and corundum. Carborundum was discarded, owing to the damage caused by particles of this abrasive material getting between sliding members of the machines. In the cases of emery and corundum, this is not as serious a matter, because particles of these abrasive materials are destroyed before they have done serious damage, but if a particle of carborundum gets between two sliding parts, its extreme hardness enables it to last for a sufficient length of time to do considerable damage. In making these special wheels, the hardness was carried as far as possible, in order to provide for slow speed drives, the limit in all cases being the ability of the abrasive material to break away from the bond and thus maintain a good cutting surface on the wheel.

Grinding Practice in the Hardinge Shop

The making of the different sizes of draw-back chucks for the bench lathes manufactured by Hardinge Bros. forms one of the important classes of internal grinding operations in their shops. The internal diameters of these chucks cover a range from 0.010 inch up to 1.687 inch. Chucks ranging in size from 0.010 inch up to 3/16 inch are finished by lapping, while the larger sizes are ground with the special wheels. In finishing these chucks, they are mounted in the lathe spindle in the regular way, and the grinding attachment drives the wheel. Before hardening, the chucks are drilled or bored to approximately the required size, and, in the cases of the smaller sizes, which are to be finished by lapping, the holes are burred to within about 0.001 inch of the standard sizes by means of circular files.

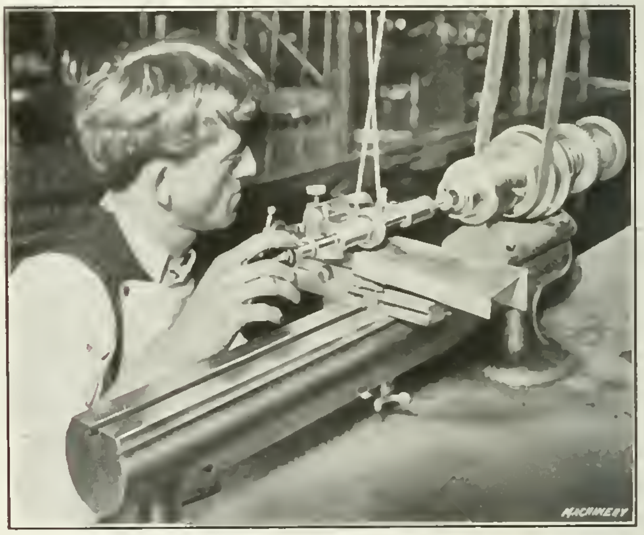

Fig. 2. Method of using the Push Spindle

The plugs used for the lapping operation are made of soft steel and are driven at speeds ranging from 4000 to 5000 R.P.M. Fig. 1 shows a machine equipped for the lapping operation on a chuck of 0.125 inch internal capacity. The lap is driven at 4500 R.P.M. and is moved in and out of the hole by means of the system of levers connecting the spindle with the rod at the right-hand side of the machine, which rod is given a reciprocating movement by a crank on a shaft behind the bench. The important point in securing accurate work in these lapping operations is to have the work so heat-treated that all parts are of equal hardness. If this precaution is not observed, the softer parts of the work will take up the abrasive and thus resist being cut away; the lap will also be damaged through the "back-biting" action of the abrasive imbedded in the work. At the same time, the harder parts of the work will not take up any of the abrasive and will be ground away faster, the full action of the lap being exerted upon them.

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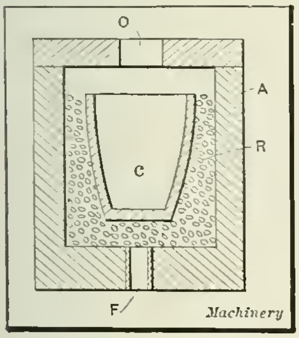
An important advantage is secured in internal grinding operations through the use of the push spindle with which the Hardinge grinders are equipped. This spindle is held by two bearings provided with dust-proof washers to prevent particles of abrasive material from damaging them, and may be advanced to the work by pushing forward the finger piece, as indicated in Fig. 2. This finger piece revolves on a bearing and is held between the thumb and index finger, as shown; the sensitive touch which the operator secures in this way enables him to tell whether he is working under proper conditions, as soon as the wheel comes into contact with the work. The sparks thrown by the wheel also act as a guide in enabling the operator to tell whether the wheel is cutting properly. Greater precision is made possible through the use of the push spindle, and much of the trouble experienced with broken wheels and spoiled work, when using the ordinary spindles that are advanced to the work by means of reciprocating slides and driven at excessively high speeds, is avoided.

The same principles as have been outlined for the internal grinding apply to external work when using small wheels. In all classes of grinding, it should be borne in mind that better control over the work and a longer life for the grinding machine are secured when operating at the lowest practicable speeds—speeds which are made possible through an intelligent development of special wheels for individual grinding operations.

* * *

SURFACE COMBUSTION

Interesting experiments have recently been carried out by Prof. William A. Bone, in connection with what is termed "surface combustion." The problem of burning an explosive mixture continuously and quietly, that is, without an explosion, has been difficult of solution. It has been noted, however, that if a mixture of gas and air, emitted at high velocity, from a Bunsen burner, for example, is permitted to strike against a piece of red hot firebrick held a short distance away from the front of the burner, the mixture will burn at the surface of the fire brick. This constitutes the principle from which the methods of what is called surface combustion have been developed. As an example of its application, the accompanying engraving is shown. A crucible *C* is placed in a furnace *A*. The crucible is completely surrounded with a highly refractory granular material *R*, and the gases of combustion escape at *O*. If the mixture of gas and air is properly adjusted, the combustion will go on quietly without a flame within the granular material, and this latter will reach a state of intense incandescence.



Arrangement for Heating Crucible by Surface Combustion

The distinguishing and essential feature of the new process is that a homogeneous explosive mixture of gas and air in the proper proportions for complete combustion, or with air in slight excess, is caused to burn without flame in contact with a granular incandescent solid, whereby a large proportion of the potential energy of the gas is immediately converted into radiant form. The advantages claimed for the new system are that the combustion is greatly accelerated by the incandescent surface, and can be concentrated just where the heat is required; the combustion is perfect with a minimum excess of air; the attainment of very high temperatures is possible; and owing to the large amount of radiant energy developed the transmission of heat to the object to be heated is very rapid.

A valuable application of the process is that of diaphragm heating. The diaphragm is a block of granular refractory material held together by a suitable binding agent, and so coarse in its structure that a gas can flow through it. This diaphragm is mounted over an empty chamber connected to the source of the combustible gaseous mixture. When the gas is turned on, it will flow through the porous diaphragm and can be ignited at its surface. It will then first burn with a flame, but as soon as the diaphragm becomes heated, the flame will gradually disappear, the combustion taking place at the surfaces of the pores of the diaphragm. Thus the diaphragm becomes a hot radiating surface, the temperature of which can be regulated by regulating the amount of gas mixture supplied.

Very high temperatures can be obtained by this method of combustion. Prof. Bone has found that in the furnace illustrated in the accompanying engraving, temperatures far above the melting point of platinum can be obtained. This method of combustion is also highly efficient. A muffle heated to a certain temperature by ordinary means was found to require 105 cubic feet of gas per hour, while the same muffle heated to the same temperature by surface combustion required only 43 cubic feet of gas per hour.

Another and perhaps the most valuable application of the process is for steam boilers. Boilers arranged for surface combustion have a mixing chamber in front of the tubes and connecting with them. The tubes contain the granular refractory material. The gas mixture is forced through the tubes at a high velocity, and complete combustion is insured after the gas has traversed a very short distance. The remainder of the granular material in the tubes acts as a baffle for the hot gases, forcing them towards the walls of the tubes in order that a large proportion of the heat may be given over to the water. A fairly large boiler has been built on this principle, equipped with 110 combustion tubes; this boiler has been successfully used in an industrial plant. While the principal idea involved is not entirely new, great advance has lately been made in its application to practical purposes.

* * *

TOO MANY PATENTS A HINDRANCE TO PROGRESS—A BRITISH VIEW

In a recent issue of the *Practical Engineer* (London) the following comments on patent protection carried too far for the best interests of progress in design, are given in an article entitled "Hindrances to Progress in Machine Tool Construction":

> "Even to the student of machine tool literature and to the designer or draftsman, it is a very difficult matter to point out any one feature in most of the present-day machines which possesses self-evident novelty. Take, for example, the present-day high-speed drilling machines. What do they comprise in essence but a drill spindle mounted on ball bearings? Some arrange their ball bearings in one way and some in another. Some have one form of belt drive and some another. But the fact remains that the chief features are the same in all cases. The difficulty in which the designer finds himself when he attempts to improve upon his machine is to do so without copying exactly his rivals' productions. On many of these the ominous word 'patent' appears, whilst all that is covered is some particular disposition of ball bearings or the like, which is not the product of the inventive brain, but the outcome of the designer's needs and constructional skill. We venture to suggest that the name and position of the manufacturer are in most cases the only watch dogs that guard against encroachment, and that the patents themselves are valueless except as commercial propositions. It should be too late in the march of progress for any person to claim as his own the application of any well-known form of ball bearing to any particular machine, but the fact remains that patents are granted therefor and are a menace to progress.
>
> "We have no hesitation in saying that the granting of patents for the slightest constructional differences, amounting sometimes to the proverbial substitution of a screw for a bolt, is becoming a hindrance to progress and a matter which will require to be dealt with."

* * *

The problem of casehardening gear teeth without distortion has been solved by the Cadillac Motor Car Co., Detroit, Mich., by copper-plating the gears all over before taking a finishing cut on the teeth. The finishing cut removes the copper plate from the tooth faces and flanks and when casehardened these parts only are hardened, the carbonizing effect of the pack being prevented on the other parts of the gear by the copper plate. The practical result is casehardened teeth with so little distortion of the gear as a whole that it can be corrected to practically perfect accuracy by means well known to gear makers.

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DOUBLE-CUTTING PLANERS

Many attempts have been made to design a planer that will cut with equal efficiency on both the forward and return strokes. Recently a planer was brought out in Great Britain which is claimed to possess certain advantages in this respect; but while it is evident that the elimination of the idle strokes means a considerable advance in efficiency, the great difficulty to be overcome is to design a planer which will cut in both directions with equal efficiency and accuracy. It is apparent that the planer, as made today, is designed to take a maximum cut in one direction only, and a radical change must be made in its design before a really satisfactory machine can be produced which will take heavy cuts in both directions. The tool-head is clamped to the face of the cross-rail, which, in turn, is clamped to the face of the housings, and the stresses produced in these parts when a cut is taken in one direction are quite different from those when the cut is taken in the other direction. In one case there is a tendency to compress all of these parts solidly, giving a firm support to the cutting tool; in the other the tendency is to pull all joints apart, thus depriving the cutting tool of the firmness of its support and creating a tendency to chatter. It appears that if planers are to be made double-cutting, the successful design must be arranged on lines quite different from those of present planers, so that equal support is given to the tool when cutting in both directions.

* * *

PANTOGRAPH PRINCIPLE IN INTERCHANGEABLE MANUFACTURING

When a new machine is developed consisting of many small parts which must be accurately shaped and cheaply produced, preparation for manufacturing ordinarily involves heavy expenditures for presses, punches, dies, jigs, reamers, boring cutters and other tools common to interchangeable manufacturing. When the future of the machine is reasonably sure, there can be no question as to the wisdom of providing the best and most efficient tools that skilled designers and toolmakers produce; but when the outcome of the venture is in doubt because of the practical impossibility of testing the commercial conditions in any other way than by putting the machines on the market, the problem may be sorely perplexing.

Generally, it will not do to put out handmade machines, as the slowness of production, inevitable inaccuracies and high cost make that procedure impracticable. The common practice in that event is to make expensive form milling cutters, dies and jigs for producing the vital parts and to make the auxiliary parts by hand and by ordinary machine tools.

The possibilities of the profiling machine in manufacturing parts of considerable size which do not require the highest accuracy of form have been known and widely applied for many years, but the pantograph principle applied to profilers, of which certain engraving machines are good examples, has not in our opinion been developed as much as its merits deserve.

Take the case of an adding machine which has been developed in the handmade form to a practical success. The matter of making parts from flat stock in hundred lots with pantograph profilers would consist first of making the "copy," say, five times scale, correcting errors by trial, and then actually producing the parts from flat stock cut into strips and held for the operations by suitable quick-action chucks. The pantograph profiler, unlike the form milling cutter on the Lincoln milling machine, is not confined to the production of contours from flat stock only, but can be designed to work in three directions, thus becoming universal in scope. If heavily designed, these machines could be made to function automatically, and produce work of widely varying forms at costs higher than punch and die work, it is true, but so low that the product could probably be placed on the market advantageously under the conditions set forth in the beginning.

* * *

APPRENTICES TEACHING APPRENTICES

In shops employing numbers of apprentices directly subject to the foreman, the common plan of instruction on the operation of machines is to delegate the boy about to give up a machine to instruct the next apprentice in its construction and operation. This method has the advantage of relieving the foreman of the duty of instructing the boys in machine operation—for which he usually has little time and which, in many cases, he could not effectually carry out—and of making each boy as he "graduates," review his knowledge by showing his successor how and what to do. This method also has disadvantages of a serious nature. Not many boys are capable of running a machine at its highest productive capacity, and they are not expected to. They are likely to gradually sink in the scale of efficiency through lack of comprehension or competent instruction until a very low state is reached. Not only may the functions of a machine be but partly understood and used, but improper instruction in oiling bearings and caring for tools, belts, etc., may lead to rapid deterioration of the machine and its product.

When the foreman wakes up to the situation, there is a grand "raking over the coals" and "jacking up all around." Boys genuinely ignorant of their duties are blamed, perhaps, for what they could hardly be expected to know, and the result is dissatisfaction all around. The foreman thinks that apprentices are nuisances generally, and the boys are sorry they started to learn the trade. Unfortunately, few foremen are qualified to act as apprentice instructors. If they are good foremen they are likely to be poor teachers, and, *vice versa*, good teachers are likely to be indifferent foremen. The ability to impart knowledge is a rare gift, fully developed only after years of training.

Conditions like those set forth are less likely to develop when the boys are in charge of an overseer who devotes himself exclusively to their instruction and to instilling those ideals which are necessary for the making of good mechanics. The plan of letting a boy instruct his successor may then work out; that is, when the boy acting as teacher has had careful training and is able to produce good work in reasonable time, and to take proper care of his machine. But unless he has been and is under competent supervision, it is likely to lead to inbreeding of vicious methods and principles.

HELPING A MAN TO FIND HIS PLACE

One of the valuable features of the new systems of management, generally known as "scientific," is that when properly conducted they aid the individual in finding that place in an organization where he can do his best work, receive the most compensation, and in general develop his latent powers so as to produce the greatest benefit to himself and his employer.

In factories organized on the task basis it is often found, for example, that a man working on a lathe cannot possibly fulfil the task that has been found to be easy for the average man. In such a case, this man is not kept at his machine, but is shifted around to other machines or work better suited to his capacity. In nearly all instances, a certain machine or work can be found in the shop whereon this man will be able to perform the set task with ease.

Under the old methods of management such a man would have been retained year after year at work for which he was not fitted. He would have been poorly paid, and at that would have been a poor investment for his employer. He would have been dissatisfied, and helpless to better his condition. Under the new system he finds his proper place, earns good wages, is satisfied and returns a much greater profit to his employer. Of course, all so-called scientifically-managed shops have not applied this important principle of management, and to the extent that they have not they have been unsuccessful with the new methods.

Scientific management is not a mere stop-watch system; it requires constant and intelligent attention. It is not a system which once installed will run itself, nor is it a system that can be run successfully by a man whose views on the relation between employe and employer are too narrow. Scientific management is a broad scheme with far-reaching purposes, and it requires a broad-gage man to handle it.

* * *

CASEHARDENING PROCESSES AND RESULTS

The common process of treating wrought iron with a carbonaceous compound to give it surface hardness is probably the oldest method employed to convert iron into steel. The surface hardness of "case" results from the infusion of carbon which penetrates the iron to depths depending on the nature of the pack and the time of heating. The converted iron (steel) hardens when heated and quenched in cold water. The ease and cheapness of the process by which common iron can be changed to steel of considerable endurance has made possible the use of the casehardening process for a multitude of purposes requiring a cheap, strong, and tough material with hardened surface. Fifty years ago, before the advent of Bessemer steel, some of the railway companies in England treated wrought-iron rails to harden the rail heads and thus increase their durability. The later development of the iron-clad and armored battleship led to the development of casehardening processes for steel armor plate of extraordinary efficiency, producing extreme hardness to a depth of several inches and leaving the remainder of the plate soft and very tough.

In machine shops the casehardening process has been used to some advantage in the making of tools, especially large milling cutters, taps, etc. Varied success has attended these efforts, and hardly any two men having experience in different shops will agree on the value of such products. One shop may obtain uniformly satisfactory work, when another can never be sure of the quality of casehardening work produced.

The reasons for these varied results are several, the chief, of course, being the nature of the pack and heat treatment. One common error is to quench the work in the bath as it is dumped out of the boxes. For all work requiring the best quality of casehardening the treated parts should be allowed to cool slowly when dumped, and then heated to the hardening temperature so as to harden on a "rising heat."

But with the best packing materials and approved heat treatment, the product will vary, and sometimes be unsatisfactory if the chemical composition of the mild steel commonly used includes impurities known to be deleterious to tool steel. Sulphur, manganese and phosphorus must be present in minimum percentages only, if the casehardened product is to have those qualities which give it reliability and durability. The salesman who offers a casehardening compound with the claim that qualities will be produced in the product which make it equal to tool steel, is not honest and sincere if he does not state that the steel used must have certain specified chemical components to start with. Another fact which should be kept in mind by the user of casehardening compounds is that the difference in cost of mild steel and tool steel is materially reduced by the cost of the compounds and the heat treatment. Not infrequently the saving may be reduced to a negligible amount.

* * *

THE MOVING PICTURE AS AN AID TO MECHANICAL INSTRUCTION*

By CHESTER L. LUCAS†

A few weeks ago, at one of the popular moving picture theatres in New York City, a film was shown to illustrate the way in which "photo-plays" are originated. Among other views, were several intended to convey an idea of the work incident to the making of the moving picture machine itself. One of these mechanical views showed the drilling of the frames of the machines, and as it was a close-range view of the work and table of the drilling machine, every detail of the operation being performed could be plainly observed. The drill could be seen entering the bushing of the jig; chips curled out from the drill with credit to the man who sharpened it, and the drill "broke through" in the most natural manner possible. Any mechanic in the audience must have felt a responsive thrill as he viewed that part of the film. Another view showed the making of the film-spool on an automatic turret lathe. The bar stock could be seen as it was fed forward; the turning tools and turret came up to the work just as a few hours before they might have been seen to do in many shops; the drills and forming tools could be plainly seen, and even the cutting-off tool was visible as it fed slowly into the work. There were several other views of a like nature, the whole comprising a most graphic illustration of some of the phases of machine shop practice.

There seems to be every reason to believe that the moving picture should be of great value in imparting mechanical instruction. While the operations shown in this case were necessarily elementary, in order to appeal to the general public, there should be no trouble in making films that would show the working of complex mechanism. If the mechanism was very small, it could easily be enlarged in showing the film, and therefore be even more clearly grasped than from observing the work itself. Again, if the parts moved with great rapidity, as in adding machine mechanism, the film could be "slowed down" until the operation was easily understood. With the addition of a lecturer, to explain difficult parts of the operations shown, such exhibitions would be highly instructive to apprentice, mechanic or engineer.

Undoubtedly the greatest stumbling-block in the path of this method of instruction at the present time is the cost of the film. It is said that the average film costs about one thousand dollars to produce, and except for the fact that each new film is copied from twelve to fifty times, there would be little profit in making films. In the case of films for illustrating mechanical operations, correct shop practice and similar subjects, no expensive company of actors would be required, which, of course, would lessen the expense of making the film.

Within a few years' time a moving picture machine will undoubtedly be just as necessary a part of the equipment of a college as a microscope is to-day. It would even now seem feasible for a large number of trade schools or educational classes to confer as to what phases of their work could best be illustrated and taught in this way, after which several films could be made, distributing the expense. These films, together with a machine for showing them, could be sent from one school to another for exhibition; thus all would derive full benefit at a minimum cost.

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* For previous suggestions and comments on this subject, see "Moving Pictures as an Aid to Teaching Trades," January, 1909; "Moving Picture Show as an Educator," page 527, engineering edition, March, 1909; and "Moving Picture Shows as an Incentive to Crime," page 604, engineering edition, April, 1909.

† Associate Editor of MACHINERY.

NOTES AND COMMENT

Monel metal, which has been termed a "natural" alloy, is regarded as a successful substitute for steel and bronze in steamship propellers. It has recently been cast in pieces weighing as much as 25,000 pounds. Several castings for propellers have been furnished to the United States government.

The question of standard colors for piping systems has been taken up by several German engineering societies, and the following color scheme has been agreed upon: Green is to indicate water; yellow, gas; blue, air; white, steam; black, tar; pink, lyes; pink with a red ring, acid; brown, oils; and grey, vacuum. A black ring or band indicates impurity; a red ring, danger; thus a green pipe with a black ring carries refuse water; a white pipe with a red ring carries superheated steam, etc.

The trackless trolley systems which, during the past year, have been inaugurated in a number of places in Europe, appear to have a considerable future on account of the very decided saving in the initial investment. As an illustration it may be mentioned that Mr. H. Jackson, in presenting a paper before the Birmingham branch of the Institute of Civil Engineers, showed that routes of trolley systems 27 miles long, in the suburbs of Birmingham, could be established complete for a service of fifteen minutes intervals for about $375,000, while the same system along the conventional electric trolley line construction would cost about $1,650,000.

It appears from a recent Blue Book published by the British government, that the United States is practically the only country of any consequence in which there is no law for the compulsory working of patents. All other industrial countries have enacted laws—some long ago—which require the patentee to manufacture the patented article within a certain number of years, or to license somebody else to manufacture it. If the patented article is not manufactured to what is termed "an adequate extent" within the specified number of years, the patent becomes invalid. Great Britain makes this time four years, but most other nations do not permit so long a period before the patent must be actually exploited.

It is stated in the *Brass World* by Roy C. Davidson of Fort Blackmore, Va., that copper may be welded in the following manner: The pieces to be welded are placed in a fire and heated to a black heat, after which they are coated with borax. The two pieces are then removed and hammered. They are again returned to the fire and this process is repeated twice, after which the joint is covered with ferrous sulphate. The pieces are now placed in the fire again and heated as hot as the copper will stand without melting, and the joint hammered together. It will be found, it is stated, that a sound and homogeneous joint will then result.

According to *Engineering*, copper deposits of great importance have been found in the Katanga district in Congo, between the Zambesi and Congo rivers. It has been estimated that the Katanga district has copper deposits of sufficient extent to fill the world's demand for copper for the next hundred years. Besides the copper deposits, gold, platinum, silver and zinc are abundantly found in this district. While the enormous mineral wealth of this province has been a matter of knowledge in financial circles for some time, comparatively little has as yet been done with relation to mining enterprises, on account of the great transportation difficulties presented.

The import of machine tools to Great Britain is steadily increasing, and some concern is felt by the British mechanical journals on this account. It is stated that the import of machine tools in 1911 was three times that in 1910, and over two and one-half times that in 1909. On the other hand the export of machine tools from Great Britain in 1911 was less in tonnage, although greater in value, than in 1910, and considerably less than the export in 1909. The Machine Tool Association formed during the past year has now a membership of eighty firms and it is expected that the activities of this organization will make it possible to place the British machine tool building business on a more satisfactory basis.

Dr. J. W. Richards, in a recent lecture before the Engineers' Society of Western Pennsylvania, gave a review of the progress made in Sweden during the past year in the production of iron and steel by electrical processes. Dr. Richards has visited Sweden every summer for several years, and is well informed on the research and experimental work done by the Swedish Iron and Steel Institute (Jernkontoret), at Trollhättan. He asserted that there was no longer any doubt but that, under the latest Swedish practice, pig iron smelted from ore in the electric furnace will shortly displace the old charcoal iron that has made the Swedish iron industry famous. In fact, some steel makers maintain that the electrically smelted iron is superior to the charcoal iron.

To find the melting points of metals which fuse only at the very highest temperatures has been found to be extremely difficult, and until recently experiments have given widely varying results. By means of electric vacuum furnaces, however, some experiments giving accurate results have been undertaken in Germany by Otto Goecke, who places the melting points of the following metals as below:

Gold	1960 degrees F.
Manganese	2277 degrees F.
Chromium	2757 degrees F.
Platinum	3182 degrees F.
Iridium	4035 degrees F.
Vanadium Carbide (Va_4C_3)	4982 degrees F.

It is stated in the *Mechanical World* that the crankshaft for a 50-horsepower engine for a certain British type of aeroplane weighs only eighteen pounds. It consists of a tubular shell made of chrome-vanadium steel, the shell being ⅛-inch in thickness. It is stated that in the tests it has proved to have a margin of safety of 38 per cent over that necessary for the 50-horsepower engine. It would seem that the aviator runs a decided risk in employing an engine where the factor of safety of one of the most vital parts is as small as this. The frightful toll paid by the lives of aviators, it seems, could be diminished to a considerable extent if such perils were avoided as are introduced by employing machinery which is worked so near the danger limit.

A mechanic, in the *Mechanical World*, calls attention to the fact that there seems to be no standard for the squares or flats on taps and reamers. He states that many firms reduce the shanks too much, and in this way not only weaken the tap or reamer, but also produce a square which is not of a standard size. Some firms make the squares with sharp corners, while others merely mill four flats, so that the end of the tap looks more like an octagon than anything else. Standardization of this detail, though of comparative unimportance, is no doubt well worth while. If taps and reamers were made with squares of standard sizes, they would be more durable, the wrenches would last longer and their number would be reduced considerably.

The first locomotive in America, built for the Camden & Amboy Railroad in 1831, is still intact in the National Museum at Washington. It is interesting to make a comparison between this engine and the locomotive recently adopted by the Pennsylvania Railroad for its heavy passenger service. The weight of the old locomotive mentioned—called "John Bull"—is 24,625 pounds, while the Pennsylvania engine with tender weighs 430,000 pounds. The two driving wheels of "John Bull" are 54 inches in diameter, while the six driving wheels of the modern engine are 80 inches in diameter. The tubes of the "John Bull" are 7½ feet long and the tube heating-surface, 213 square feet. In the modern engine, the tubes are nearly 21 feet long, and the heating surface is 4420 square feet.

THE DESIGN OF CONICAL HELICAL SPRINGS*†

By E. R. MORRISON‡

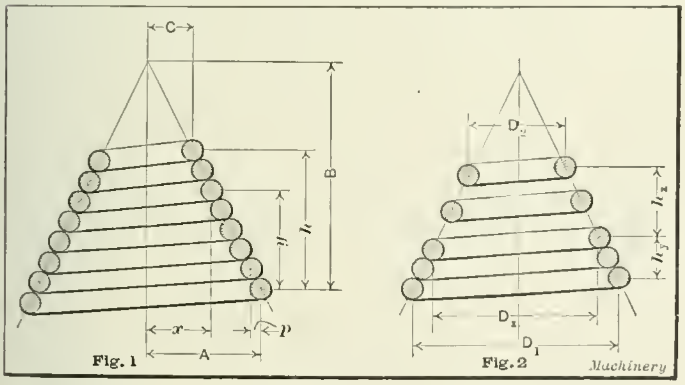
On account of their physical characteristics, conical helical springs divide themselves into two distinct classes, according to their use. The formulas applicable to a spring of this type used as a compression spring are not at all applicable if the spring is to be used as an extension spring. This is more obvious if we note that the safe load which an extension spring will carry is governed by the capacity of the largest or weakest coil, which condition is reversed in the compression state, where the spring retains its flexibility until the load becomes great enough to close up the smallest or strongest coil. It is the object of this article to develop the formulas applicable to the various types of conical helical springs. Round bar coils only will be considered.

Notation—Dimensions in Inches, Weights in Pounds

S = stress,
G = modulus of torsional elasticity,
f = deflection,
f_x = deflection under load P_x
H = free height,
h = solid height, assumed to equal $d \times N$,
y = solid height at any convenient coil,
P = capacity of spring,
P_x = any load not exceeding P,
P_1 = capacity of largest coil,
P_2 = capacity of smallest coil,
D_1 = mean diameter of largest coil,
D_2 = mean diameter of smallest coil,
d = diameter of bar from which coil is made,
A = mean radius of largest coil,
B = apex height of cone,
C = mean radius of smallest coil,
N = number of coils,
p = average horizontal pitch of coils,
w = weight of one cubic inch of steel,
l = length of bar in spring,
W = weight of spring,
x = mean radius of any convenient coil.

Deflection and Capacity of Extension Spring

It is obvious that P_x in this case must be understood to be not greater than the capacity of the weakest coil, inasmuch as a greater value of P_x would distort the spring beyond the realm of rational formulas. A conical spring is composed of an infinite number of elementary cylindrical coils, each element being in itself a uniform diameter helical spring, and each element differing from its neighbor in the one respect that each successive element has a mean diameter infinitesimally less than its first neighbor, and likewise infinitesimally greater than its neighbor on the other side. These increments of change in the mean diameter result in corresponding increments of change in the deflection of the successive elements, and being all governed by the one general expression for deflection of cylindrical helical springs, may be added together by resorting to calculus. Since the increments of change in the mean diameter are in this case in proportion to the increments of change in the solid height, it follows that the increments of change in the deflection also follow those of the solid height, and that we may expect to arrive at the summation of the deflection through a summation of the increments of change in the varying solid height, which for successive elementary cylindrical coils increases from 0 to its maximum h.



Figs. 1 and 2. Diagrams for the Derivation of Spring Formulas

Now the expression for deflection in cylindrical coil springs is:

$$f = \frac{\pi S}{G} \left(\frac{D}{d} \right)^2 h$$

and for capacity:

$$P = \frac{\pi S d^3}{8 D}$$

The value of D is here, however, the variable, represented by $2x$. Therefore, in each elementary cylinder:

$$\frac{f_x}{f} = \frac{P_x}{P}, \text{ or } f_x = \frac{8 P_x (2x)^3 h}{G d^5} = \frac{64 P_x x^3 h}{G d^5}$$

Further,

$$\delta f_x = \frac{64 P_x}{G d^5} x^3 \delta y$$

$$f_x = \int_0^h \frac{64 P_x}{G d^5} x^3 \delta y = \frac{64 P_x}{G d^5} \int_0^h x^3 \delta y.$$

But, as shown in Fig. 1, $\frac{B}{y} = \frac{A}{A - x}$; whence $x = A - \frac{A y}{B}$

$$\text{Hence } x^3 = A^3 \left(1 - \frac{3 y}{B} + \frac{3y^2}{B^2} - \frac{y^3}{B^3} \right)$$

Hence,

$$f_x = \frac{64 P_x A^3}{G d^5} \int_0^h \left(1 - \frac{3 y}{B} + \frac{3 y^2}{B^2} - \frac{y^3}{B^3} \right) \delta y$$

$$f_x = \frac{64 P_x A^3}{G d^5} \left(h - \frac{3 h^2}{2 B} + \frac{h^3}{B^2} - \frac{h^4}{4 B^3} \right)$$

Also, from Fig. 1, we have: $B = \frac{A h}{A - C}$, whence:

$$f_x = \frac{64 P_x A^3}{G d^5} \left(h - \frac{3 h^2 (A - C)}{2 A h} + \frac{h^3 (A - C)^2}{A^2 h^2} - \frac{h^4 (A - C)^3}{4 A^3 h^3} \right)$$

But $A = \frac{D_1}{2}$ and $C = \frac{D_2}{2}$. Hence,

$$f_x = \frac{8 P_x D_1^3 h}{G d^5} \left(1 - \frac{3 (D_1 - D_2)}{2 D_1} + \frac{(D_1 - D_2)^2}{D_1^2} - \frac{(D_1 - D_2)^3}{4 D_1^3} \right)$$

$$= \frac{8 P_x D_1^3 h}{G d^5} \left(\frac{D_1^3 + D_1^2 D_2 + D_1 D_2^2 + D_2^3}{4 D_1^3} \right)$$

$$= \frac{2 P_x h}{G d^5} (D_1^3 + D_1^2 D_2 + D_1 D_2^2 + D_2^3) = \frac{2 P_x h (D_1^4 - D_2^4)}{G d^5 (D_1 - D_2)}$$

$$= \frac{P_x (D_1^4 - D_2^4)}{G d^4 \frac{(D_1 - D_2) d}{2 h}}$$

Observe now that the expression in the denominator is the average horizontal pitch p (see Fig. 1) of the coils:

$$p = \frac{\frac{D_1 - D_2}{2}}{N}; \text{ but } N = \frac{h}{d}; \text{ hence, } p = \frac{(D_1 - D_2) d}{2 h}$$

Therefore,

$$f_x = \frac{P_x (D_1^4 - D_2^4)}{G p d^4}$$

This then is the formula for the deflection of any extension type conical helical spring under load P_x, the value P_x not exceeding the capacity of the weakest coil, equivalent to the

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[*] With Data Sheet Supplement.

[†] See MACHINERY, March, 1911, "The Design of Grouped Helical Springs," and other articles there referred to; January, 1910, "The Design of Automobile Springs," and other articles there referred to; and also MACHINERY'S Reference Book No. 58: "Helical and Elliptic Springs."

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capacity of a cylindrical helical spring of a mean diameter equal to D_1 and bar diameter equal to d.

If the value of P_x equals the capacity P of this spring, we have:

$$P = P_x = \frac{\pi S d^3}{8 D_1}$$

Substituting this value of P_x, we have the total deflection:

$$f = \frac{\pi S (D_1^4 - D_2^4)}{8 G p d D_1}$$

which is the final formula for the total deflection of the extension conical helical spring.

It will be noticed that the previous discussion is based on the assumption that the solid height of the spring is equal to the diameter of the bar times the number of coils in the conical spring. However, as one coil seats within the other, the solid height is really less than that assumed; the solid height becomes less as the taper of the coil becomes greater, until for a true spiral spring the solid height is reduced to the diameter of the bar. The actual deflection is dependent on the "slant height" of the conical coil which is equal to $d \times N$, as assumed for the solid height, rather than upon the actual vertical height. Due to this assumption, the changing of the angle of the cone formed by the spring does not change the actual deflection so long as the value of the slant height itself is not changed. Inasmuch as the above discussion is based on the slant height, the actual solid height of the spring and also the free height of the spring should be corrected by deducting from the value of these heights the difference between the slant height and the solid height. Stated briefly, the assumption that the solid height is equal to $d \times N$ is necessary in order to obtain the correct value of the deflection; but after this deflection has been obtained, correction should be made for this assumption.

Deflection and Capacity of Compression Spring

The deflection of a compression spring of this type is a fundamental problem of the same type. In this case, however, the summation is not the summation of increments of deflection under a uniform load and varying stresses, but the summation of increments of deflection when each elementary spring is stressed to a maximum, and hence under uniform stress.

In this case $f = \frac{\pi S}{G}\left(\frac{D}{d}\right)^2 h$, becomes $f = \frac{\pi S}{G}\left(\frac{2x}{d}\right) h$

$$\delta f = \frac{\pi S}{G}\left(\frac{2x}{d}\right)^2 \delta y \text{ and } f = \int_0^h \frac{\pi S}{G}\left(\frac{2x}{d}\right)^2 \delta y$$

But $x = A - \frac{A y}{B}$. Hence:

$$f = \frac{4 \pi S A^2}{G d^2}\int_0^h \left(1 - \frac{2y}{B} + \frac{y^2}{B^2}\right) \delta y$$

$$= \frac{4 \pi S A^2}{G d^2}\left(h - \frac{h^2}{B} + \frac{h^3}{3 B^2}\right)$$

But $B = \frac{A h}{A - C}$, and $A = \frac{D_1}{2}$, and $C = \frac{D_2}{2}$. Hence the expression above can be transformed to:

$$f = \frac{\pi S h}{3 G d^2}(D_1^2 + D_1 D_2 + D_2^2)$$

$$f = \frac{\pi S h (D_1^3 - D_2^3)}{3 G d^2 (D_1 - D_2)}, \text{ and since } p = \frac{(D_1 - D_2) d}{2 h}$$

$$f = \frac{\pi S (D_1^3 - D_2^3)}{6 G p d}$$

which expresses the total compression for a conical helical compression spring.

The capacity, solid, equals that of the smallest coil, or:

$$P = \frac{\pi S d^3}{8 D_2}$$

Deflection of Compression Spring for Given Loads

If the given load is less than P_1, the entire spring remains flexible, and the formula for deflection is the same as that derived for an extension spring, the condition of varying stress still being present.

If, however, the load exceeds P_1, then a portion of the spring will become solid. The division point may be found, for $P_x = \frac{\pi S d^3}{8 D_x}$, and since the load in cylindrical coils varies inversely as D:

$$\frac{D_x}{D_2} = \frac{P_2}{P_x}, \text{ whence } D_x = \frac{D_2 P_2}{P_x}$$

The deflection of the two portions of the spring should now be considered separately and added, using the two final formulas just developed.

Fig. 2 shows a graphical illustration of the divided spring. Let p_x be the average horizontal pitch of the unclosed portion, above D_x. Let p_y be the average horizontal pitch of the solid portion, below D_x.

The total deflection is then:

$$f = \frac{\pi S (D_1^3 - D_x^3)}{6 G d p_y} + \frac{\pi S (D_x^4 - D_2^4)}{8 G d D_x p_x}$$

In Fig. 2, h_y is the height, solid, of the solid portion of the spring. Its value is derived thus:

$$\frac{h_y}{h} = \frac{D_1 - D_x}{D_1 - D_2}, \text{ whence } h_y = h\,\frac{D_1 - D_x}{D_1 - D_2}$$

Bar Length for Conical Spring

Fundamentally, $l = \pi\left(\frac{D}{d}\right) h$, so that we have in a conical spring

$$l = \delta \pi \left(\frac{2x}{d}\right) \delta y, \text{ or}$$

$$l = \frac{2\pi}{d}\int_0^h x\,\delta y = \frac{2 A \pi}{d}\int_0^h \left(1 - \frac{y}{B}\right) \delta y = \frac{2 A \pi}{d}\left(h - \frac{h^2}{2 B}\right)$$

And since $B = \frac{A h}{A - C}$, and $A = \frac{D_1}{2}$, and $C = \frac{D_2}{2}$, we get:

$$l = \frac{\pi h}{d}\left(\frac{D_1 + D_2}{2}\right)$$

Weight of Conical Spring

Fundamentally, $W = \frac{l \pi d^2 w}{4}$. Hence

$$W = \frac{\pi^2 d h w}{8}(D_1 + D_2)$$

Summary of Formulas

Summarizing and substituting for S a value of 80,000 pounds per square inch, and for G a value of 12,600,000 we have:

Extension Conical Spring Formulas

$$f = 0.002493\,\frac{D_1^4 - D_2^4}{p d D_1}$$

$$P = 31{,}416\,\frac{d^3}{D_1}$$

Compression Conical Spring Formulas

$$f = 0.003324\,\frac{D_1^3 - D_2^3}{p d}$$

$$P = 31{,}416\,\frac{d^3}{D_2}$$

Weight in each case, $W = 0.35\, dh\, (D_1 + D_2)$.

Bar length in each case, $l = 1.571\,\frac{h}{d}(D_1 + D_2)$

Numerical Examples

Example: Compression spring, $D_1 = 4\,9/16$ inches; $D_2 = 3\,9/16$ inches; $d = 1\,1/16$ inch; $h = 7\,1/16$ inches.

Then $N = \frac{h}{d} = 6.65$; $\frac{D_1 - D_2}{2} = 0.5$; $p = \frac{D_1 - D_2}{2\,N} = 0.075.$

$$f = 0.003324\,\frac{(4\tfrac{9}{16})^3 - (3\tfrac{9}{16})^3}{0.075 \times 1\tfrac{1}{16}} = 2\tfrac{1}{16} \text{ approximately.}$$

See the accompanying Data Sheet Supplement for table of cubes, and also for other powers of numbers required in conical spring calculations.

$$H = 7\ 1/16 + 2\ 1/16 = 9\ 1/8 \text{ inches.}$$

Example: Same spring in extension.

$$f = 0.002493\,\frac{(4\tfrac{9}{16})^4 - (3\tfrac{9}{16})^4}{0.075 \times 1\tfrac{1}{16} \times 4\tfrac{9}{16}} = 1\tfrac{7}{8} \text{ approximately.}$$

$$H \text{ (extended height)} = 7\tfrac{1}{16} + 1\tfrac{7}{8} = 8\tfrac{15}{16} \text{ inches.}$$

As might have been expected, the free height for the compression type is greater than the possible extended length for the extension type. This is because sufficient load to fully stress the smaller or stronger coils cannot be applied without distorting the extension spring, whereas the coils may all be stressed to maximum stress in the compression type, the closing of the coils solidly together protecting the spring from over-stress.

Reversion to Cylindrical Helical Springs

It will be noted that in each of our final formulas we have introduced the factor $(D_1 - D_2)$ and the value of $p = \left(\frac{D_1 - D_2}{2\,h}\right) d.$ This has been done to leave the formulas in as simple a form as possible. Note, however, that if D_1 and D_2 each be taken as equal to D or to each other, the formulas in each case revert to the fundamental cylindrical helical spring formulas, as should be expected.

Substituting $D_1 = D_2 = D$ in the extension formula

$$f_x = \frac{2\,P_x\,h}{G\,d^5}\,(D_1^3 + D_1^2\,D_2 + D_1\,D_2^2 + D_2^3), \text{ we have}$$

$$f_x = \frac{8\,P_x\,D^3\,h}{G\,d^5}$$

This is the fundamental formula for the deflection of an extension helical cylindrical spring under any load P_x, derived directly from the formula for load:

$$P = \frac{\pi\,S\,d^3}{8\,D}$$

in which S has been replaced by its value in the formula

$$f = \frac{\pi\,S}{G}\left(\frac{D}{d}\right)^2 h \text{ giving } P = \frac{G\,f\,d^5}{8\,h\,D^3}$$

from which $f = \frac{8\,P\,D^3}{G\,d^5}\,h$

Substitute, again, $D_1 = D_2 = D$ in the compression formula:

$$f = \frac{\pi\,S\,h}{3\,G\,d^2}\,(D_1^2 + D_1\,D_2 + D_2^2), \text{ and we have}$$

$$f = \frac{\pi\,S}{G}\left(\frac{D}{d}\right)^2 h$$

the fundamental formula for the deflection of a compression helical cylindrical spring.

The reason for this comparison between the formulas for cylindrical helical springs and conical springs, is particularly, to bring out the fact that, while each of the conical formulas are thus shown to revert to the same form when $D_1 = D_2$, yet the conical spring formulas themselves, for extension and compression springs, are different. As already mentioned, one is an expression for deflection under a given load, regardless of stress, while the other is the expression for deflection under a uniform maximum stress. The former condition is that of the conical extension spring, while the latter is that of the compression type.

Auxiliary Formulas

The expressions for deflection and capacity are the main formulas for all helical springs; from these are developed such other formulas as may be desired. In this particular case, care must be taken in making such further developments, if using the expressions $D_1^4 - D_2^4$ and $D_1^3 - D_2^3$, to note that resulting formulas will not revert to simple cylindrical helical formulas, because of the fact that a zero quantity has been introduced when D_1 becomes equal to D_2.

Therefore, further formulas are based on the longer but primary formulas which we have arrived at before the introduction of the quantity $D_1 - D_2$.

The Ratio between Free and Solid Heights

Since $H = f + h$, we have, for compression springs:

$$H = \frac{\pi\,S\,h}{3\,G\,d^2}\,(D_1^2 + D_1\,D_2 + D_2^2) + h$$

$$= h\left[1 + \frac{\pi\,S}{G}\left(\frac{D_1^2 + D_1\,D_2 + D_2^2}{3\,d^2}\right)\right]$$

$$= h\left[1 + \frac{\pi\,S}{G}\left(\frac{D_1^3 - D_2^3}{3\,d^2\,(D_1 - D_2)}\right)\right]$$

In a similar way, for extension springs:

$$H = h\left[1 + \frac{2\,P_x}{G}\left(\frac{D_1^3 + D_1^2\,D_2 + D_1\,D_2^2 + D_2^3}{d^5}\right)\right]$$

$$= h\left[1 + \frac{2\,P_x}{G}\left(\frac{D_1^4 - D_2^4}{d^5\,(D_1 - D_2)}\right)\right]$$

By introducing the factor $(D_1 - D_2)$ the formulas are thus simplified as before, so that they may be readily solved with a table of cubes and fourth powers.

Deflection when only Free Height is Given

Considering first the compression type, we substitute the value of h as found from the formulas in the last paragraph, in the general formula for f. Hence:

$$f = \frac{H}{1 + \frac{G}{\pi\,S}\left(\frac{3\,d^3}{D_1^2 + D_1\,D_2 + D_2^2}\right)} = \frac{H}{1 + \frac{G}{\pi\,S}\left(\frac{3\,d^2\,(D_1 - D_2)}{D_1^3 - D_2^3}\right)}$$

In a similar way, for extension coils:

$$f = \frac{H}{1 + \frac{G}{2\,P_x}\left(\frac{d^5}{D_1^3 + D_1^2\,D_2 + D_1\,D_2^2 + D_2^3}\right)}$$

$$= \frac{H}{1 + \frac{G}{2\,P_x}\left(\frac{d^5\,(D_1 - D_2)}{D_1^4 - D_2^4}\right)}$$

General Considerations

In the compression type it is sometimes desirable to fix the heights, both free and solid, and afterwards ascertain the resulting capacity. If the heights so fixed exceed the allowable deflection by the compression formula, the spring will not return to its original free height. In other words, it will have taken a set. If the difference in heights is less than that of the compression formula, it cannot be assumed that there will be a uniform stress throughout the spring when solid, as there would have been, had the spring been built to the highest free height possible, and the capacity will not then be in proportion to the deflection. If the deflection, for instance, is one-half of the formula deflection, the capacity will not necessarily be one-half that of the strongest coil, instead of equal to that of the strongest coil. This type then appears indeterminable for capacity, the difficulty being to so pitch the coils as to assure uniform stress when the spring is solid. This difficulty does not present itself in cylindrical coils as we have a uniform stress at solid height.

Uniform stress at solid height in a conical spring requires a pitch of coils in proportion to the deflection of same at maximum stress, or, which is the same thing, in proportion to the diameters of the various elements. As the diametrical increase per unit of bar length is not a straight line formula, the pitch of coils necessary to gain uniform stress when solid would have to follow the law of a definite curve. While it may be possible to develop a machine which will so pitch these elementary coils, yet the demand does not seem to have developed such a machine.

Where the deflection is made originally greater than the maximum stress will allow, the first compressions of the hardened spring will reduce the deflection to the maximum which the steel will stand. Thus, in such a case there is an assurance of uniform stress.

The laws governing the action of grouped cylindrical helical springs apply likewise to grouped conical springs. Briefly, the design should maintain the same free and solid heights throughout, which means that for all coils in the group the $\frac{D_1}{d}$ ratio should be the same, and the $\frac{D_2}{d}$ ratio should likewise be the same for all coils.

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THE CUTLER-HAMMER MFG. CO.'S STUDENT COURSE

The Cutler-Hammer Mfg. Co., Milwaukee, Wis., has a course for training engineering graduates which differs in some essentials from those offered by other companies. The course embraces from three to six months of shop work in the various departments, from two to six months of testing room work, with additional time not specifically determined by any hard or fast rules, in the engineering department in designing work. In all cases the student is given an opportunity to use his own initiative. An attractive feature, from the student's point of view, of this course is that he is paid a salary which enables him to support himself, and to thus raise his self-respect. He is paid $60 a month for the first six months; $75 a month for the second six months; and $90 a month at the end of the first year. Progress beyond that figure depends solely on each man's ability and energy.

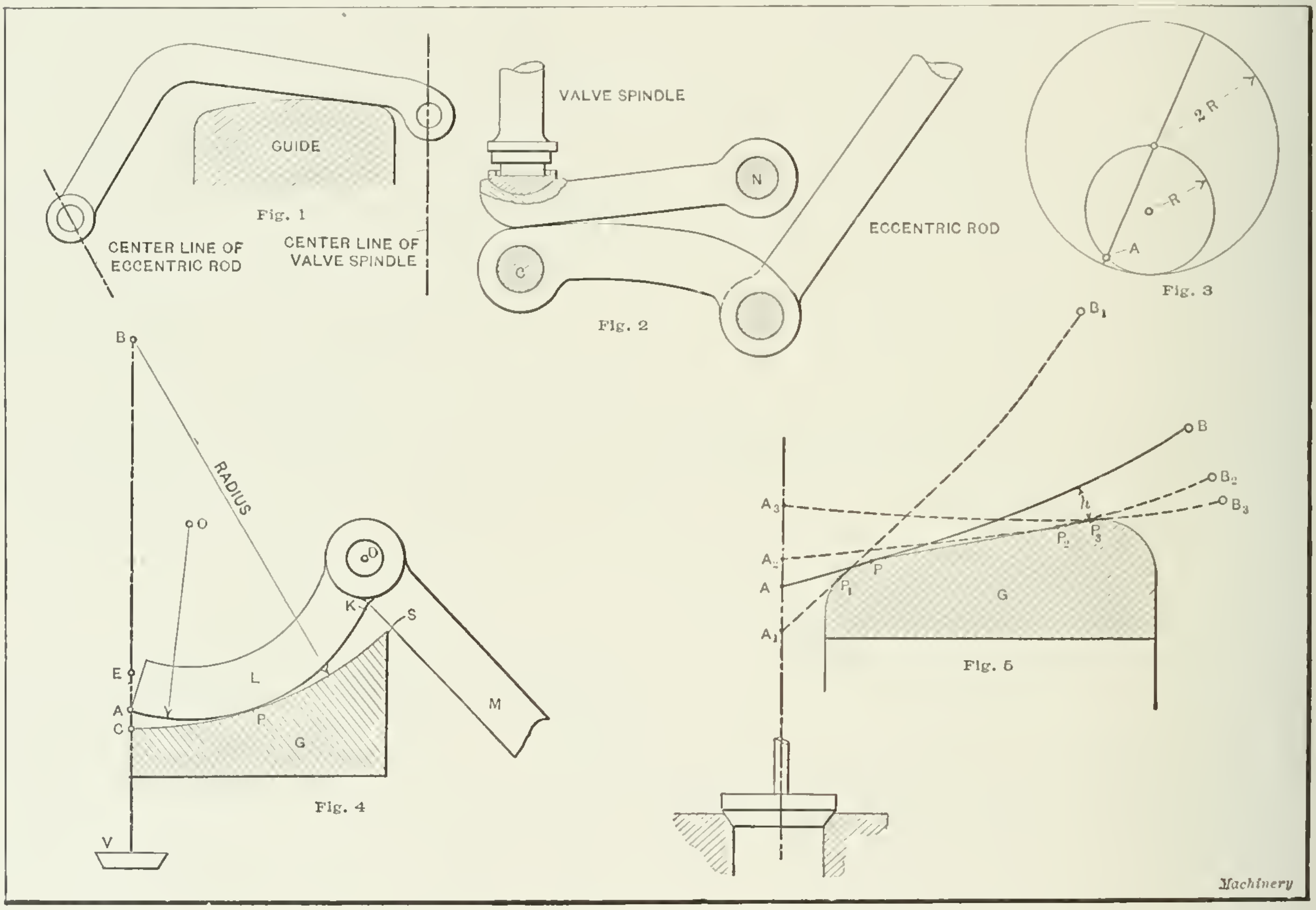
The company expects to meet with a loss in the training of these students during the first year, but it is expected that during the second and third years there will be an opportunity for returns on the investment, it being hoped that the students will remain for that length of time, observing the implied obligation. It is interesting to note that the company considers a pleasant personality a qualification for entering this student course. A disagreeable personality, it is stated, diverts the attention of the fellow workers from business, and hence involves a distinct loss.

ROLLING LEVERS

By H. L. NACHMAN[*]

Rolling levers are commonly employed to actuate the valves of large gas engines as well as the poppet-type valves of steam engines, which are extensively used in Europe. These levers may be divided into two classes—the single-lever type shown in Fig. 1, and the double-lever type shown in Fig. 2. In the first case the lever rolls on a fixed guide, and has thus a continuously moving fulcrum, which travels from one end of the guide to the other. In the second case the levers are fulcrumed at fixed points, as at *C* and *N*, Fig. 2, and roll upon each other.

The levers should have a pure rolling motion in order to insure a minimum of wear. The valves should be opened quickly and should close with a constantly decreasing velocity, so as to seat quietly and without shock. It is not practicable to construct a mechanism that would fulfill these requirements with theoretical exactitude, but it may be of some interest to show how a simple pair of rolling levers that will approximately satisfy the requirements, may be designed. If a circle of radius *R* rolls inside of another circle, the radius of which is 2 *R*, as shown in Fig. 3, any point *A* in the small circle will travel along a straight line passing through the center of the large circle, as shown. In Fig. 4 the method of applying this principle to a valve motion is indicated. Here *G* is the fixed guide with a cylindrical surface of radius *BC*. The rolling lever *L* is actuated by a rod *M*. As the point of contact, *P*, travels from *C* to *S*, the point *A* will move from *C* to *E* along line *CB*. The valve stem is assumed to be attached at point *A*.



Figs. 1 to 5. The Principles of Rolling Levers

The example shown is a case of pure rolling motion. The point *P* is the instantaneous fulcrum of the rolling lever; therefore, the velocity of any point is proportional to its distance from this fulcrum. At the beginning of the motion the contact point is at *C*; hence the velocity of *A* is then zero. At the end of the motion the fulcrum is at *S*, and the velocity of *A* is to that of point *D* as *AK* is to *DK*. If *M* is actuated by an eccentric, as is usually the case, the valve will start to move slowly, its velocity being gradually increased to a maximum value, and will then again become zero at the end of the upward motion. The same action in reverse order takes place on the downward stroke. The constructional difficulties of this mechanism, however, are such that it is not used in practice, and it must be modified to some extent. In its modified state, while there is not a pure rolling action, excellent results are nevertheless, obtained.

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In both the single and double lever type it is usual to make one of the two elements straight, and find the proper curve of the other element, to give the desired motion to the valve. In the single-lever type it is necessary to continue the guide to the center line of the valve spindle in order to start the valve at a velocity of zero. This would require the guide to be forked, which, however, is not generally done, and, therefore, the lever will strike the spindle at the moment that the valve opens with a perceptible shock. The velocity at the end of the stroke, however, may be kept quite low by a suitable form of lever.

In Fig. 5 let P be the point of contact of the lever and guide at the moment when the valve starts to open. The velocity ratio of the lifting point A to the driving point B (assuming pure rolling motion) is as AP to BP. It is evident that this ratio increases rapidly as the contact point travels toward the right. The rate at which the velocity increases depends on the radius of curvature of the lever, and therefore on the distance h between the guide and the lever. The larger this distance is, the more slowly will the valve open. It is customary to make h from 1/16 to 3/8 inch. Near B the radius of curvature should increase, thus reducing the velocity of the valve as it comes near to its top position. This decreases the stresses in the mechanism due to inertia. For pure rolling action, point A and contact point P should always be in one straight line perpendicular to the path of point A. The distance of point P from this perpendicular is a measure of the amount of sliding. To eliminate side pressure on the valve spindle, the center line of the eccentric rod and of the valve spindle, and the common normal to the curves at the contact point must all meet in a common point.

The two rolling levers in Fig. 2 are used for operating the exhaust valve of a large gas engine. The condition of pure rolling is that the point of contact must always lie on a line joining the two fixed centers C and N, at which the levers are fulcrumed. Generally one of the levers is simply made straight, while the other is made of such curvature as to give the desired motion to the valve.

* * *

SOME DISADVANTAGES OF SPECIALIZATION

In an address on "Comparison between Industrial Conditions in the United States and Europe," read by Mr. A. L. Valentine of Hartford, Conn., before the American Society of Swedish Engineers, the disadvantages that sometimes are incident to a too highly developed system of specialization, were referred to. With relation to the training and experience of the men in charge of shops and departments, Mr. Valentine said:

"The superintendents and foremen in America are usually experts in their respective lines, which is evidently an advantage, although at times this special knowledge and skill is gained only at the expense of a more general understanding of shop work and mechanical matters. If special skill is gained in such manner, it may prove a disadvantage. No matter how efficient a man may be in doing a certain line of operations, it is evident that his usefulness would be increased if his knowledge were not confined entirely to the kind of work he is doing. In this particular respect it may not be out of the way to mention that in Europe the apprenticeship system is very much more developed than here, and that a man can hardly ever expect to hold as responsible a position as that of shop foreman, for example, who has not served an apprenticeship, and thus gained a general knowledge of mechanical matters. In this country, on the other hand, it is not unusual that a man who has operated but one kind of machine or machines will eventually take charge of a department of such machines. However great an importance there may be attached to special training, the general training will always be of supreme value."

* * *

Haste may make waste in tool grinding as well as in tool using.

ACTUAL AND CONSTRUCTIVE PATENT INFRINGEMENT—2

By E. D. SEWALL*

The deductions made in the previous installment of this article are not, it appears to the writer, wholly in accord with a number of recent decisions of the circuit courts and circuit courts of appeal, about to be referred to. The original doctrine of contributory infringement which has already been briefly set forth, in a narrow sense imposes restrictions on the public beyond the terms of the patent claims, although in a broader sense it does not, but deems the contributor to join with another in infringing the complete combination claimed. The cases about to be referred to, however, hold as contributory infringers persons who have not conspired with another to make or use, without authority, the patented thing.

A Dangerous View of Contributory Infringement

The first of these cases, decided in 1896, is the celebrated Heaton-Peninsular Button Fastener Company *vs.* Eureka Specialty Company, 77 F. R., 288, reversing the circuit court. Complainant was the owner of a patent for a machine for fastening buttons by stapling them to a shoe. It sold machines, made in accordance with the patent, having attached thereto a plate on which were delineated the following words: "This machine is sold and purchased to use only with fasteners made by the Peninsular Novelty Co., to whom the title to said machine immediately reverts upon the violation of this contract of sale." The fasteners were ordinary unpatented and unpatentable staples, adapted to be fed from a magazine on the machine. They had to be of a size to fit the magazine and were not claimed as a part of the combination patented. Defendant sold such staples to one of the purchasers of a patented machine. No demand for the return of the machine was made thereafter. The court was satisfied that defendant had knowledge of the contract of sale and held him as a contributory infringer, on the theory that although the machine had been sold to the purchaser the use had been restricted, and defendant had conspired with the purchaser to violate the use, the right to impose restrictions upon the use being a portion of the patentee's monopoly.

Another similar case is Cortelyou *vs.* Johnson, 145 F. R., 932, reversing the circuit court. In this case the patentee of a copying machine known as the "rotary neostyle" sold the machines under a restriction requiring the paraffined paper and the ink used with the machine, both unpatented, and forming no part of the machine claimed, to be purchased from the makers of the patented machine. Defendant was proven to have sold ink to a purchaser of the machine. The circuit court held him as an infringer of the patent, but the circuit court of appeals reversed the court below on the ground that it was not affirmatively shown that defendant had knowledge of the conditions, and the U. S. Supreme Court affirmed the court of appeals.

The Court's Statement of the Conditions

The circuit court of appeals in this case stated its intention to follow the Heaton Peninsular case when the facts were the same, even though "as an original question" they might have ruled differently. The court then points out the embarrassments likely to follow the application of this decision:

"When confined to articles, whether patented or not, which are made for the express purpose of inducing infringement and are not intended for any legitimate use, the doctrine of contributory infringement is logical, just and salutory. But we doubt the wisdom of extending it to the ordinary commodities of life, used in connection with a patented machine, because the patentee sells or licenses the machine upon the condition that he alone is to furnish those commodities. Care should be taken that the courts in their efforts to protect rights of patentees do not invade the just rights of others engaged in legitimate occupations, by creating new monopolies not covered by patents and by placing unwarrantable restrictions upon trade. We think it is clear that the doctrine may be carried far enough to produce such results. For instance, should the patentee of a fountain pen, by such a notice as we have under consideration, be permitted to hold as an infringer one who sells ink to the owner of the pen even though he knows the restrictions? To compel the dealer to make inquiries and take the precautions necessary to save himself from being sued as an infringer would place intolerable burdens upon business. . . . If the doctrine be driven to its ultimate conclusion, the merchant and the consumer may find themselves enmeshed in a network of monopolies embracing all the necessaries of life. No one may safely sell coffee to the consumer but the patentee of his coffee mill, no one can furnish him flour but the patentee of his baking pans, and he may yet be compelled to buy milk from the patentee of his milk can and soap from the patentee of his bath tub."

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The Indefinite Meaning of the Law

This is a very forceful statement of the evils of the doctrine; but it alleges no definite legal ground whereby these evils may be checked, and leaves the question to be decided on a consideration of the mere degree of the restraint imposed, or the particular things with respect to which the restraint applies. If the restraint applies to the sale of soap and flour perhaps it may not be sustained; but if it applies to ink or wire perhaps it may be sustained.

In Dick *vs.* Milwaukee Specialty Co., 168 F. R., 930, defendant was held guilty of infringement for selling, with knowledge of a restriction, unpatented ink to be used with a patented copying machine known as a mimeograph. In Crown Cork & Seal Co. *vs.* Standard Brewery, and same *vs.* Greenberger, 174 F. R., 252, the Brewery Co. was held to be an infringer of a patented machine purchased by it under a restriction that only crown seals (not patented) made and sold by the patentee of the machine should be used with it, because it used seals made and sold by another. Here the court said defendant was liable "*even though he buys and pays for the machine and is vested with the legal title thereto*, and its use by him in violation of such restriction is an infringement of the patent." Greenberger, who furnished the crowns, was held guilty of contributory infringement. In Commercial Acetylene Co. *vs.* Autolux Co., already referred to, the defendant company was held for contributory infringement not only because it aided in reconstructing the patented package, but on the further ground that it had aided in violating a license agreement set forth on a plate secured to the receptacle.

These last cited cases, it will be seen, hold that under the patent laws, although one has bought a machine and paid the full price for it and obtained the legal title to it, he may not use it except in accordance with the wishes of the patentee, if any be expressed, and that the patentee may restrain trade in unpatented supplies used with a patented machine. There are many other cases to the same effect, all based on the decision rendered in 1896 in the case of Heaton-Peninsular Co. *vs.* Eureka Supply Co.

In view of the doctrine of the Heaton-Peninsular case, it has also been held that where a patented machine has been leased on condition that unpatented supplies therefor be purchased from the patentees, it is contributory infringement for a third party to furnish such supplies to the licensee with knowledge of the conditions of use. In Tubular Rivet Co. *vs.* O'Brien (93 F. R., 200), defendant was held liable under the patent laws for supplying to a licensee of a patented machine tubular rivets of a well-known kind in common use, because the license agreement required the licensee to purchase such rivets only from the licensor. Similarly, in Rupp, *et al.*, *vs.* Elliott, (131 F. R., 730), one who supplied ordinary wire to be used by a licensee in a patented machine was held to be an infringer.

The Right to Fix Resale Prices on Patented Articles

Another form of ultra-claim infringement, by judicial interpretation, consists in the resale, by a purchaser, of a patented device at a price less than that fixed by the patentee as the resale or retail price. This interpretation of the law is also ostensibly based upon the opinion in the Heaton-Peninsular case. In Victor Talking Machine Co. *vs.* The Fair (123 F. R., 424), one of the leading cases on this point, patented talking machines were sold to a department store subject to a condition appearing on a plate fixed on each machine that they should not be resold at a price less than $25. The department store offered them for sale at $18 each, and on appeal to the circuit court of appeals was held to be guilty of infringement of the patent and enjoined from making any further sales at cut prices. In Automatic Pencil Sharpener Co. *vs.* Goldsmith Bros. (190 F. R., 205), the rule was stated as follows: "The owner of a patent may sell the patented article under restrictions as to the price at which it shall be resold, and is entitled to an injunction to restrain a violation of such restrictions, by one having full knowledge of them, as an infringement of the patent."

In the case of Edison *vs.* Smith Mercantile Co. (188 F. R., 925), the facts, as appears from the decision, were substantially as follows: Patented talking machine records were made and sold by the patentee subject to a restriction on the price at which they were to be resold. The stock of Edison records in the store of an authorized dealer became damaged by fire. Some cartons containing the records were smoked, others blackened, and others more seriously injured. The stock was abandoned to an insurance company which took it over. The insurance company sold the stock to a salvage company and the latter sold the records in question in the case to the defendant who sold them at retail at less than the resale price fixed by the complainant, the patentee. Defendant was held to be an infringer of the patent for the record. The court remarked with reference to the language of the resale restriction imprinted on the records and the cartons containing them: "Whether the language in question effectively operates in this way after the article has once reached the ultimate user, and has been used, is a question not presented by this record, and which may not be in all material respects the same question as the present one."

There are other cases on the same point decided in the same way; but in the District of Columbia, in an application by the patentees of a medicine known as "sanatogen," for an order restraining a druggist from selling sanatogen at a cut price as an infringement of the patent, the order was denied by the Supreme Court of the District of Columbia without comment. (Bauer Chemical Co. *vs.* O'Donnell, August 4, 1911.)

Review of the Present Conditions

The class of cases of which Dick *vs.* Milwaukee Specialty Co. is a representative, holds that the patent law may be used to restrain trade in unpatented materials to be used with a patented machine which has been sold by the patentee, and legal title to which has passed from the patentee. This ruling nullifies with respect to patented articles the general rule of common law that the owner of a chattel is entitled to the free and innocent use thereof, and appears to nullify the common law, and the state and federal statutes against contracts in restraint of trade, which are, in the language of Mr. Justice Holmes, "contracts with a stranger to the contractor's business (although in some cases carrying on a similar one) which wholly or partially restrict the freedom of the contractor in carrying on that business as he otherwise would." (Northern Securities Co. *vs.* U. S., 193 U. S., 197.)

The class of cases of which Rupp *et al.*, *vs.* Elliott is a representative, holds that the patent law may be invoked to restrain trade in unpatentable materials to be used with a patented machine which has been leased, and likewise appears to nullify to a like extent the laws against contracts in restraint of trade.

The class of cases of which Victor Talking Machine Co. *vs.* The Fair is an example, holds that the patent law may be used to prevent a purchaser and holder of the legal title to a patented article from selling it at a price lower than that dictated by the patentee, thus nullifying to that extent the general rule of law against restrictions on alienation. "If a man be possessed of a horse or any other chattel, real or personal, and give his whole interest or property therein, upon condition that the donee or vendee shall not alien the same, the same is void, because his whole interest and property is out of him, so as he hath no possibility of reverter, and it is against trade and traffic and bargaining and contracting between man and man." (Hughes, J., quoting from Coke on Littleton in Dr. Miles Medical Co. *vs.* Park & Sons, 220 U. S., 373.)

In the case of Dr. Miles Medical Co. *vs.* Park & Sons, the U. S. Supreme Court held that such a contract with respect to an unpatented proprietary medicine was a contract in restraint of trade, and void so far as it affected interstate commerce. The same court has held that a like contract with respect to the price at which copyrighted books should be resold, is not sustainable as a right conferred by copyright. saying: "To add to the right of exclusive sale the authority to control all future retail sales by a notice that such sales must be made at a fixed sum, would give a right not included in the terms of the statute, and, in our view, extend its operation by construction beyond its meaning." (Bobbs-Merrill Co. *vs.* Strauss, 210 U. S., 339, Day, J.)

In all three classes of cases above, the injury to the patentee was breach of contract, a wrong which the state courts and general law and equity are capable of dealing with, and was not an infraction of a patentee's right to exclude others from making, using or selling the invention, and there was no need therefore to resort to the patent law, and no remedy in the patent law appropriate to the wrong.

What Can be Done to Change the Present Situation?

Ordinary citizens, unlearned in the law, and accustomed to believe that the people, in consenting to the grant of a patent, have consented only to refrain from making, using and selling without permission from the patentee that which is defined in the claims of the patent, evince surprise and resentment when they learn that they may also be restrained by the law from making, using and dealing in ordinary unpatented articles of commerce; from deriving the protection of the general laws against restraint of trade when patented articles are involved; from selling at any price they see fit patented articles that they have bought. They begin to ask themselves whether they are not paying too high a price for the benefits derivable from public encouragement of invention. The people forced the annulment of the registration law of 1793 because of the abuses that grew up under it, and the enactment of the present law in its place in 1836. Since that time industrial conditions have changed. Trusts and corporations established for the purpose of monopolizing trade and manufacture prevail everywhere, and if the patent laws are to be construed to aid restraints of trade beyond those which the people consented to submit to by the grant of patents. the people are likely to demand, finally, their amendment or abolition.

Action in Great Britain

Already the English people have declared their intolerance of any interpretation that shall enable a patentee to monopolize more than the patent grants, urged thereto by practices of American corporations upheld by American courts. The British patent act of 1907 thus declares:

> "Sec. 38. (1). It shall not be lawful in any contract made after the passing of this Act in relation to the sale or lease, or license to work, any article or process protected by a patent, to insert a condition the effect of which will be
>
> (*a*) to prohibit or restrict the purchaser, lessee, or licensee from using any article or class of articles, whether patented or not, or any patented process, supplied or owned by any person other than the seller, lessor, or licensor, or his nominee; or
>
> (*b*) to require the purchaser, lessee, or licensee to acquire from the seller, lessor, or licensor, or his nominees, any article or class of articles not protected by the patent;
>
> and any such condition shall be null and void, as being in restraint of trade and contrary to public policy."

Action in the United States

The people of the United States, by their representatives in Congress, are showing their dissatisfaction with ultra-claim restraints enforced under the cloak of patents, as appears from proceedings in the last session of Congress. On May 8, 1911, a concurrent resolution was submitted in Congress resolving: "That a joint committee of both Houses of Congress is hereby created . . . empowered and directed . . . to ascertain the methods of sale, leasing, disposing and control of patented articles in the United States; to ascertain whether patents are used or misused in the establishment of industrial trusts or monopolies; and to investigate all other matters material or pertinent to the purposes of this resolution, and to report their findings to Congress with recommendations as to any needful legislation to protect the public interest and to promote the general welfare."

Among other bills to amend the patent laws introduced in Congress is Senate Bill 2158, "To protect trade and commerce against unlawful restraints and monopolies," providing (Section 8) "that every person engaged in any business, any portion or all of which constitutes a violation of this Act, shall forfeit by reason of such violation any and all rights which such person may have to protection under or right to damages for infringement upon any patent right held or owned by such persons, whether directly from the United States or under purchase, assignment or otherwise; and the right to the free manufacture and use of any and all articles, devices, or machines so held under right of patent by the person who shall have violated any of the provisions of this Act, shall thenceforth be open to all."

House Bill 2930 provides "that whenever any letters patent issued by the United States, or any article, commodity, compound, device, mechanical appliance, or machine protected by patent . . . is owned, leased, used, or controlled by any individual, firm, association, syndicate, corporation, or combination which is engaged in any vocation, business, or enterprise in violation of any law of Congress or of any state, prohibiting, restraining or regulating trusts, monopolies, or combinations in restraint of trade, the right to any protection under the patent laws of the United States shall cease and terminate."

House Bill 8661 reads as follows: "That no owner, proprietor, or beneficiary of any letters patent of the United States covering any tool, implement, appliance, or machinery shall, directly or indirectly, by any means or device whatsoever, make it a condition or provision, expressed or implied, of any sale or lease of, or license to use, any such tool, implement, appliance, or machinery, that the purchaser, lessee, or licensee thereof shall not buy, lease, or use, whether in connection with the operation or use of such tool, implement, appliance, or machinery, or otherwise, machinery, tools, implements, appliances, material, or merchandise of any person, firm, corporation, or association, other than such vendor, lessor, or licensor; nor shall any such owner, proprietor, or beneficiary of any such letters patent, directly or indirectly, by any means or device whatsoever, revoke any such sale, lease, or license made by any such owner, proprietor, or beneficiary, on account of the purchase, lease, or use oy any such purchaser, lessee, or licensee, of machinery, tools, implements, appliances, material, or merchandise of any person firm, corporation, or association, other than such vendor, lessor, or licensor: Provided, that nothing in this Act shall be construed to prohibit the appointment of agents or sole agents to sell or lease machinery, tools, implements, or appliances.

"Sec. 2. That any such owner, proprietor, or beneficiary of any such letters patent who shall violate the provisions of this Act, and any other person, whether or not an agent of such owner, proprietor, or beneficiary, who shall wilfully assist in, or become a party to, any such violation, shall be punished for each offense by a fine not exceeding five thousand dollars."

Conclusion

Those who attain to power from the exercise of special privileges are very apt to reach for more. Corporations that have become wealthy through the monopoly of patents have grasped for further monopolies of things not protected by patents, and of things which though patented have been sold, returned their profits, and passed without the monopoly. And in this they have been sustained by U. S. courts, but not yet by the Supreme Court.

If the patent statutes do accord this ultra-claim privilege to a patentee, it is apparent that the people are going to change the statutes. Whether they do accord this privilege or not cannot be deemed settled until the Supreme Court shall have passed upon it. "A question arising in regard to the construction of a statute of the United States concerning patents for inventions cannot be regarded as judicially settled when it has not been so settled by the highest judicial authority which can pass upon the question." (Andrews *vs.* Hovey, 124 U. S., 694, Blatchford, J.)

The question may therefore be regarded as still open to discussion. If the patent statutes do not sustain the patentee's right to put a restraining hand on trade beyond the right to exclude others from making, using and selling the thing claimed in his patent, it would be inadvisable to complicate the statutes by the addition of declaratory sections, and by the possible imposition of drastic qualifications out of sympathy with the spirit of patent law.

A good law by inaccuracy or laxity of administration and interpretation may prove as injurious to the community as a bad law accurately applied. If some things that are done and permitted in the name of patent law are warranted by it, the law ought to be amended, or perhaps even abolished. But if such things are unwarranted by it, the remedy lies in more accurate administration and more careful application. The writer thinks the United States patent law, accurately applied, is, as it was expected to be by its framers, promotive of public welfare. Possibly it may be advantageously amended in minor particulars, but as a body of statutes it is believed to have no superior in its particular field. It would be unfortunate if the greed of those who have been granted special privileges by the patent law, in grasping for further privileges under the cloak of that law, should arouse such resentment in the people as to force hasty and drastic legislation where none is needed. The warning words of Professor Robinson are worthy of heed by all friends of the patent privilege: "Continued concessions to the patentee are as unjust, and ultimately as disastrous, as continued restrictions of his powers; for they constantly give rise to new grounds of litigation and are sure to produce, at some time, a reaction in public sentiment under whose impulse the entire system of exclusive privileges may disappear." (Robinson on Patents, Vol. 1, section 23.)

* * *

An automobile fire engine in Newark, N. J., was recently disabled when responding to a fire call by a fireman's coat, that had carelessly been thrown over a rear wheel becoming jammed between the driving chain and sprocket. The chain was broken and other damage done that put the machine out of use for several days. The accident is but another illustration of the folly of building motor trucks with unprotected chains and sprockets.

DIAGRAM FOR FINDING HORSEPOWER TRANSMITTED BY WORM-GEARING

By F. A. G.

A great many manufacturers of worm-gear drives in Europe build and guarantee drives for a given horsepower at a given speed. The accompanying diagram is one which has been used to determine the necessary factors in this connection in the designing-room of a large gear factory. The diagram makes it very simple to find the pitch of the gearing, if the speed of the worm and the horsepower are given. The most important rule for worm drives is to keep the diameter of the worm as small as possible. The diagram, therefore, gives for each pitch and each horsepower and speed the largest allowable pitch diameter of the worm. Under no circumstances is it advisable to make the pitch diameter of the worm larger than allowed by the diagram, as the gearing may then run hot and start to cut. On the other hand, there is no objection to making the pitch diameter smaller. The larger the lead of the worm the greater is the efficiency. In order to obtain the best results, double or triple threads should be used for the worm.

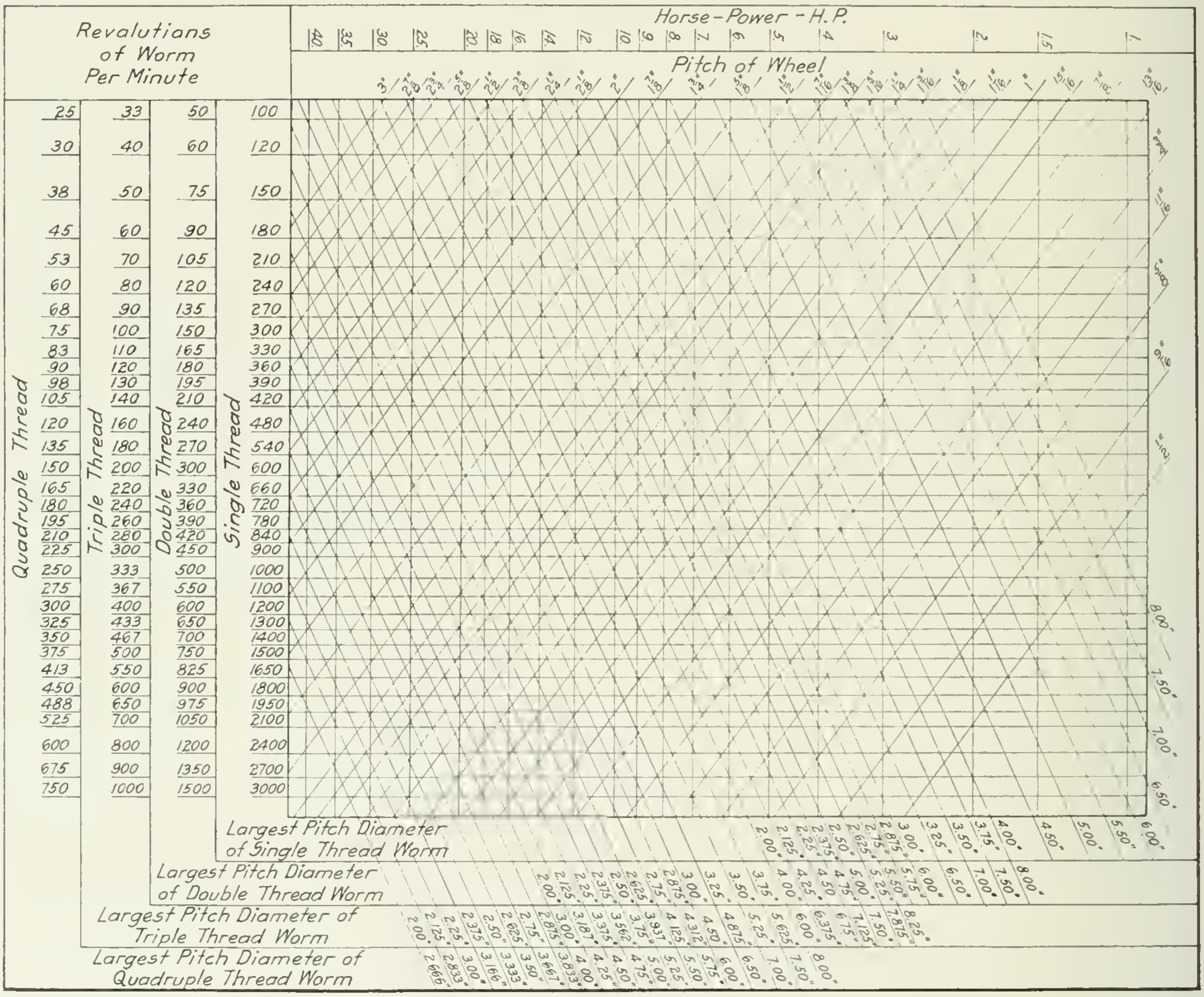

Fig. 1. Diagram of Relation between Horsepower, Pitch and Revolutions per Minute of Worm Gearing. Gear, Phosphor-bronze; Worm, Hardened Steel

For cast-iron worm-wheels and worms with unfinished teeth, the pitch should be 1.33 times greater than that obtained from the diagram, as this is prepared for worm drives with cut teeth, made from any suitable materials. In the case of unfinished teeth, the pitch diameter of the worm should be only 0.8 times that given in the diagram.

The best material for worm gearing is hard phosphor-bronze for the worm-wheel and hardened steel for the worm. The next best materials are cast iron for the worm-wheel and hardened steel or cast iron for the worm. Steel or steel castings for both the worm-wheel and worm are only allowable for slow speeds. The teeth in the worm-wheel and the thread on the worm should always be cut, whenever the gearing is to be used steadily or at a reasonably high speed.

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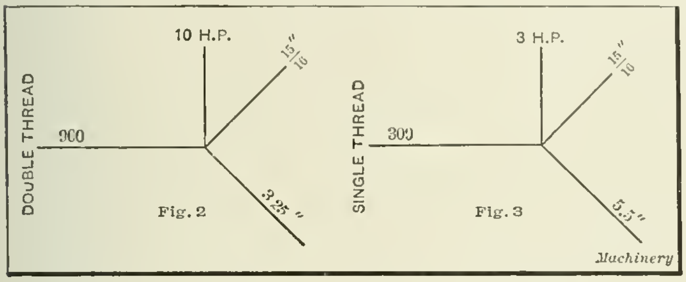
* The following articles on this and kindred subjects have previously been published in MACHINERY: "Table for Calculating the Outside Diameter of Worm-wheels," April, 1911; "Allowable Load, and Efficiency of Worm Gearing," September, 1910, engineering edition. See also the previously published information referred to in connection with the last-mentioned article.

As an example of the use of the diagram, assume that an electric motor making 900 R.P.M. is to transmit 10 horsepower by means of worm gearing, the ratio of which is to be 1 to 30. By entering the diagram as indicated in Fig. 2, we find that for single thread, the pitch should be about 1⅛ inch. This would make the pitch diameter too small, and therefore the use of a double thread is necessary. In that case the pitch will be about 15/16 inch, and the maximum pitch diameter of the worm somewhere about 3¼ inches. These factors having been found, the diameter of the worm-wheel, the center distance, and other necessary dimensions are determined as usual.



Figs. 2 and 3. Diagrams indicating Use of Diagram in Fig. 1

A lathe requiring 3 horsepower is to be driven through a cast-iron worm-wheel. The worm makes 300 R.P.M., and the speed ratio is to be 1 to 90. By entering the diagram as indicated in Fig. 3, we find that a pitch of 15/16 inch would be satisfactory for a phosphor-bronze worm-wheel, but for a cast-iron worm-wheel the pitch should be 1.33 times larger or equal to about 1¼ inch. The pitch diameter of the worm-wheel is found in the usual manner, the worm being assumed to have a single thread.

* * *

The American Society of Automobile Engineers has undertaken the standardization of motor trucks. At a recent meeting of a committee of the society it was decided tentatively that a motor truck should be capable of rendering normal or continuous service under its tonnage rating, and should have an overload capacity, for temporary or emergency service, of 25 per cent above its normal capacity. It was recommended that the desirable speed of trucks of various capacities should be as follows:

For 1-ton trucks	15 miles per hour
For 2-ton trucks	12 miles per hour
For 3-ton trucks	10 miles per hour
For 4-ton trucks	9 miles per hour
For 5-ton trucks	8 miles per hour

* * *

It is reported by Consul-General John E. Jones, of Winnipeg, Manitoba, that an industrial exhibition will be held this year in Winnipeg which will be the largest and most important ever held in Western Canada. The exhibition will be opened on July 10. The secretary and treasurer of the exhibition is Dr. A. W. Bell, Chamber of Commerce, Winnipeg.

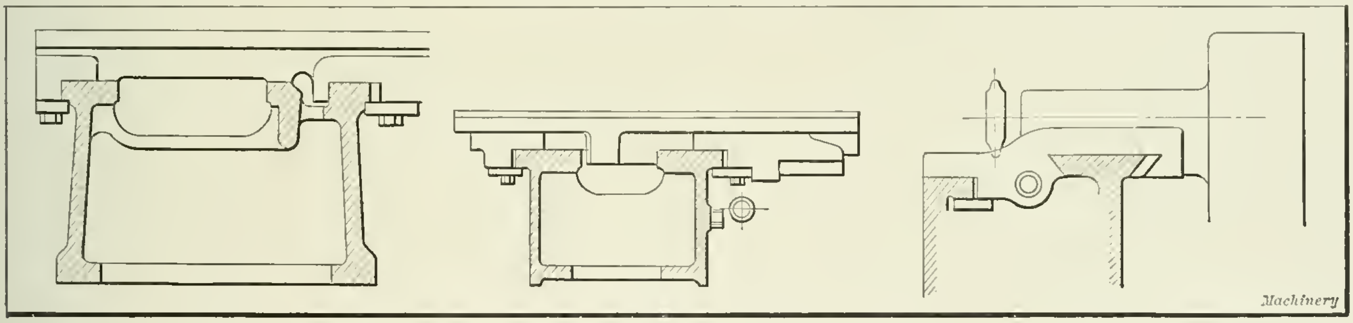
THE ADVANTAGE OF THE "NARROW GUIDE"[*]

By H. T. MILLAR[†]

The analytical faculty is very necessary in designing, for although it is the constructive ability which is brought into play when planning a structure or mechanism, this latter should also be analyzed for agreement with mechanical laws. It seems unfortunate that there is not more of critical analysis published in the technical press, since the contributors often have special facilities for it. These remarks are especially prompted by the article by Mr. J. G. Horner on "The Forms of Lathe Beds" in the February number of MACHINERY. In discussing the "narrow guide" lathe bed, Mr. Horner states that in the last five or six years it has effected a revolution in lathe construction. There is no analysis, however, of the claims made for it, and it is, therefore, the purpose of the writer to analyze the conditions of guiding surfaces, and the narrow guide in particular.

The question of the advantage of the narrow guide does not enter a great deal into American lathe design. If there has been any tendency to alter American designs, it has been away from the principles of the narrow guide, since the inverted V is perhaps the most highly developed instance of the principle, and the tendency has been to increase its included angle on account of the vertical pressure. The question arises, however, in American designs of other machines.

The accompanying illustrations Figs. 1 and 2 are taken from Mr. Horner's article and illustrate lathe carriages made by J. Lang & Sons, Johnstone, and J. Stirk & Sons, Halifax, respectively. Fig. 3 shows an example of American practice as embodied in a Brown & Sharpe gear cutting machine. Referring to Figs. 1 and 2, Mr. Horner says: "It is possible with these designs to obtain a length of guide of as much as ten times the width between the guiding surfaces, which has the effect of producing a steady motion with a greater amount of freedom from twisting than is the case when the saddle fits on the front and rear outer edges of the shears."



Figs. 1 to 3. Different Designs embodying the Narrow Guide

In other words, according to this, the amount of cross-wind is a function of the ratio of the length of a slide to its width, and hence the narrower a slide is made in proportion to its length, the less would be the cross-wind for a given amount of clearance between the strip and the slide. This is accepted almost as an axiom by many machine-tool designers. It can easily be shown, however, that this is not so, and that for a given length of slide and a certain clearance between the strip and the slide, the amount of cross-wind is unaffected by the width between the guiding surfaces. This was shown by a contributor in the April number of MACHINERY, and, in order to make the present analysis of conditions complete, it will be briefly reviewed here. Fig. 4 illustrates in diagrammatic form two slides superimposed. They are similar in every respect, except that one has a narrow guide and the other fits on the front and rear edges of the shears. Let w be the width of the narrow guide and W the width of the ordinary guide; let K be the clearance between the slide and the strip, and ϕ and ϕ_1 be the respective angles of cross-wind, which in this case may be regarded as infinitesimal. Then triangle ACE is similar to triangle APO; hence AE is proportional to

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[*] See MACHINERY, April, 1912, "Narrow vs. Wide Guides for Machine Tools," and January, 1912, "The Introduction of the Narrow Guide on Machine Tools."

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OA, and triangle $A_1C_1E_1$ is similar to triangle A_1PO; hence A_1E_1 is proportional to OA_1.

The angle of cross-wind for width W (in radians) $= \dfrac{AE}{OA}$

and for width $w = \dfrac{A_1E_1}{OA_1}$.

Therefore, for a given length of slide and clearance K the amount of cross-wind is independent of the widths W and w.

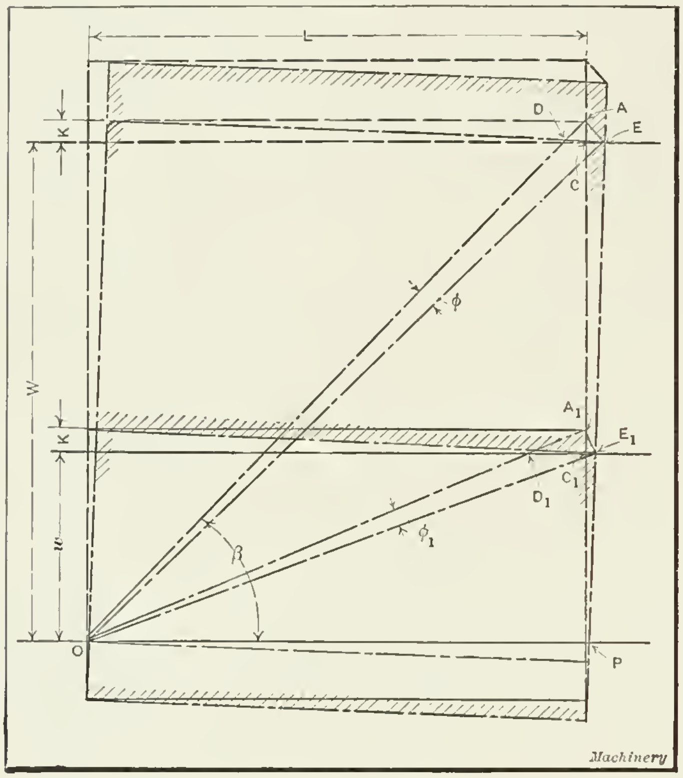

Fig. 4. Analysis of Cross-winding Action

The fact that the angle of cross-wind is a function of the strip clearance K and the length of the slide does not seem to have suggested itself to most writers on the narrow guide, but it will be easily seen that this is so.

The backlash or clearance K is equal to AC. Then,

$$AE = \frac{AC}{\cos\beta};\quad OA = \frac{OP}{\cos\beta}.$$

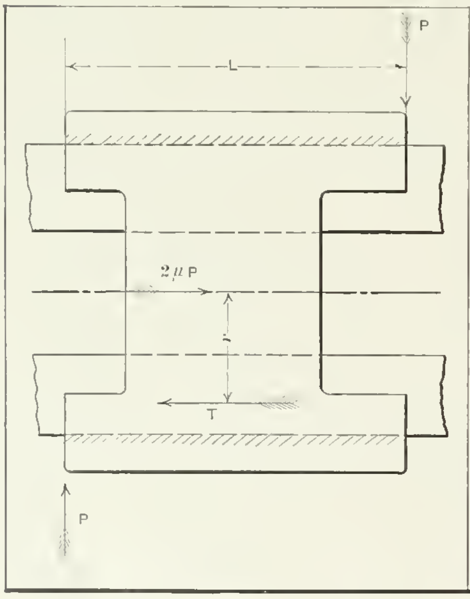

Fig. 5. Analysis of Frictional Resistance and Leverage

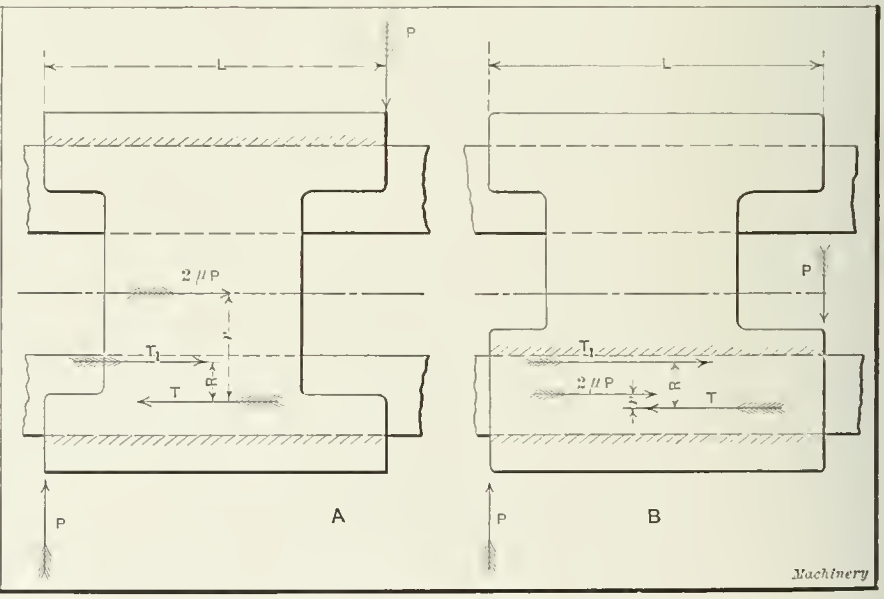

Fig. 6. Comparison between Wide and Narrow Guide

$$\text{Cross-wind} = \frac{AE}{OA} = \frac{AC}{OP} = \frac{\text{clearance}}{\text{length of slide}}$$

From this it is apparent that the narrowing of the width between the guiding surfaces does not directly affect the angle of cross-wind. When a generally held reason for an accepted practice is disposed of by mathematical considerations, it is wise to look around for another reason. It is not safe to dismiss a point too quickly which has been accepted and in practice for a considerable time. In this case, the narrowing of the distance between the guiding faces may have advantages, although it does not affect the angle of cross-wind. One advantage is that the chance of closing in the bed by setting up the strip too tightly is avoided. This, however, is probably not a very important point. Mr. Horner, elsewhere in his article, suggests what appears to the writer to be the chief advantage of the narrow guide. He says: "In conjunction with this, it is also the practice to bring the lead-screw as close as is practicable to the guide ways, and the twisting tendency and friction caused by the old-style construction is minimized. Thus the force is applied at the correct place near the guide ways."

It is in the resultant improvement in the relative positions of the feeding force, the resistance, and the guides, that the advantage of the narrow guide lies. In the case of the lathe, the narrow guide in front is near to the resistance due to the cut and the feeding force of the rack or lead-screw. If we take a general case of a slide moved forward by a force eccentric to the guides, and neglect for the moment any resistance due to the cut and friction on the top of the bed, we shall see that there is a limiting case for the proportion which the eccentricity of the force bears to the length of the guides. In Fig. 5 is a diagrammatic view of the slide, where T is the propelling force with the eccentricity r; P is the resultant pressure on the guides. Let μ be the coefficient of friction; then $T \times r = P \times L$, or $T = \dfrac{P \times L}{r}$. The resistance to motion (excepting the cut, friction on top of bed, etc.) equals $2\mu P$, and is assumed to act midway between the guides. Hence,

$$2\,\mu\,P = T = \frac{P \times L}{r}, \text{ and } \frac{L}{r} = 2\,\mu$$

Hence, if the ratio of the length of a slide to the eccentricity of the propelling force is not at least as great as the ratio of 2μ to unity, it is impossible to move the slide. Since the coefficient of friction is not likely in this case to exceed 0.1, and will probably be less, the limiting case for movement under these conditions would be when $L = 1/5r$, or, in other words, when the eccentricity of the feeding force is five times the length of the slide. The conditions in practice, of course, never reach this minimum.

In practice, however, the case is complicated by the addition of other resistances—resistance due to the cut, the friction on the top of the bed, and the sliding friction of the shaft bearings. Since the shaft generally revolves, this latter friction is very small. The effect of the friction on the top surface of the bed varies a great deal in different cases. The resistance due to the cut is the greatest, and in the case of lathes varies in position, and consequently the moment varies. The conditions which obtain due to the cutting resistance are illustrated in Fig. 6, where, at A, is shown the ordinary construction with a wide space between the guide surfaces, and at B the conditions obtaining in a lathe with narrow guide. Let T_1 be the resistance due to the cut; T, the feeding force, and P the pressure on the guide as before. We see then that $2\mu P + T_1$ must not exceed T if movement is to take place.

$$PL = Tr - T_1(r - R) = Tr - T_1r + T_1R \qquad (1)$$

$$2\mu P = T - T_1 \qquad (2)$$

From (1) we get

$$T - T_1 = \frac{PL - T_1R}{r}$$

$$2\mu P = \frac{PL - T_1R}{r}$$

$$2\mu = \frac{L}{r} - \frac{T_1R}{Pr}, \text{ or } \frac{L}{r} = 2\mu + \frac{T_1R}{Pr}$$

In the limiting case, then, the minimum proportion for the length of the slide to the eccentricity of the feeding force is, of course, greater by the amount $\frac{T_1R}{Pr}$, than in the former case.

We can now see the reasons for the advantages of the narrow guide. The frictional resistance of the guiding surfaces may be assumed to act midway between them. If the position of the guide is such that this resistance has a small moment the conditions are improved. Comparison of the conditions in A and B, Fig. 6, illustrates the advantage of the narrow guide. It is evident that if the direction of the feeding force and the direction of other resistances were in the same straight line, the width between the guiding surfaces would be immaterial; in fact, no guides would be necessary. This is, of course, a condition impossible to attain in practice.

Conclusions

In conclusion it may be stated:

1.—That the width between the guiding surfaces does not affect the angle of cross-wind, but that this is a function of the length of the slide and the clearance between the strip and the bed.

2.—That the narrow guide has advantages, but that these advantages are dependent mainly upon its correct location: It must be placed close to the resistance and the feeding force; a narrow guide strip at the back of the carriage would probably be more detrimental than the ordinary wide guide. For the same reason, in American tool construction only one V and one flat way are used. The V must be nearer to the feeding force and the resistance.

3.—That when the narrow guide is placed near to the feeding force, its advantage lies in the reduction of the moment of the frictional resistance and the required feeding force.

4.—That some advantage is derived from the better mechanical construction possible with the narrow guide, since the guiding surfaces cannot be closed in, and most makers fit a taper strip in place of the common angle-strip set up with the points of screws acting against it.

* * *

On March 7, Henri Selmet, a Frenchman, flew in an aeroplane from London to Paris, a distance of 222 miles, in 2 hours and 57 minutes, without alighting anywhere on the way. This is the most remarkable record ever made in fast flying, the average speed for three consecutive hours being 75 miles an hour. The flight was made in a storm accompanied by very high wind, and most of the time in a drenching rain. While this weather, of course, increased the dangers of the flight, the speed made could probably not have been accomplished if it had not been that the aviator was riding on a favoring gale, the same as do birds of migration. Even if the aeroplane should become actually useful in the future as a means of transportation under certain conditions, it is very likely that it will be necessary to make a close study of wind conditions, and to arrange flights so as to take advantage of favorable air currents.

* * *

It should no longer be a question of whether or not you need or desire safeguards around machinery. The only question for debate now is, which kind.—*The Wood-Worker.*

DETERMINATION OF HELIX ANGLES[*][†]

By GEORGE W. BURLEY[‡]

When calculating the angles of helices or spirals (as they are usually, though wrongly, called) for setting the tables of universal milling machines, the heads of twist-drill flute milling machines, etc., it is necessary to employ the formula:

$$\tan \alpha = \frac{\pi D}{L}$$

in which

α = the helix or spiral angle required,

D = the diameter of the work,

L = the lead of the helix or spiral.

Having calculated the value of $\pi D \div L$ for any particular case, the next step in the process is the consultation of a table of natural tangents for the determination of the value of α from $\tan \alpha$. To do away with calculations and consultation of a trigonometrical table, the table in the accompanying Data Sheet Supplement has been prepared, this table giving the values of the helix or spiral angles for a large number of values of the ratio of L to D. For the determination of the helix or spiral angle for any value of $L \div D$ not included in the table, the "simple proportion" method will give a result sufficiently exact, owing to the slight differences between consecutive helix-angle values in the table.

As an illustration, let us suppose that we wish to determine the value of the helix or spiral angle for a case when $L \div D = 3.75$. Consulting the accompanying table we find that when $L \div D = 3.70$, $\alpha = 40$ deg. 21 min., and when $L \div D = 3.80$, $\alpha = 39$ deg. 35 min. Therefore, when

$$\frac{L}{D} = 3.75,\ \alpha = \frac{40^\circ\,21' + 39^\circ\,35'}{2} = 39^\circ\,58'.$$

This is the same value that would be obtained if the formula above were used, there being no difference between the exact value and the approximately calculated value of the angle. This is a very close result, but in no case is the difference between the two values greater than 7 minutes, and this only where the angle is in the neighborhood of 90 degrees, so that the percentage of error is very slight, and, therefore, negligible.

* * *

PROPOSED INSTITUTION OF MACHINE TOOL ENGINEERS

A society, known as the Institution of Machine Tool Engineers, is proposed by the *Practical Engineer*, London. This journal points out that the Institution of Mechanical Engineers in England is not giving the subject of machine tools a great deal of attention, and that, in many cases, not only the quantity but the quality of papers on machine tool design, presented before this society, has been rather unsatisfactory. In most cases, the only thing that has been done has been to discuss finished machines in a way similar to that in which a salesman discusses his own and his competitors' products. The designer's side of the subject of machine tool design has, in nearly all cases, been left severely alone. There is also need for standardization, which a society of machine tool designers would be able to accomplish in a more satisfactory manner than the larger societies. Some of the opinions stated by the *Practical Engineer* in drawing a picture of British conditions are true of conditions in this country. Our engineering societies have done little to gather and distribute information dealing with the design of machine tools, notwithstanding the fact that the machine tool industry is, so to speak, the basis of all machine building industries.

* * *

It is claimed that soap water used instead of ordinary water in mixing concrete makes it waterproof. A grain elevator, at times exposed to inundation, was built in Germany from reinforced concrete made with soap water, and this building was successful in withstanding the effect of the water, while another building of the same material, but having been made without soap water, failed to completely keep out the water.

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[*] With Data Sheet Supplement.

[†] See also MACHINERY'S Data Sheet No. 93, "Table Giving Lead of Spiral for Given Angle," and MACHINERY'S Data Book No. 6, "Bevel, Spiral and Worm Gearing," pages 18 and 19.

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THE USE OF ENGRAVING MACHINERY*

By C. H. COPPACK†

Having seen some articles in MACHINERY on special work done on the Gorton engraving machine, the writer thought that a description of the uses to which the machine made by Taylor, Taylor & Hobson, Ltd., of Leicester and London, can be put, would be of interest. This machine was originally made for engraving photographic mounts with the maker's name, which formerly had to be done by rolling before lacquering. With this machine, the work can be done after all surfaces are lacquered, as no burr is raised by the engraving process. The machine was so much in demand that it was re-designed after a few years, making it available for a wider range of work.

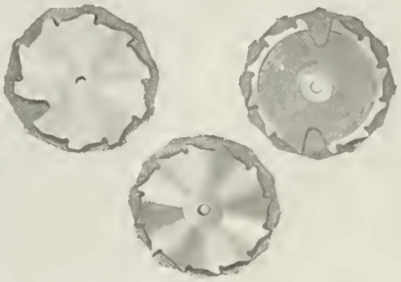

Fig. 1. Steel Wheels, with both Ratchet Teeth and Figures on Rim, cut in Engraving Machine

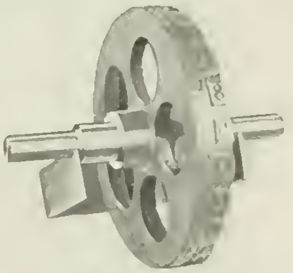

Fig. 2. Time Recorder Wheels cut by Engraving Machine in Four and One-half Hours

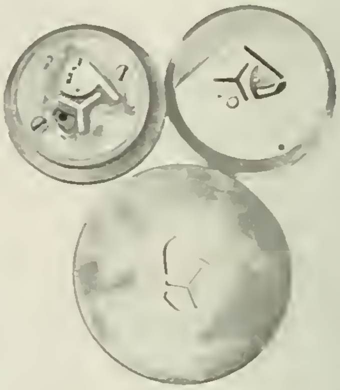

Fig. 3. Punch, Die and Stripper cut in Engraving Machine

The principle of operation is that of the pantograph with sliding adjustments for varying the size of the letters or designs made from the copies. The copies must be at least three times the size of the work to be produced, and are in one plane only. The varying depths are obtained by a hand feed through a screw. The variety of work which has been done on this machine is very great. Letters may be cut varying in height from 0.002 inch to 3 inches. Twenty letters have been cut on the head of an ordinary brass pin in one line. The machine has also proved useful in making models. Enlarged copies of the parts are made on a drawing, say ten times the actual size, and then transparent celluloid about 0.020 inch thick is placed over the drawing and the outline scribed on this. The celluloid is then cut out, both a male and female model being thus obtained. This is especially useful when making press tools. Numerous punches and dies have been made on this type of machine. The dies and punches are left with about 0.005 inch of metal for hand finishing.

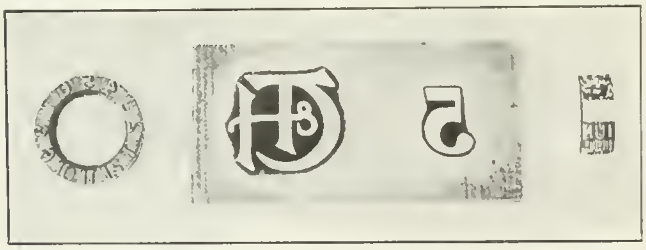

Fig. 4. Additional Examples of Work done in Engraving Machine

In instrument work, when about one hundred pieces are sometimes required, it would not pay to make press tools, especially if the piece were at all irregular. In this case the machine proves especially advantageous, as the pieces may be turned out at a cost of perhaps only one-half that of the press tools. One example of work done by this machine is that of the type wheels used in time recorders, where one wheel has twelve numbers and another sixty. Of course by means of die-casting processes, these wheels can be made cheaper in quantities, although the dies are expensive, but the metal of die-castings does not stand a great deal of wear; even brass types wear considerably in the course of time, and the best results are obtained with machine steel, casehardened. The cost of cutting the pair of wheels for the time recorder shown in Fig. 2 is about 84 cents, the time required being four and one-half hours, and the work being done by a girl.

Another interesting piece of work done on this machine is the cutting of sets of steel wheels as shown in Fig. 1, having ratchet teeth on the sides and figures on the rims. The ratchets are cut solid with the wheel. The ratchet spaces are recessed as indicated, so that a square-ended pawl can be used. The teeth are cut within a limit of 0.001 inch, and opposite teeth are tried across the center with a special gage. The figures are cut in exact relation to the ratchet teeth so that when a dozen of these wheels are put together, they will print a row of figures in a perfectly straight line. This would have been a very difficult matter to accomplish if the ratchet had been riveted to the rim, as it would then have been difficult to obtain the same accuracy.

In Fig. 3 is shown an example of punch and die work done on the engraving machine, the illustration showing a punch, die, and stripper. The punch is cut to a depth of 0.300 inch with a cutter of 0.050 inch diameter. The die is cut to a depth of 0.200 inch with the same cutter, leaving in each case 0.003 inch for finishing. Both punch and die are made of tool steel. The stripper is made of cast iron, 1/4 inch thick, and is finished complete on the engraving machine.

In Fig. 4 (center) is shown an embossing punch, cut 1/8 inch deep, the corners being finished with a cutter 0.005 inch in diameter. At the left in the same illustration is shown a small wheel with figures, which was cut in fourteen minutes in lots of two hundred.

* * *

A new industrial school, combining, it appears, certain features of the trade school and high school in one, has recently been opened in Vienna, Austria. The school is claimed to be the largest educational structure in the world, and practically all trades are taught. The building has a capacity for 5200 students, simultaneously instructed, and 337 separate study-rooms are provided, making the average number of pupils per room and teacher not more than between fifteen and sixteen. The building has five complete stories besides basement, and is built so as to entirely enclose a court yard. The total length of the building is about 425 feet, and the total width about 250 feet. In addition to the square building surrounding the court-yard, two buildings connect the long side wings, thereby forming three separate courts. Besides the study-rooms for the education in the trades, considerable space is set aside for gymnasiums, recreation rooms, a restaurant where the students can obtain meals at cost, etc.

* * *

The famous 1400-H.P. Corliss engine which operated the machinery at the Philadelphia Centennial in 1876 and which subsequently was used to operate the plant of the Pullman Palace Car Co., in Chicago, was recently dismantled and sold for scrap iron.

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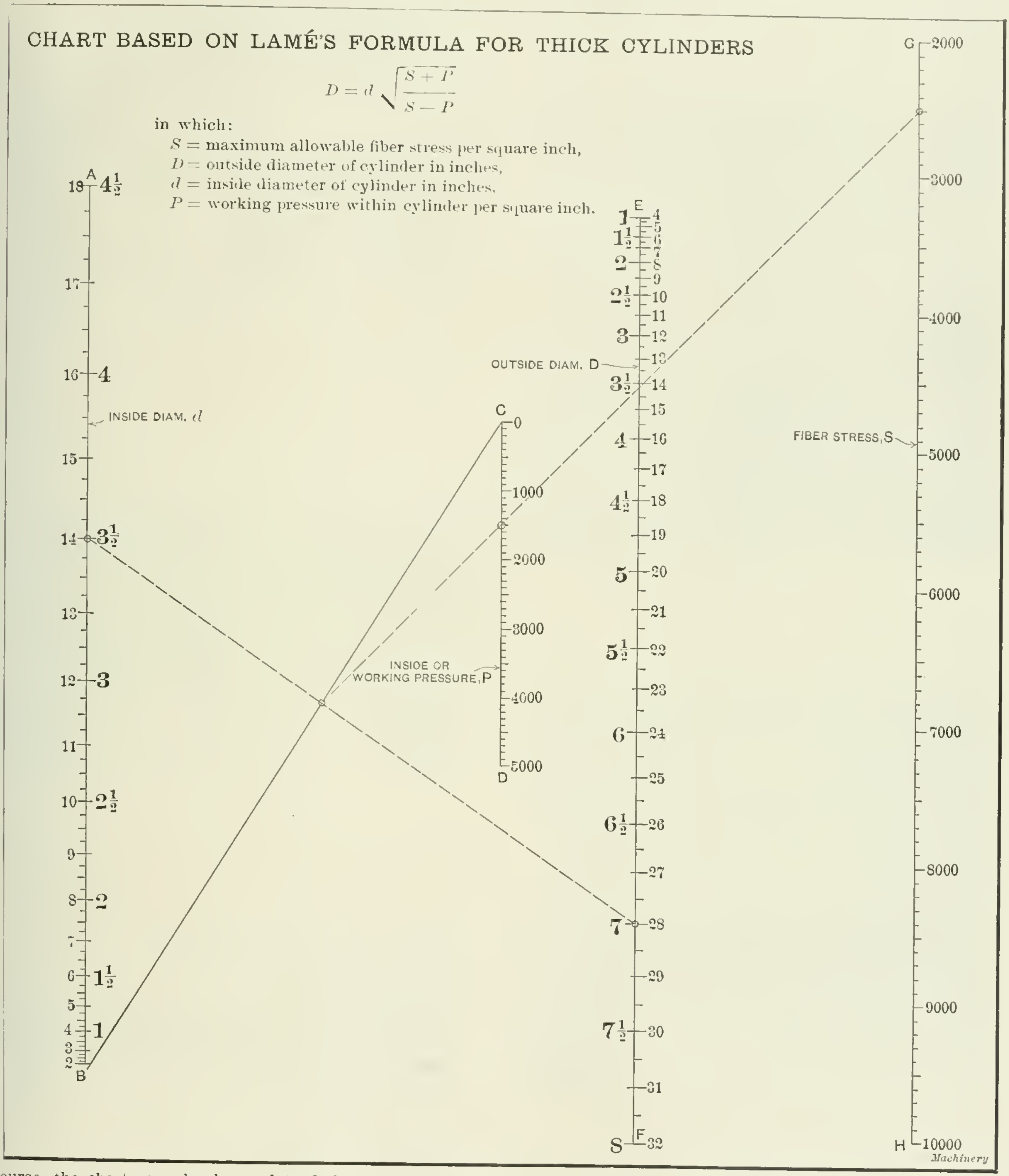
* The following articles on this and kindred subjects have previously been published in MACHINERY: "Brass Engraving, by Machinery," April, 1912; "Engraving Calibrated Circular Scales," and "Equipment for Engraving Pearl Revolver Handles," April, 1911; "Gorton Special Engraving Machine," March, 1911; "Die Sinking and Engraving Machines," May, 1908, engineering edition.

† Address: 4 Gotha St., Leicester, England.

CHART FOR THICK CYLINDERS*

By JOHN B. PEDDLE†

The accompanying chart for the rapid determination of the dimensions of thick cylinders is based on Lamé's well-known formula. This chart makes it possible to find the outside diameter of the cylinder very quickly when the fiber stress, the working pressure, and the inside diameter are known. Of course, the chart can also be used to find any other of the four quantities when three of them are known. The method of using the chart is as follows:



Locate the fiber stress on line GH and the working pressure within the cylinder on line CD; draw a line through the two points thus located, and extend this line until it intersects the auxiliary line or axis BC; through the point of intersection with this line draw a line which passes through the dimension for the inside diameter of the cylinder as found on scale AB, extending this line until it intersects scale EF. The point of intersection with line EF gives the required outside diameter. It will be seen that the scales AB and EF are provided with a double set of figures. When using these scales, the heavy-faced figures on AB should be used in connection with the heavy-faced figures on EF, the same rule being followed with regard to the light-faced figures.

An example of the use of the chart is indicated by the dotted lines. Assume that the allowable fiber stress per square inch is 2500 pounds. The working pressure within the cylinder is 1500 pounds per square inch, and the inside diameter is 14 inches. By following the directions given, we find that the outside diameter should be 28 inches; or, if the inside diameter were 3½ inches, as given by the heavy-faced figures, then the outside diameter would be 7 inches.

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[*] See MACHINERY, July, 1909, engineering edition, "Thick Cylinders," and the articles there referred to. See also MACHINERY'S Reference Book No. 17, "Strength of Cylinders," and MACHINERY'S Data Sheet Book No. 17, page 35, "Ratio of Outside Radius to Inside Radius of Thick Cylinders."

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ANCIENT PISTOL AND SOME OLD TOOLS FROM A NEW ENGLAND SHOP

By F. R. HUMPHREY*

About 1850, one of the most progressive concerns in this country was the Robbins & Lawrence Co., of Windsor, Vt. This company had a good reputation and was well known everywhere, and a machinist who had served his apprenticeship there had no trouble in commanding the highest wages in any machine shop in the country. In many ways this company was far ahead of its competitors. An old gentleman who had served his apprenticeship in this shop claimed that the equipment of jigs and fixtures at that time was twenty years ahead of that of any firm manufacturing a similar line of work.

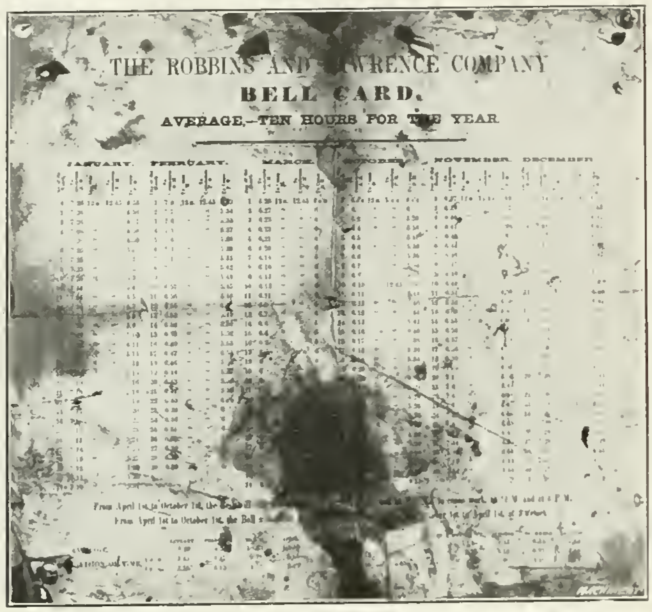
THE ROBBINS AND WRENCE COMPANY
BELL CARD.
AVERAGE.—TEN HOURS FOR THE YEAR
JANUARY. FEBRUARY. MARCH. OCTOBER. NOVEMBER. DECEMBER.

Fig. 1. A "Bell-card" of the Robbins & Lawrence Co., Windsor, Vt., in use about 1850

In Fig. 1 is shown a reproduction of the "bell card" which was used about 1850. The card from which the photograph was taken has apparently seen some hard usage; the dark stains covering it represent tobacco juice. This card gave the time when the factory bell—still in place on the old shop—would ring each day of the year. The time varied a few minutes each day, and was so arranged that the working hours of the shop averaged ten hours for the whole year, while at the same time the use of artificial light was avoided. During the month of December the average working time was only 7 hours and 54 minutes, while during the months of May, June, July and August, the men worked 11 hours a day.

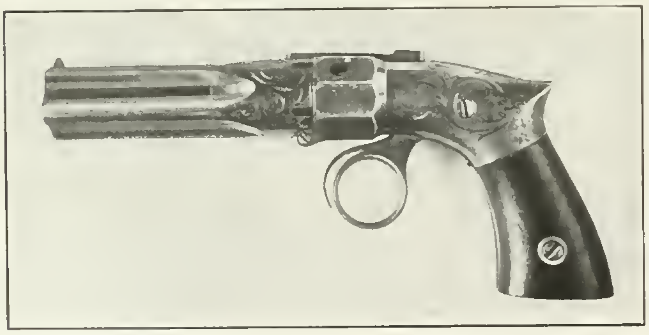

Fig. 2. An Old Pistol made by the Lawrence & Robbins Co., patented 1849

Fig. 2 illustrates a five-barreled "hammerless" revolver which was patented in 1849. This old weapon shows, in many of its details, indications of the skill of the mechanics working with the poor facilities of that time. The revolver is of 0.28 caliber. The forward part of the barrels, shown at *A* in Fig. 3, is rifled, and the rear part, shown at *B*, is chambered for the powder and ball. Percussion caps were used to cause the explosion of the powder. At *F* are shown the vents through which the gases and smoke from the caps escaped. At *C* is shown a part of the frame which is made from a steel casting, and evidently machined by the use of jigs and fixtures. The grips at *E* are made of fine selected black walnut. The chambers, the plate and the frame are ornamented with scroll design which was hand engraved.

The hammer shown at *A* in Fig. 4 struck each cap in succession. It was milled in such a manner that it would revolve one-fifth revolution while being drawn back or set, and it traveled straight ahead when released. It was milled with a combination of straight and spiral grooves, so as to be able to move in the manner indicated. The nut *H* fits on the hammer. The triggers, of which there are two, are shown at *B*. They are so arranged that by pulling back the ring *K* the hammer is set; then, by a slight pressure on the small trigger *L*, the spring *M* is released, and the hammer is driven forward. The trip *N* is part of the trigger *L*. The button *C* is a release which acts the same as the trip *N*. The screw *D* serves to lock the barrel in place. Spring *O* returns the trigger after firing. At *E* is shown a rear view of the chambers. This view shows the nipples for the caps and the vents through which the gases escape. At the bottom is shown the hinge. The latch *F* serves for a rear sight, and the spring at *G* holds the latch in place.

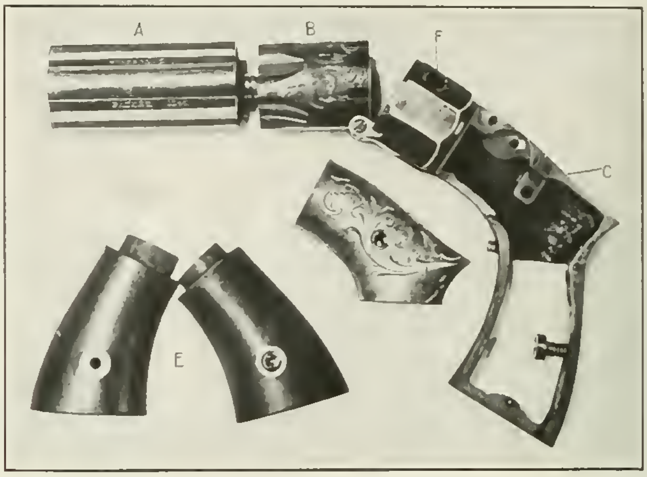

Fig. 3. Main Parts of Pistol in Fig. 2

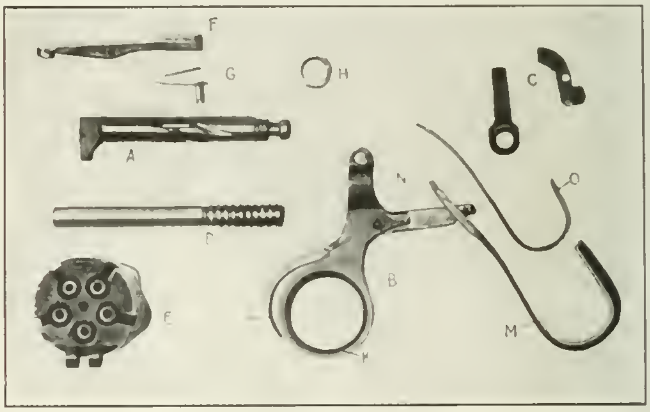

Fig. 4 Details of Pistol

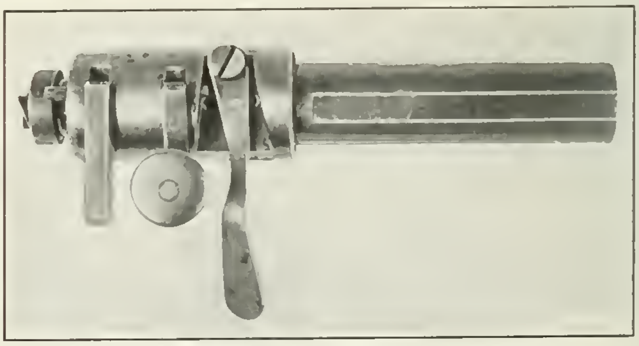

Fig. 5. An Old Hollow Mill and Threading Die with Holder

In Fig. 5 is shown a combination hollow mill and die. This unique tool was used on one of the early turret lathes. The details of the tool are shown in Fig. 6. The body *A* is made of soft steel in one piece; the hollow mill *H* is set into the spindle *B* and is threaded on the inside, thus forming the die. The lever *C* has a pin which engages in the slot *J* and thrusts spindle *B* forward in holder *A*. Parts *E* and *F* swivel on pin *D*. The thumb piece *E* travels in the cam slot *K* and forces the spindle forward; the lock *F* keeps the spindle from turning and catches in the notch *L*.

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* Address: P. O. Box 585, Windsor, Vt.

In Fig. 7 is shown a box-tool which was used on the same machine as the former tool; the details of this tool are shown in Fig. 8. The box *A* is machined from a forging; parts *B*, *C* and *D* are bushings which are used as back-rests; *C* and *D* are held in place by the nuts *E* and *F*. The tool is provided with two turning tools *G* and *H*, and a forming tool *K*. The tool *G* is held in place by clamp *J*, and the tools *H* and *K* are held by clamps *L* and *M*, and screws *O* and *P*. There are three screws *N* which are used for adjusting the tools relative to the center. These tools were used in the Windsor shops and happened to be left when the gun department was moved by the Winchester Arms Co. to New Haven, Conn.

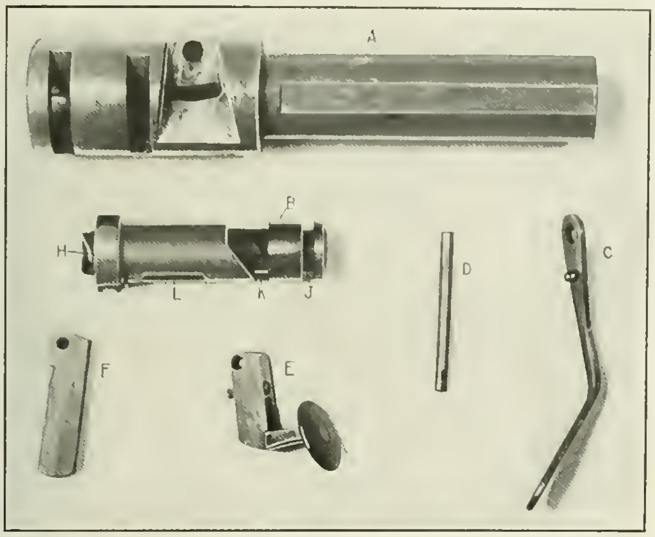


Fig. 6. Details of Tool shown in Fig. 5

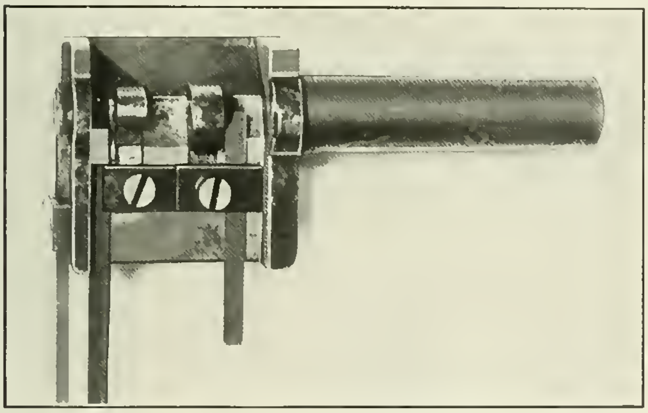


Fig. 7. A Box-tool from about 1850

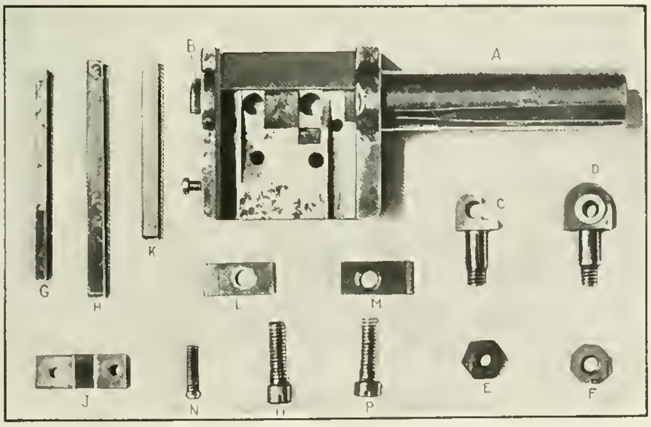


Fig. 8. Parts of Box-tool shown in Fig. 7

* * *

A careless workman with a big monkey-wrench is expensive to have around where there are many small bolts or nuts to be tightened.

OCEAN LINERS WITH DIESEL ENGINES

It appears that the trials of the *Selandia*, a Diesel engine-driven liner, with a gross tonnage of 4900, marks a new departure in the driving of large ocean-going vessels. The East Asiatic Co., for which this vessel was built by Messrs. Burmeister & Wain, Copenhagen, Denmark, has three vessels of this type, and appears to be fully satisfied with their performance, as eight more motor-driven vessels have been ordered, two of 10,000 tons and six of 6000 tons capacity.

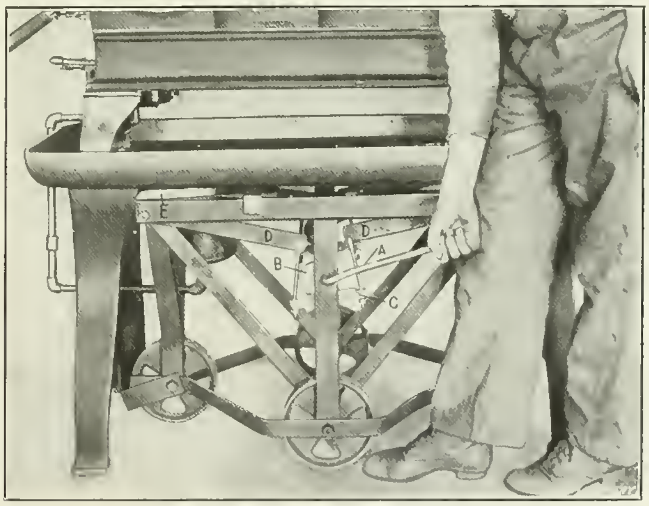
It is stated that, contrary to the expectations, there was a complete absence of vibration and noise during the trials of the vessel. In fact, even steamship engineers agreed that the machinery ran more quietly than steam-engines. The engines are under perfect control, as was proved during the trials, when the *Selandia* almost collided with another steamer, but was saved through the prompt reversing of her engines. Only fifteen to twenty seconds was necessary to change the direction of rotation from full-ahead to full-astern. On account of the absence of funnels, the vessel presents a peculiar appearance. The exhaust is led up through the hollow mizzen-mast, and the outlet is about 25 feet above the deck. The advantages gained in cargo-carrying capacity are considerable. The great bulk of the space usually given over to coal bunkers can be used for cargo. The main fuel tank of the vessel is provided for by her double bottom, which has a capacity for 900 tons of oil, sufficient to keep her main engines going during a voyage of twenty thousand miles under average condition.

The vessel is provided with twin-screws driven by two eight-cylinder engines, each developing 1250 brake horsepower (1500 indicated horsepower) at 140 R. P. M. The machinery cost about $50,000 more than steam engines, but it is expected to save some $40,000 a year by the use of the Diesel engines. This saving is accounted for partly by the saving on the fuel and partly by the fact that the vessel can carry 1000 tons of cargo more than a steam-driven vessel of the same capacity.

* * *

A HANDY TRUCK FOR MOVING MACHINES

The accompanying illustration shows a homemade truck, used in the shops of F. E. Wells & Son Co., Greenfield, Mass., that is extremely useful in moving or shifting the positions of partly erected machines. It is called the "back-saver" by the men, for it eliminates a great deal of lifting and pulling when moving a machine.



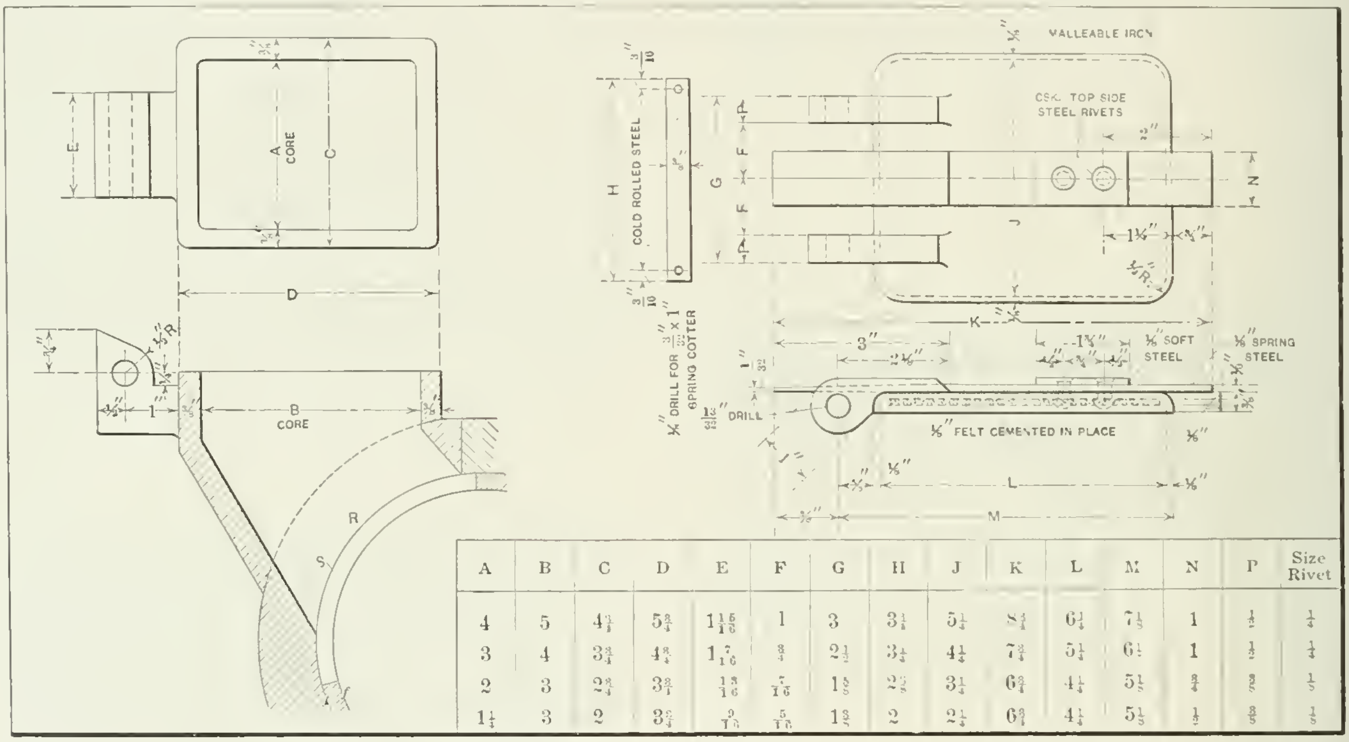
A Handy Truck for Moving Machines

The truck is run under the body of a machine, and handle *A* is pulled upward. This handle terminates in the cam *B*, which acts against bar *C* and forces the bar down. This bar is attached to the inner ends of the levers *D*, and the motion imparted to *C* raises the outer ends of these levers, throwing the lifting blocks, one of which is shown at *E*, against the body of the machine, and thereby raising the machine enough to clear the floor. In this position the machine may be readily wheeled to the new location, and by depressing the handle, the load is dropped. The high point on cam *B* is slightly flattened, so that the device will remain at that position until intentionally changed.

OIL-WELL DESIGN

By F. D. BUFFUM

The accompanying illustration shows a design of oil-wells and covers that for several years has proved to be satisfactory and superior to grease- or oil-cups. It needs less frequent attention, is easy to fill, and the oil-well cannot be lost or stolen like an oil-cup. The design is inexpensive, the lubricant is in contact with a large part of the journal, and coats it with a film much better and more evenly than a cup, and without waste. It also feeds the lubricant automatically without any adjustment. The lid and hinge boss are made similar to the Master Car Builders Association's standard used in railway service. As long as the hinge boss and the other external parts of the oil-well mouth are made of standard dimensions, the lid design and the material can be varied considerably, just as in the case of the M. C. B. journal box. No part of the passage at *R* should be smaller than the entrance, and the bushing should be cored out at *S* to correspond with the dimension *A* in the table. The dimensions given are suitable for ordinary steel or iron castings. The oil-well should be located at the top of the bearing when practicable, and should be made deep and of large capacity, the dimensions shown at *A* and *B* being the minimum dimensions.



A	B	C	D	E	F	G	H	J	K	L	M	N	P	Size Rivet
4	5	4¾	5¾	1 15/16	1	3	3¼	5¼	8¼	6¼	7⅛	1	½	¼
3	4	3¾	4¾	1 7/16	¾	2½	3¼	4¼	7¾	5¼	6⅛	1	½	¼
2	3	2¾	3¾	13/16	7/16	1⅝	2⅝	3¼	6¾	4¼	5⅛	¾	⅜	⅛
1¼	3	2	3¾	9/16	5/16	1⅜	2	2¼	6¾	4¼	5⅛	½	⅜	⅛

Dimensions of Oil-well and Cover

These oil-wells are adapted to any kind of machinery especially heavy outdoor machines where cups are liable to be stolen, jar off or break, and also to plug up with dust in summer or freeze in winter. They can be used with either grease or oil, and, with the latter, are economical of the lubricant, because it is soaked up by the wool waste with which they should be packed when oil is used. This waste then feeds the oil to the journal by capillary action, evenly and continually, and without attention for long periods of time. There is nothing to regulate or adjust, and the journal is coated with a film of oil without spilling any. The main advantage, however, is in the saving of the operator's time in attending to the lubrication. To fill, all that is necessary is to hook open the cover, pour in the oil and slam the cover down again.

The easiest thing for the designer of any machine to do is to indicate a tapped hole and call for a grease- or oil-cup where lubrication is required, and, until a few years ago, when the writer went into the operating end of the business, he supposed that it was entirely satisfactory. However, he found that it didn't take much of a machine to require half an hour or more a day attending to cups. They have to be filled when they are empty and that is not always a convenient time. Labor occupied in filling and fixing them is an expense and a delay that has to be paid for, and a small sum daily amounts to a good deal in a year.

In looking for a more satisfactory substitute, the oil-well with spring-hinged cover, used on railway motor journals for mine locomotives and for their gear cases, appeared to be just the thing. These were made in a variety of designs, but the one that seemed to be the best and cheapest was adopted and improved in minor particulars. A few were used with great satisfaction to the machine operator, and their advantages were clearly demonstrated.

These oil-wells cost no more in the end than cups, if the outlet is large and is *cored* in the lining metal and not cut out afterwards. Valuing that metal at 30 cents per pound, the opening need not be so very big to save the cost of the well and cover, and the price of the cup which is saved helps out too.

The purpose of this article and of the table submitted in connection with it is to urge that manufacturers adopt *some* standard design and thus secure the advantages of interchangeability and low cost that the master car builders' standard obtained for the railroads. There is no advantage in having a lot of different designs and sizes, such as are now in use, when the adoption of standards would cut the cost down to no more than the 25 cents, at which the M. C. B. cover retails. To have a standard, all that is required is to retain the dimensions of the hinge boss and the outside of the oil-well. The cover design can be varied to suit the designer. He can make it thicker or thinner, with felt or without, and of cast iron or other material, and still have interchangeability. For larger covers, or for hand holes, the writer would suggest the regular M. C. B. standard.

* * *

INTERESTING TEST PIECES OF MONEL METAL

At the recent motor boat show in New York some interesting test pieces of monel metal were exhibited. This metal, which has the strength of steel, takes a finish like pure nickel, and is less corrodible than bronze, was shown in the form of a 1¼-inch diameter cold-drawn rod bent over flat, surface to surface, without fracture. Another ¾-inch rod, cold-drawn, was tied in a close knot with no fracture. Other test pieces of hot-rolled rods which had shown tensile strengths of 100,000 to 103,000 pounds per square inch, with yield points ranging from 76,000 to 81,000 pounds, were to be seen.

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To produce a solder that will fuse at a low temperature, add six drops of mercury to each ounce of solder. With this, soft metals melting at a low temperature, can be soldered.

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* Address: Ellsworth, Pa.

THE FACTOR OF THRUSTS IN MACHINE DESIGN

By WILL O. WYNNE

The successful and effective working of many mechanisms depends entirely upon the direction of the thrusts set up in them. The question of the direction of thrusts is a phase of the designer's work which is very often left to look after itself. Negligence in this respect sometimes results in the failure of a mechanism to produce satisfactorily the desired result. When designing a new movement, a thorough analysis of all of the strains and thrusts set up will sometimes reveal the possibility of counteracting the thrust of one member by that of another, thus producing a more self-contained arrangement, and possibly reducing, to an appreciable extent, the power required for driving the mechanism.

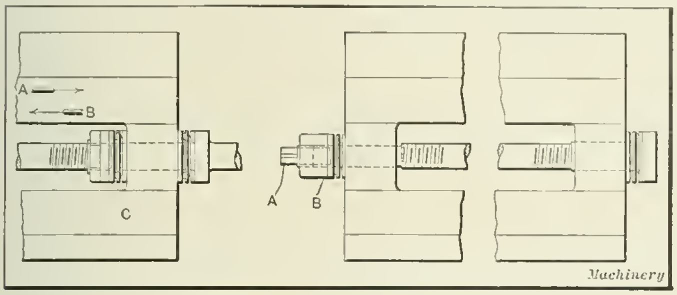


Fig. 1. Direction of Thrusts in Ordinary Carriage Construction

Fig. 2. Improved Design of Carriage Construction in which the Screw is always in Tension

Of course, there are many arrangements, theoretically incorrect, in which the thrust is not sufficient to affect the successful working of the mechanism. Such a condition of affairs is illustrated in Fig. 1. When the carriage on slide *C* is drawn, by means of the screw, in the direction of arrow *A*, the screw will be in tension, the thrust being taken by the collar on the outside of the slide *C*. When the direction is reversed, however, the carriage moving in the direction of arrow *B*, the thrust is taken on the ball washers on the inside of the slide. The screw is thus in compression. The disadvantage of this construction is not as apparent in small machines, but where heavy thrusts are set up, as in planers, it is obviously advantageous to arrange for the screw to be in tension irrespective of the direction of movement of the driven carriage. In addition to this, the construction as shown in Fig. 1 renders it rather difficult to introduce the usual form of lock-nut.

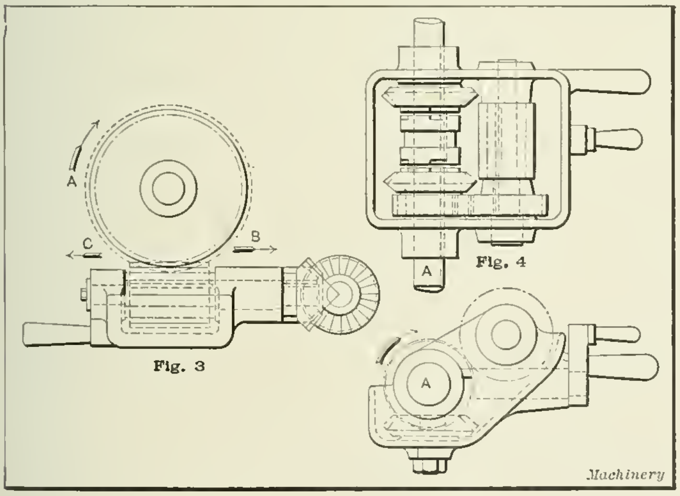


Fig. 3. Direction of Thrusts in Worm and Worm-wheel Design. Fig. 4. Worm-box with Reversing Mechanism

The arrangement by means of which the screw is always kept in tension is shown in Fig. 2, and is self-explanatory. This method allows the application of an exceedingly simple locking nut. The screw *A*, after the adjustment of the nut *B*, is forced against the end of the traversing screw; thus the thrust of the traversing screw, the adjustment of the nut *B*, and the locking of the nut by screw *A*, all act upon the same side of the thread of the traversing screw, forming a most effective lock.

In automatic trip motions, in which the feed is to be tripped while the machine is cutting, the question of direction of thrust is, in some cases, of paramount importance. This can be simply illustrated by a worm and wheel in which it is required that the box carrying the worm shall fall, throwing the worm out of gear with the worm-wheel, and thus disconnecting the feed. The worm-box, as commonly constructed, is shown in Fig. 3, and is usually pivoted at the apex of the bevel gears that impart motion to the worm-shaft. If the worm-wheel is arranged to rotate in the direction of arrow *A*, the thrust on the worm is in the direction of arrow *B*. This thrust acts on the pitch line of the worm, and the pitch line produced passes above the center of rotation of the worm-box; thus, the box is prevented from falling by the thrust of the worm. The greater the thrust on the worm, the greater also will be the tendency for the worm to be forced deeper into mesh with the wheel. If the direction of rotation is reversed, the thrust will be in the direction of arrow *C*, tending to throw the box downward, and the greater the thrust, the more effective the action when the support to the box is tripped.

An instance somewhat similar to the foregoing is that of a worm-box driven by spur-gearing, as is illustrated in Fig. 5. In this case, the box is hung on shaft *A*, which imparts motion to the worm-shaft and worm by means of spur gears *B*. If shaft *A* rotates in the direction of arrow *C*, the thrust of the spur gears on the box is in an upward direction, and this thrust will hold the box up when the support is tripped, thus necessitating some auxiliary motion to push the box out of gear. If the direction of rotation of the shaft *A* is reversed, the thrust tends to throw the box downward, and the mechanism has now all the elements of an effective automatic trip.

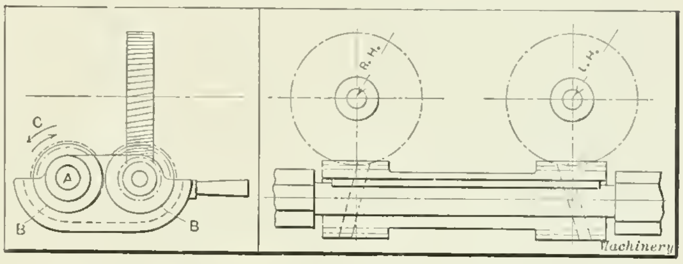


Fig. 5. Worm-box with Spur Gear Drive

Fig. 6. Twin-screw Drive in which the Thrusts are Balanced

It is very often necessary to be able to trip the worm while feeding in either direction. In this case it is advisable, if possible, to mount the reversing mechanism in the worm-box, as shown in Fig. 4. As the rotation of shaft *A* is in the direction of the arrow, the driving pressure thus always tends to throw the worm-box downward.

The consideration of the automatic balancing of thrusts has led to the design of a planer drive, as outlined in Fig. 7. This arrangement has been used by the writer for some time. The drive, as shown, illustrates a large planer table driven by a double rack. It is generally known that with this style of drive, under ordinary conditions, it is practically impossible to equally distribute the drive between the two racks. This, however, is automatically accomplished with the drive arranged as shown.

The racks *A*, of ordinary straight tooth type, are bolted to the table; bull wheels *B* mesh with the racks and ride loosely upon a large stationary shaft fixed in the bed. In mesh with the bull wheels are separate rack pinions *C*, riding loosely on a long stationary shaft *D*, carried in brackets bolted to the under side of the bed. Keyed to these rack pinions are two separate helical gears *E*, with teeth cut at opposite angles. In mesh with these two wheels is a solid double helical pinion *F* keyed to the driving shaft *G*, but free to move endwise along the shaft. The shaft *G* is driven by the usual gearing, with which we are not concerned. When shaft *G* is rotated, the double helical pinion *F* drives the helical gears *E*, which, in turn, drive the rack pinions and the racks. The pinion *F*, due to its being of a double helical form, will continually be in a state of either compression or tension; thus, if at one instant the driving pressure on one rack became greater than on the other, the difference of pressure would immediately be transmitted to the pinion *F*, causing that pinion to move endwise, and to again equalize the pressures on the two racks.

Whereas, in the usual double rack drive, great care is necessary in mounting the gears on their respective shafts in order to try to obtain an even drive, this trouble is entirely eliminated and a perfect self-contained automatically balanced drive is obtained with the arrangement above described. It will also be seen that whereas the end thrust on the pinion, whether compressive or tensile, is all self-contained, the resulting thrusts on the single helical gears are taken on ball washers mounted between the pinions *C* and the brackets carrying the shaft *D*.

The same principle might be employed in the driving of a twin-screw planer, or, in fact, in any machine which is driven by two members, one member always receiving the thrust set up by the other. The application of this drive to a twin-screw planer is shown in Fig. 8. A short article bearing somewhat upon this subject appeared in MACHINERY, August, 1911, engineering edition, on page 943: "Points in the Design of a Power Elevating Cross-rail." While nothing whatever can be urged against the principle advocated in the raising and lowering of the cross-rail by means of which the thrusts are regularly balanced, using right- and left-hand screws, the construction, however, due to the possibility of automatic balancing, could be considerably improved in that the coupling for maintaining alignment could be eliminated.

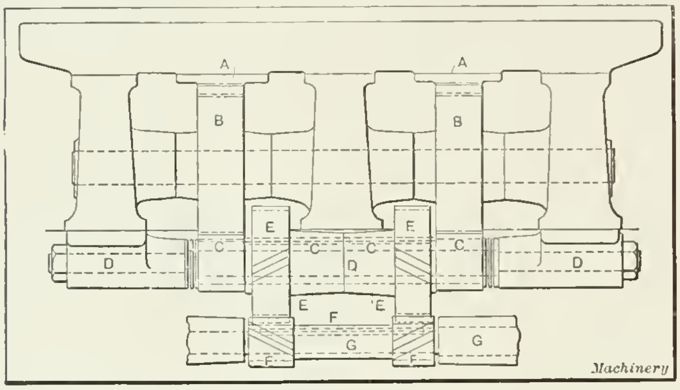


Fig. 7. Improved Form of Double Rack Planer Drive

After the alignment of the cross-rail has been obtained, the shaft carrying the worms can be rotated and moved endwise until the worms bear equally on both wheels, this position of the shaft then being fixed by means of a collar on each side of the central bracket, care being taken to have sufficient clearance between the worms and their brackets, as shown in the drawing. This construction, however, might fail to appeal to those who place little reliance upon a long shaft of small diameter under compression—among whom may be numbered the writer—although he is well aware that the shaft could be arranged to be in compression when lowering the slide.

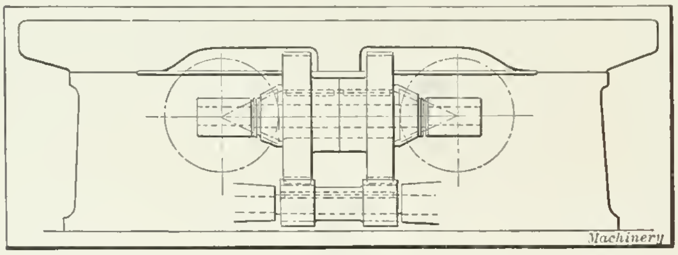


Fig. 8. Twin-screw Planer with Drive having Thrusts Equalized

This principle could be, and is, in fact, used advantageously under such conditions as shown in Fig. 6, in which the worms are solid with a tube that is free to move endwise along the driving shaft. This principle is the subject of several patents, but a little consideration will reveal the fact that this arrangement is by no means perfect. Similar examples could be cited and others will occur to all who are connected with machine designing, but enough has been said to illustrate the advisability of a little more consideration of a subject which is sometimes the sole basis of a satisfactory mechanism.

* * *

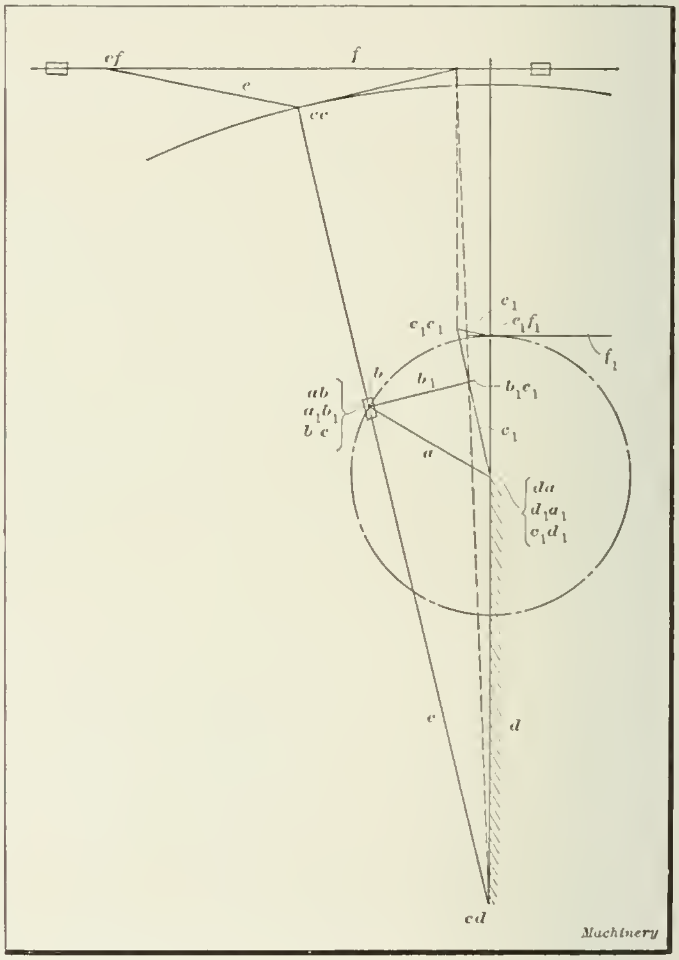
Saving a dollar in wages or in factory costs, and losing two in efficiency, is really not a money-making proposition, although lots of people seem to think it is.

THE PHOROGRAPH—A REJOINDER TO A CRITICISM

By FREDERICK H. MOODY*

In the criticism appearing in the February number, relative to the writer's article "The Phorograph," published last October, Mr. Sullivan is evidently laboring under a misapprehension of the possibilities of the phorograph system of analyzing mechanisms. Those who have used it are certain that if it had been given a fair trial on the drawing board, in comparison with the "instantaneous center" method, the criticisms offered would never have been made. The opinion of several users of the system is that there is no comparison in the simplification of the analytical work resulting from it.

In the original article, mention was made that the phorograph formed part of the instruction in the mechanical engineering course at the University of Toronto. In the early stages, the instantaneous center method is still employed, for it seems as if that method could not be improved upon from an instructional standpoint, as all the principles are presented in such a clear and logical manner that the relative movements of the parts are more readily understood by the student. However, this method has decided limitations in practice. For example, consider the difficulties of solving a problem by the instantaneous center method for a link attached at its ends to nearly parallel links; the instantaneous centers would be away off the board somewhere in space, making such a solution impracticable. It also requires a great deal more line drawing than the phorograph method. In the latter method, the area over which the operations are carried, so to speak, is kept within smaller compass. In consequence, while the fundamentals are taught by the instantaneous center method, that method is superseded by the phorograph in the later stages of the course.



Quick-return Motion as analyzed by the Phorograph

Consider next some of the specific criticisms. The statement is made in the criticism that "the results are all correct except that in the quick-return motion illustrated, the velocity of the oscillating arm is represented by the line c_1d_1–c_1e_1, and it still remains to solve for the velocity of the ram in order to complete the solution." To call this an omission rather than an error would have been more to the point. As the writer's article was merely explanatory of the phorograph, rather than an effort to thoroughly analyze specific mechanisms, it was not deemed necessary to carry the solution to a conclusion. The accompanying illustration shows the same mechanism with the addition of the ram f, joined to its connecting link at ef. Points ce and c_1e_1 have the same motion. As a point in link e, the image e_1f_1 of the point ef, must be somewhere along a line through c_1e_1 parallel to c. Likewise, as a point in ram f, which has a horizontal motion, the image must be in d produced, as only such points have a horizontal motion. Hence, the image is at the intersection of these two lines at the point e_1f_1. The ram velocity at that particular instant is thus the length c_1d_1–e_1f_1. With regard to the original statement calling the quick-return mechanism a Whitworth, the writer stands corrected.

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* Address: 70 Bond St., Toronto, Canada.

Exception is taken by the critic to the statement that the image found by the solution outlined, is not *on* the constantly-revolving link itself, *i. e.*, in the simple four-link mechanism, the point b_1c_1 is not on a. Near the bottom of the second column of the original article, there is the following statement: "The link a is considered as a large member of sufficient size to include the images in all positions." The line shown representing the link a is only a skeleton line connecting centers, the actual link comparing as regards size to the disk-crank commonly found on large stationary engines. This, of course is only a constructional assumption. The scaling methods suggested by Mr. Sullivan are good, representing natural developments in any method of graphical solution.

The line of reasoning outlined by the critic in his second to last paragraph, and in the first sentence of the last paragraph, emphasizes his unfamiliarity with the subject he is criticizing. The conditions mentioned, while from a casual inspection presenting much the same appearance, are fundamentally different, and require an intelligent knowledge of the application of the phorograph to obtain the correct solution, for it will be noticed in the first instanced case that the block is sliding on the stationary link on which all points are the same, while in the second case, the block is sliding on a movable link on which all points have different relative motions. If the solution originally outlined be carefully analyzed, it will be found to be perfectly correct and logical, embodying in a simple manner the phorograph principle.

Near the end of the criticism, there is this statement: "In Fig. 4 of Mr. Moody's article, it will be found difficult to project b_1c_1–c_1d_1 to a tangent from ce accurately." If the original article be correctly read, it will be found that no such move is attempted. The construction that was outlined may be seen by referring to the accompanying illustration, which in this particular is the same as the one referred to. Quoting from the original article: "The distance between b_1c_1 and c_1d_1 corresponds to the distance between bc and cd; so in order to obtain the full image of the link c, we must join cd and b_1c_1, producing this line to meet a tangent from the point ce. From this point of intersection, drop a perpendicular to cut a line through c_1d_1 and b_1c_1 produced, in the point c_1e_1. The line between c_1d_1 and c_1e_1 is the image c_1 of the link c, obtained by simple proportion, this method of obtaining it being simply a constructional means of so doing." The tangent at ce is at right-angles to c—a simple construction. No difficulty should be experienced through graphical errors in the other points, as the locating points are all a good distance apart, minimizing the possibility of error.

In conclusion, the writer wishes again to emphasize the fact that if the phorograph be first properly understood, its application will lead to simplification in the solution of problems commonly solved by the method of instantaneous centers.

* * *

A small tube and bulb containing mercury and so arranged that the rise of the mercury due to its temperature closes an electric circuit and rings a bell, may be effectively used as an alarm for hot bearings. The apparatus is attached directly to the bearing, and when several bearings are connected, an ordinary electric bell indicator can be used to show which bearing is hot.

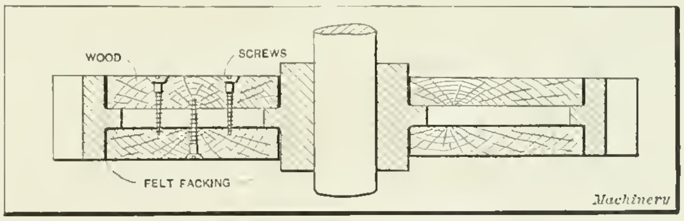
DATA ON ROPE-DRIVING

In a paper read by Mr. R. E. Hart before the Association of Engineers-in-Charge (England), the author stated in a concise manner the main requirements for a successful rope-drive. The main features of an ideal rope-drive are that the diameter of the pulleys shall not be less than thirty times the diameter of the rope used, and the driving and driven pulleys shall, if possible, be of equal diameter; but where this cannot be arranged, their ratios should not be greater than 5 to 1. The distance between the pulley faces should, if possible, be not less than 25 feet, and the drive should be horizontal, with the slack side of the rope on the top. The speed may be from 2000 feet to 4000 feet per minute. If the speed is too low the ropes are apt to slip, and if too high the action of centrifugal force affects the efficiency. There should be a distance of from 4 feet to 6 feet clearance under the ropes, and the ropes must, of course, not rub on anything. An allowance of 2 or 3 inches clearance between the bearing foundations and the sides of the pulleys must be made so as to leave room for the ropes to be put onto the pulley. The pulleys must also be accurately in line, well balanced, and the grooves exactly alike. All gears between the prime mover and the rope-drive should, if possible, be avoided; the ropes should be kept dry, properly lubricated, and not too tight. They should all be put on at one time, and the full load should be applied to them as soon as possible after they are in place. Carrier pulleys, rollers, and angular drives should be avoided as much as possible. Regarding the two types of rope generally used—namely, three-strand and four-strand—the former can be made more pliable than the latter, and it is also stronger; but these advantages are more than counterbalanced in the four-strand rope, because, compared with the three-strand, it stretches very much less, and it has a larger surface in contact with the pulley grooves; it is also capable of a stronger splice. A well-made four-strand rope is, moreover, nearly as strong as a three-strand, but it requires more skill to splice it. The general opinion now is that cotton is the best material to use for driving-ropes, and Egyptian cotton, though a little more expensive than American, is generally preferred.

* * *

A CURE FOR NOISY GEARING

A little kink for eliminating the noise of gearing is given in the *Practical Engineer* (London). Trouble was experienced from the excessive noise made by the gearing of a crane placed in such a position that the noise was highly objectionable. Several methods were tried to eliminate it. Grease and oils of all kinds were used with but temporary success. Finally the following method was tried: The annular space between the hub and the rim was packed with wood. This wood butted tightly up against felt pads as shown in the engraving. The pieces of wood were secured to each other by ordinary wood screws, care being taken not to have the heads project. Good hardwood should be used, and rubber might be used to advantage instead of felt, except for exposed outdoor work. This method eliminated the objectionable noise from the gearing.



A Method for Eliminating the Noise in Crane Gearing

* * *

In a report by the secretary of the French Aero Club, relating to aviation in France during 1911, the following figures indicating the development of aeronautics are given. In that country alone 13,000 flights were made across country, and in total 1,625,000 miles was covered; the total time that aeroplanes remained in the air was 30,000 hours. The English Channel has been crossed thirty-seven times. The accident record has decreased, and during the year 62,500 miles was flown for every fatal accident.

INDUSTRIAL EFFICIENCY*

The word "efficiency" has been used somewhat to excess for some time past. A great many people are writing and talking of efficiency who do not seem to have a clear conception of what that word means. It is the special business of the engineer to study efficiency, but the fact that a man styles himself an "efficiency engineer" is not necessarily a recommendation. Recently a man prominent in the industrial field stated that it seemed as if everyone who had failed at everything else was advertising himself as an efficiency engineer. Now, it is possible to be entirely in sympathy with *bona fide* efforts to increase efficiency without being in sympathy with all this talk about efficiency by people who do not know what the engineer means by this word. A society has recently been formed for the promotion of national efficiency which has spent some time trying to find a definition of the word efficiency. This being the case, there is apt to be a great deal of misunderstanding on this subject.

What we want to do is not necessarily to change our methods of work, but to do our work thoroughly, and this cannot be done by merely talking. The author's work has sometimes been criticised because it is said to have been done too thoroughly—he goes too much into detail, etc. However, any work which has anything to do with engineering must be done thoroughly.

Possibilities for Greater Industrial Efficiency

With regard to industrial efficiency, it does not seem to be necessary to present a great many ideas, but it is necessary that the fundamental ideas and causes be clear. Some time ago, the financiers of this country thought that they had solved the industrial problem by the great economies made possible by consolidation into huge combinations. Large trusts were formed, and it was believed that by eliminating competition it would be possible to manufacture and sell a great deal cheaper than had been possible in the past. These expectations, however, do not seem to have materialized, because the continually increasing cost of living in this country seems to indicate that we need something more than able financiering to round out our theory of industrial economy. This has been a growing conviction on the part of students of our economic conditions for several years, but the most critical were not prepared for the admission, before the Interstate Commerce Commission, in November, 1910, by some of the most noted railroad financiers of the country, apparently seconded by Mr. Morgan himself, that they had done everything possible to reduce the expense of operating railroads, and that from now on the public must accustom itself to increasing freight rates. These financiers thus admitted that in the branch of industry in which the financial man is, perhaps, more nearly supreme than in any other, and in which competition has been practically eliminated, rising costs forced them to ask the public to bear a portion of their burden.

The student of economics asks if there is not something lacking in our system of industrial economy that makes such requests necessary, or even possible. If it is a fact that in any branch of industry every possible economy has been effected, and that in the future costs will be higher, we are confronted with a very serious condition, the far-reaching effect of which it is hard to foresee. It has been our boast in the past that with our labor-saving machinery and our improved methods, we had so reduced costs as to make the luxuries of today the necessities of tomorrow. If, in any branch of industry, we are forced to acknowledge that costs will in the future be higher, are we not pointing to the time when these necessities will again be luxuries?

The statement, which happily few believe to be a fact, that in any industry the minimum cost has been reached, and that hereafter costs must be higher, is such a serious one, and fraught with such serious consequences to our industries at large, that many of us feel like asking the great financiers who are backing this statement to speak for themselves only, for there are many engineers who not only do not agree with them, but who believe there are means of increasing efficiencies and reducing costs that the financier has as yet no conception of. These methods have been applied in isolated cases, and to a greater or less degree to a great variety of industries, and they have produced a better and a cheaper product; and the workers are better paid and better satisfied.

In making this statement, it is not intended to disparage the work of the financier, but to remind him that the civilization of to-day has not been built up solely by his efforts. In this process, the engineer and his able assistant, the skilled mechanic, have been even more integral factors than the financier, and until they hold up their hands and say the end is reached, that modern combination of engineer and mechanic, the mechanical engineer, respectfully asks that they withhold their cry of despair, and allow him to present what Mr. Brandeis calls his "Gospel of Hope."

Present Tendencies in the Development of Industries

Until within a few years, all mechanical knowledge was empirical. It had been gathered by cut-and-try methods through centuries, and was handed down with no written record. Yet, it is wonderful what great progress had been made. The master workman of a century ago was justly proud of his work and of the apprentices that went forth from his shop. With the perfection of the steam engine, which is the foundation on which our civilization is built, and which was the invention of a mechanic whose work has had a greater influence on the world than that of all the financiers that ever lived—with the perfection of the steam engine, the master workman obtained cheap power, and was enabled to increase the size of his shop. The increase in size of the workman's shop gradually developed the factory system of today, in which the foreman and workmen have no interest other than their daily wage, and where they are too often laid off without cause and without notice, to suit the plans of the owner. Is it surprising that, under these conditions, their interest in the training of apprentices should lag, and that the foremen and workmen should take but little trouble to train men who will shortly become their competitors?

The Use of Records

But this is not all. The owner too often puts all responsibility for the promotion of efficiency upon his superintendent and foremen, yet limits them in the wages they are allowed to pay, or the records they are allowed to keep. The records, as a rule, are just sufficient for him to make criticisms by, but not enough detailed to enable the foreman or superintendent to know where the inefficiencies are, or which of his men are most valuable to him. In one concern a man who had complete charge of all the cost records frankly avowed that he was not keeping these records for the benefit of the superintendent; he was simply keeping them so that he would know what was being done; he did not care anything about the superintendent. In other words, he was there to criticise, not to help. He had a lot of clerks to help him do the work. Now, he did not say so, but this is what was in his mind: Those records were to keep somebody from stealing something. In fact, there are too many records to keep somebody from stealing something, and not enough to help the man who has to do the work to do it right. The difficulty of keeping people from stealing things is not great; we do not have any difficulty in that. The records of cost and material should be kept to enable people to do the work right.

Having no individual record of his men, the financial head too often orders that all men of a certain class shall be paid the same wage, and for a long time it has been extremely difficult for the capable man to rise much above his fellows, no matter how much more, or better, work he did. What has been the result? The capable man, failing to rise above his class, has devoted his energy to raising his class, and by means of his union has forced his employer to raise the class wage, regardless of the work that was done. But let us not blame the financier or the owner too much for that. When he allowed his foreman or, perhaps, his superintendent to raise wages, he found that very often the brother-in-law, or the nephew, or somebody like that, got the high wages and the efficient man did not, and that has happened too often. When he found that out he said, "Well, we will pay machinists all the same wage." But when he made that statement, he put the strongest possible weapon into the hands of the men who wanted a union. They then said, "If we cannot get increased wages for the efficient man individually, we will get higher wages for our whole class," and they then banded together to get the union wages, and you cannot blame them.

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* Abstract of an address by Mr. H. L. Gantt before the American Society of Swedish Engineers, Brooklyn, N. Y., March 23, 1912.

The employer now complains bitterly; but has he not combined with his fellow to get all he could for what he had to sell? Are the workmen not playing the same game he has played, and playing it better? By forcing the capable man to remain in his class, the employer has held back the individual, but greatly strengthened the class, until today the employer with his combination on one side, and the workman with his union on the other, stand facing each other as two great armies, each trying to get the better of each other, by manoeuvering, if possible, but by fighting, if necessary. Without considering who is to blame for this condition, let us ask if there is any remedy.

The Causes of Industrial Unrest

While arbitration has certainly averted strikes, it has not settled anything, or diminished the desire of either party to oppose the other, and can only be considered as a temporary expedient. Collective bargaining has certainly increased the wages of the workman, but cannot alone offer a final solution of the labor problem, for wages cannot be increased indefinitely. The railroad presidents claim that the increase of wages obtained by this means necessitates increased freight rates, which, if granted, must necessarily, in a measure at least, increase the cost of living. Thus, neither arbitration nor collective bargaining, on which we have placed so much confidence in the past, gives promise of any permanent solution of our difficulties, and the time seems rapidly approaching when the friction of conflicting interests will seriously hamper our further development. We, therefore, naturally, ask why these interests conflict. The answer is plain; neither party has been willing to consider the interest of the other. The employer has too often insisted on paying the lowest wage, regardless of the service rendered, while the employe, through his union, has demanded the highest wage, regardless of what he gave in return.

I heard something in the last two or three days that quite astonished me. I have heard the same thing from three or four persons, but the last time I heard it from a rather unexpected source. I have heard a number of men make the statement recently that the financier—the capitalist—was getting too large a percentage of the earnings of the increase in wealth. A man told me that a millionaire friend of his in Wall Street had made that statement to him. Now, there is not any question that within the last fifteen years there has been a much greater percentage of the increased wealth harvested by those who already had wealth. The worker, the engineer, the producer, did not get the same proportion of it that he had gotten previously, and that is one of our troubles today. The very serious unrest in this country, England and the countries of Europe, is due to the fact that the workmen have made up their minds that they are going to get a larger percentage. Now, we have got to face that condition and find out what is the proper thing to do, and try to do it as soon as we can, and prevent what seems to be the impending conflict, which is due to the fact that both employer and employe have disregarded the great principle of equity, which is the foundation of all harmony.

In the commercial world it has long been recognized that transactions which do most to promote prosperity are those which are beneficial alike to buyer and seller. Does not the same law hold good in the industrial world in the purchase of labor? With the operation of such a law, the interests of the employer and employe become identical, and we have laid the foundation for their harmonious cooperation. Having done this, we are ready for the next step, namely, the promotion of efficiency in the utilization of human effort. The progress so far made in this direction has in many cases been in spite of a lack of equity in the relations between the employers and employes. Consider how much faster progress could be made if all men were assured of an equitable return for their efforts.

As a matter of fact, real efficiency is impossible without equity, for no man will continue to put forth his best efforts without a proper reward. The idea of doing work efficiently is comparatively new to people in general. It is only within very modern times that the best educated people have given any thought at all to the subject of physical work. The only serious subject requiring manual skill that was considered worthy of their attention was that of fighting, or war. As a matter of fact, it was Sir Henry Bessemer's search for a stronger metal with which to make field guns that gave us Bessemer steel. Until within a few generations, it has been very much more important to defend the wealth you had than to acquire more than sufficed for your daily needs. Hence the importance of defence. The time has come, however, when a man no longer has to defend his property with his skill or life, and can devote his energies to acquiring a surplus for himself and family. The great majority of men are ambitious to secure such a surplus, and are willing to work efficiently and industriously if they can be assured of an equitable compensation. The precise method of compensation is comparatively immaterial, provided efficiency is rewarded and not penalized, as is too often the case.

What has become of the ingenious Yankee, of whom we heard so much forty years ago? Are Yankees less ingenious today? Not at all; but our factory system of today too often fails to reward either ingenuity or efficiency, and these men have turned their attention to getting their advancement through their labor union. How much better it would be for the community at large if these men could devote their labors to the promotion of efficiency, and thus get their reward. A system of industrial economy based on industrial warfare is so evidently wrong that few will undertake to defend it, for it necessarily groups employers and employes into two hostile camps. Under such conditions, cooperation within each class is to be expected, and the combination of employers on the one hand and the formation of labor unions on the other are the only natural results.

Now, it seems that these segregations of interest which are practically mutual in their nature, are the cause of a great deal of our industrial difficulties. It is not out of place to dwell so long on the industrial unrest, because the great problem before us today, industrially, is the very problem outlined in the foregoing paragraphs. It is necessary to utilize the human efficiency in such a way that all the reward of the increased efficiency does not go to one class. The man who works wants his share, and it is, therefore, necessary to devise ways and means to give him a larger proportion of the results of his labor. Any scheme for the utilization of the energies of the community for the benefit of one class of people only, would develop an oligarchy which would ultimately be overturned by a revolution. England presents an example of the conditions that follow improper economic relations. It is felt in England that even though the coal strike be settled, they have not passed their worst danger. There is an industrial unrest there of which the coal strike is merely a symptom, and the whole country is stirred up a great deal more than is indicated by that strike.

The Task Idea

In trying to find a means for uniting the interests of the employer and employe, the task idea was developed; that is, the idea of putting before each workman a certain task to be performed in a given time, assuring him his regular wages if he could not perform the given task, and promising him a suitable reward in case he was able to perform the given task in the given time.* One of the important points relative to this method, frequently called "scientific management," is that the reward or bonus must be great enough so that the workman will feel that he is fully compensated for the extra exertion required to do the task. The bonus is usually from 20 to 50 per cent of the regular day rate. Task work does not necessarily mean more severe work, but it means more continuous work, but at the same time, work under more favorable conditions.

Another important point that should always be noted is that having set a task, the responsibility for its performance does not rest upon the workman alone. Every case of lost bonus must be investigated by the management, and the reason determined. It seems very difficult to get people to grasp that idea and to go to that trouble. If a man does not make the bonus, they seem perfectly willing and content to let him lose it and pay little attention to him, but this is a great mistake and tends to discredit the system. The man is discouraged—it may not have been his fault; the machinery may have been out of order or the appliances he has been working with may have been unsuitable; the material may have been inferior in quality. All these reasons may have prevented him from performing his task. Frequently imperfections and defects in material bought have been found simply by investigating why the workman has been unable to perform his task; yet, that material may have passed inspection, but the imperfections have been such that they could not be located in that manner, although they would show up when the workman got ready to perform his work.

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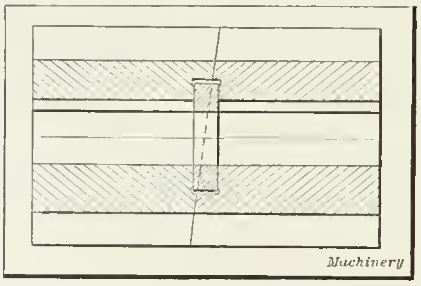
* The subject of task work and the methods employed were dealt with in the December, 1911, number of MACHINERY, in an abstract of a paper entitled, "Task Work—The Basis of Proper Management" read by Mr. H. L. Gantt before the National Machine Tool Builders' Association.

If, again, when some workman is unable to accomplish his task, a capable man, in whom he has confidence, tries to find out what the reason is, he will feel satisfied and try to earn his bonus the next day. Therefore, in the task system, next to the subject of the proper task comes the necessity of investigating every case of lost bonus and of determining the reason. If a proper scheme of management is devised, by which all the available knowledge is used to plan the work, and if the tasks are set in accordance, and the workman liberally compensated for the performance of the task, there is no question but that marked economy can be produced by this new method of management.

* * *

SIMPLE METHOD OF INTERLOCKING MILLING CUTTERS

The accompanying illustration shows a simple method for interlocking milling cutters. As indicated, the method consists simply in milling or planing off the ends of the two halves of the cutter at an angle, and providing recesses in the angular faces as indicated. The angular faces are not intended to bear tightly against each other, and, hence, do not need to be absolutely true, but the bearing is on a washer placed in the recess mentioned, as it is much easier to provide true bearing surfaces in that manner.



"Interlocking" Milling Cutters

The method was originated by the firm of J. A. Kühn of Frankfort a. M, Germany, and was recently described in the *Zeitschrift für Werkzeugmaschinen und Werkzeuge*. It seems that this method has certain advantages over the ordinary interlocking methods on account of its simplicity. It may not be exactly right to call the method an interlocking one, as it is rather a case of "overlapping" milling cutters. The object in view, however, with both the interlocking method generally used in this country and the method shown in the accompanying illustration, is the same.

* * *

According to *Power*, Sir Hiram Maxim recently made a statement regarding the superiority of American workmen. It was his experience that in England, for example, while there are plenty of men to be hired at a salary of about 30 shillings ($7.50) per week, it was difficult to find a man at £5 ($25) a week for a position requiring care and intelligence. In Canada and in the United States he believed a positively different state of affairs to exist. In 1877 to 1880 he had charge of an electrical works in which a considerable number of young men were employed, and today nearly every one of them is in a high position. Young American mechanics are found studying algebra and geometry, while in England the penny novel takes the place of scientific books.

A SMALL MACHINE VISE

By CHESTER L. LUCAS*

Fig. 1 shows a small vise or clamping fixture which has proved valuable for holding miscellaneous pieces in the toolroom, as pins, screws, or small flat blocks, upon which some slight machining operation such as drilling or milling must be performed. This vise is made from a Starrett toolmaker's clamp and consists essentially of a jaw *A* which is held to the inside face of the end of the clamp by a fillister-head screw *B*. The other jaw *C* is a counterpart of the first, and, in making, the two are clamped together and holes drilled for the two dowel pins *D* which are more clearly shown in the line engraving, Fig. 2. These dowel pins are made a driving fit in the holes in the movable jaw of the vise and a sliding fit in the holes in the stationary jaw. Small spiral springs placed behind these pins insure that the jaws will open when the pressure on the movable jaw is released. Two vertical V-grooves are cut in the centers of the jaws so that round or square pieces may be rigidly held in an upright position. By cutting a socket in the back side of jaw *C*, to receive the clamping screw, the flat tip shown on the screw may be dispensed with, but it works very satisfactorily as shown. The object of using the two dowel pins, which, by the way, is the important feature of the fixture, is to provide a means for holding work perfectly true, the tendency otherwise being for the inner jaw to lift the work when pressure is applied behind the jaw. With this method of guiding the jaws, no trouble is encountered from this source. For holding the clamp and jaws on the table of the milling machine, two holes may be drilled through the center of the bottom part of the clamp. These holes are countersunk from the top, and flat-head screws may be passed through and into T-nuts or blocks in the T-slot of the milling machine table. When the clamp is wanted for regular work, the fillister-head screw *B* and the jaws are removed.

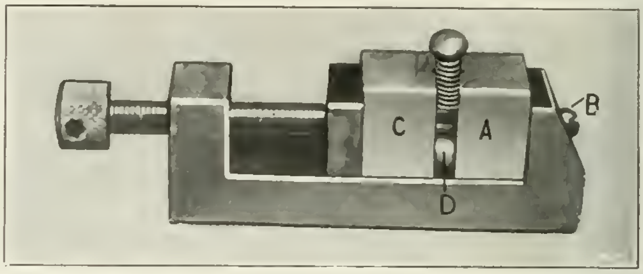


Fig. 1. Small Machine Vise, made by adding Jaws to a Toolmaker's Clamp

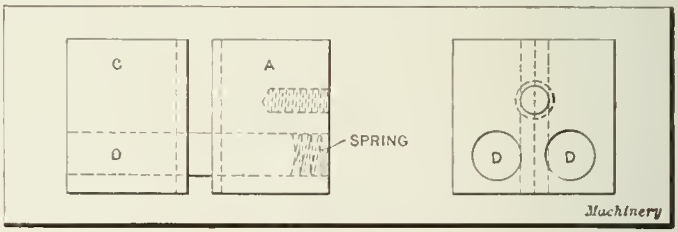


Fig. 2. Details of Jaws

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The Supreme Court of the United States will not reopen the Dick mimeograph constructive patent infringement case, and the decision of March 11 stands, affirming the right of the makers of a patented machine to prescribe what supplies shall be used with it. The gravity of the situation is generally recognized and Congress should immediately pass such legislation as is required to relieve an intolerable condition. Legislation is also required that will give inventors better protection and prevent the buying up and shelving of patents by corporations seeking to monopolize any line of manufacture and selling.

* * *

At the factory of the Wells Bros. Co., Greenfield, Mass., the 300 employes who do not go home to their lunches are supplied by the firm with hot coffee, which is provided free of charge.

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* Associate Editor of MACHINERY.

UNUSUAL HOBBING OPERATION

The shaft seen to the left in Fig. 1 is used in the construction of the Amplex motor cars (built by the Simplex Motor Car Co.), for advancing the spark or varying the points of ignition in the engine cylinders. As the illustration shows, this shaft has four equally spaced spiral grooves which are ¼ inch wide and ⅛ inch deep. When the shaft is assembled as shown in the view to the right, it is connected with the shifting fork and timer gear, and the right-hand end is equipped with a clutch which is coupled to the armature of the magneto. The four spiral grooves for giving this spark advance shaft a rotary movement, are cut by hobbing in a Lees-Bradner hobbing machine. The operation is both novel and interesting and presents some new features in the design and application of a hob.

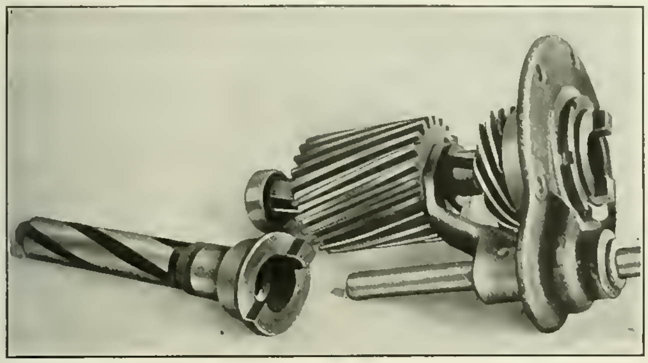
Fig. 1. Spark-advance Shaft having Helical Grooves which are cut by Hobbing—Shaft assembled with Shifting Fork and Timer Gear

The way the machine is arranged for this work is shown by the detail view, Fig. 2. The shaft is held at one end, by a draw-in collet inserted in the horizontal work-arbor, and the other end is supported by the regular tailstock center. The cutter-head containing the special hob is set at right angles to the axis of the work. This hob has four teeth, and the four helical grooves in the work are cut simultaneously. The four teeth are equally spaced and each tooth finishes its own groove. The hob and shaft rotate in unison, there being approximately one revolution of the cutter spindle for each revolution of the work spindle. In Fig. 2 is shown a shaft that has just been completed.

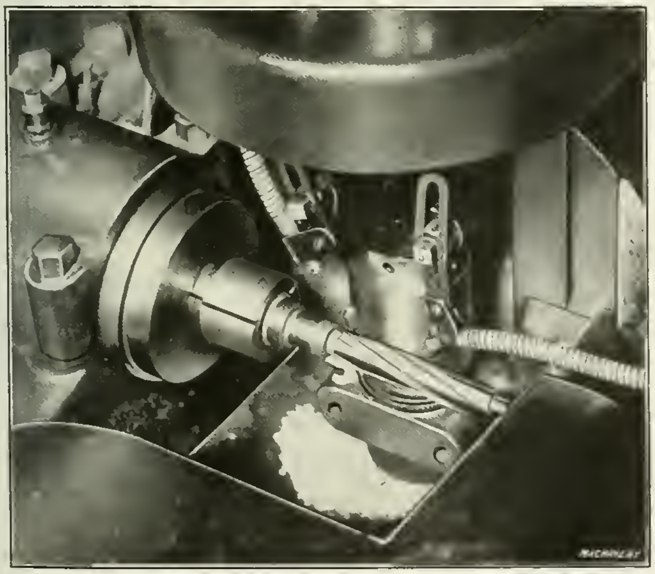

Fig. 2. Method of Hobbing Shaft in Lees-Bradner Hobbing Machine

The relative action of the work and hob, as well as the construction of the latter, are shown more clearly in the diagrammatical view, Fig. 3. As previously intimated, the hob is set in a perpendicular position, the four cutters and the axis of the work all being located in the same horizontal plane, as shown in the end view. The shaft to be splined rotates in the direction indicated by arrow *w*, and the hob, as shown by arrow *h*. In addition, the shaft has a longitudinal feeding movement to the left, and is geared to produce the angle of the helical groove that is required to be generated. The action of the hob and work is as follows: Cutter *A* cuts groove A_1 (see end view) and when the hob has rotated one-quarter revolution, thus bringing cutter *B* to the front, the work has also turned a corresponding amount (plus the rotation due to the geared movement), so that cutter *B* enters groove B_1. Another quarter turn brings cutter *C* into groove C_1 and in the same manner, tool *D* enters groove D_1. The geared movement previously referred to causes each cutter to follow a helical path on the work. When a cut is started at the end of the shaft, the gashes generated by the four cutters are at an angle owing to the rotation of the shaft, and in order to make the cutters follow the helical path thus started, as the work feeds longitudinally, it is necessary to have a correct movement; in other words, if a single gash were cut across the shaft, without the correct movement and with the cutter and work rotating uniformly, the angle of this gash would be zero, that is, the cut would be parallel to the axis.

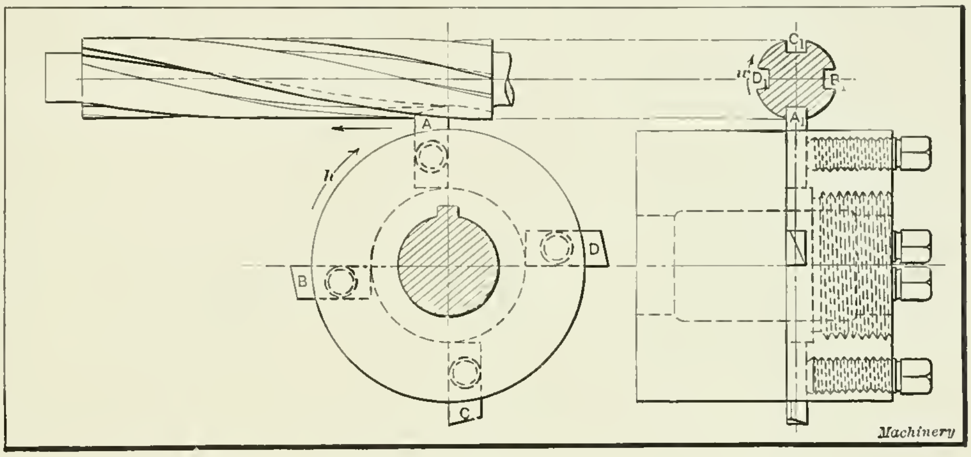

Fig. 3. Diagram showing Work and Four-toothed Hob used for Cutting the Helical Grooves

It will be seen that the hob is, practically, a four-tooth fly-cutter and each groove is milled to the proper depth by a single tool. The four grooves are finished in one passage of the work and the time required for hobbing a shaft is seven minutes. The length of the shaft is 7¾ inches, the diameter, ⅞ inch, and the material 0.020 carbon steel. The lead of the spiral is 11.568 inches and the spiral angle, 13 degrees 22 minutes. Each groove generated by this hob is similar to a helical keyway in that the sides on a cross-section taken at right-angles to the axis of the shaft are practically parallel to a radial line passing through the center of the groove. The groove differs in this respect from a theoretically correct thread groove, the sides of which are square on the longitudinal section.

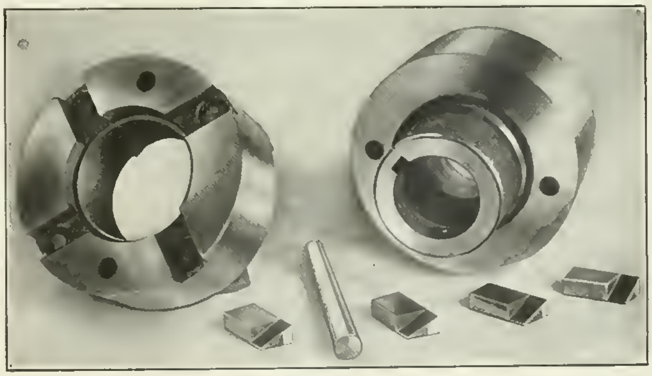
Fig. 4. The Component Parts of the Four-toothed Hob

The construction of the hob, as well as the form of the cutters, is shown in Fig. 4, which is a view of the hob before assembling. It consists of a body having a threaded hub over which is screwed the locking ring seen to the left. This ring contains the tool slots which are ground to size and are accurately spaced equi-distant from each other, in order to secure uniform spacing of the spiral grooves on the shaft. It will be noted that these slots are offset so that the front or cutting face of each tool will be on a radial line. The cutters are made from high-speed steel and the cutter shanks are ground to fit the slots in the locking ring, so that they are interchangeable. The cutting edge is parallel to the axis of the hob and the under side of each cutter has a rather large clearance angle in order to clear the lower side of the groove. When a hob becomes dull, it is sharpened by simply grinding the tops of the teeth.

* * *

CUTTING SPEEDS AND FEEDS FOR TWIST DRILLS

The accompanying diagram originated by Messrs. E. G. Wrigley & Co., Ltd., of Birmingham, England, is published by the *Practical Engineer* (London). It gives speeds and feeds applicable to ordinary practice for high-speed and carbon steel twist drills, when drilling mild steel. As the values given are not experimental or test rates, but intended for everyday practice, they may, of course, be exceeded under favorable conditions. It is, however, generally desirable to keep the cutting speed comparatively low, so as to avoid overheating of the drill point, and consequent waste of power.

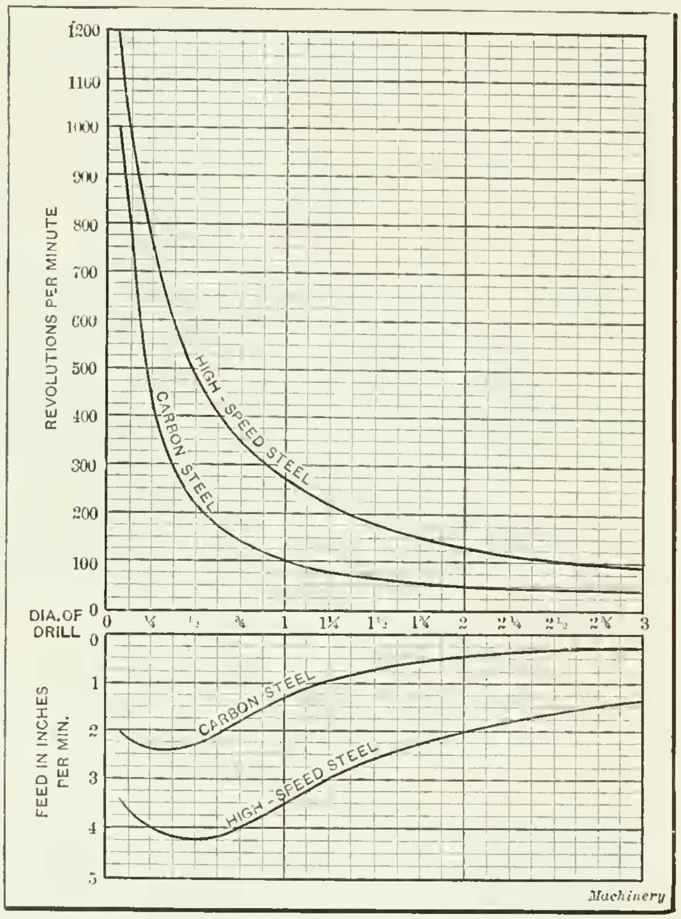

Diagram of Cutting Speeds and Feeds for Twist Drills

* * *

The Kempsmith Milling Machine Co., Milwaukee, Wis., caseharden the gears used in the feed boxes of the Kempsmith milling machine. The gears are packed in cast-iron boxes about 12 inches long, 8 inches wide and 6 inches deep with a German casehardening compound. The boxes are provided with a cast-iron cover having a groove for sealing. The groove is filled with clay when the cover is applied and the cover is held in place by two keys engaging lugs at the ends. When the boxes are placed in the furnace they are turned upside down, the purpose being to hold the covers more securely and prevent the gases from escaping. The covers are provided with four lugs or feet at the corners, on which the box rests, and in the reversed position the cover is not likely to work out of shape. The practice works well.

EMPLOYER'S LIABILITY AND WORKMEN'S COMPENSATION[*][†]

Under the common law and employers' liability statutes, employers are held for the consequences of accidents to employes, only provided the employer or his supervising agent is negligent; and not even in such case if the employe has been contributorily negligent or the injury has been due to the negligence of a fellow-servant or co-employe; or in case the hazard was of such a character that it belonged to the usual risks of the occupation which it is considered the employe assumes by accepting the employment. These three defenses are known respectively as the "contributory negligence," the "fellow-servant" and the "assumption of the risk" rules.

Purpose of Workmen's Compensation Acts

The purpose in workmen's compensation acts is to cause the employe, or his dependents in event of his death, to receive compensation on a reasonable basis, without regard to fault. The Court of Appeals of New York held a law making the employer directly liable for such compensation to be unconstitutional as "taking property without due process of law," that is, in this case without the employer having contracted to pay under such circumstances and without his having been guilty of a tort, that is, a wrong which would give the employe a right to recover.

The method of avoiding the effects of this decision, by offering to employers an opportunity to come under a workmen's compensation act voluntarily, it being made advantageous for them to do so, has taken several different forms, *viz.*:

In New York the option was given to employers to whom the compensation act did not directly apply, to avail themselves of its provisions by agreement with employes. There was no special inducement to do this, however, and the rates of premium to cover the risk under the compensation act were so much higher than rates charged by the same companies to cover the risk under the common law and the employers' liability act, that virtually no employers took advantage of the privilege.

In several states—California, Illinois, Kansas, New Hampshire, and Wisconsin—compensation acts have been passed of the usual type; that is, providing for payments of a definite percentage of the wages (usually with a minimum and a maximum for a certain number of weeks, and of a definite amount based upon the weeks in event of death) for all accidents occurring while at work, without regard to fault. Under these laws it was made optional with the employer either to come under the act or not to do so; but in case he did not do so, two of the usual defenses, *viz.*: the "fellow-servant" rule and the "assumption of the risk" rule were abrogated, and in most cases the "contributory negligence" applied only to reducing the damages. In some of these states, *viz.*, Illinois and Kansas, if the employes refuse to be under the compensation act, these defenses are available against him and his dependents.

In three states, Massachusetts, Ohio, and Michigan, laws have been passed offering to employers the election to insure their employes so as to provide compensation to them and their dependents for the consequences of all accidents occurring while at work, without regard to fault. In these states, also, in case the employer does not so elect, the defenses of the "fellow-servant" and "assumption of the risk" rules have been taken away, and also the defense of "contributory negligence," except that in Ohio and Michigan it may be used to reduce the amount of the verdict.

Respects in which Laws Differ

In other respects, the laws in regard to insurance in these three states differ very considerably. Thus in Ohio the insurance must be in a state insurance fund, charging premiums fixed by a board, with the privilege of assessing for more;

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[*] Abstract of a paper read by Mr. Miles M. Dawson, attorney-at-law and consulting actuary, before the fourteenth annual convention of the National Metal Trades Association, New York City, April 11, 1912.

[†] For a list of articles on industrial accidents and employers' liability, which have previously been published in MACHINERY, see the note accompanying the article published in the November, 1911, number, entitled "The Prevention of Industrial Accidents."

and, of course, with the privilege of taking into account previous payments in fixing payments for future years. In Massachusetts, the insurance may either be in a mutual association of employers under state supervision or in any licensed mutual or stock insurance company. In Michigan the insurance may be in a state fund, in a licensed or stock insurance company, or by the employer himself satisfying the state board that by reason of his resources and the number of his employes, it will be safe to permit him to be the insurer.

In New Jersey, the law provides for the compensation of all accidents occurring while at work without regard to fault, and applies to all employers unless by written notice to a given state officer they elect to remain under the common law and the employers' liability act. If they do so elect, the "fellow servant" and "assumption of the risk" rules are abrogated, "the contributory negligence" rule can only be used to reduce the verdict, and the burden of proving "contributory negligence" is put upon the employer instead of, as previously, the burden resting upon the employe to prove that he was not contributorily negligent.

Under these different laws, elective in form, there have been very different results. Thus, as has been stated, exceedingly few employers accepted the provisions of the New York law. In New Jersey, on the contrary, since it took an act upon the part of the employers to keep from going under the law, a very large proportion of them have accepted its provisions; but some large employers have refused to do so, among others the Standard Oil Company, while some other employers have obtained more advantageous rates by refusing to do so. There is no provision under the New Jersey law for mutual insurance. Consequently, a number of New Jersey employers have joined together to organize a stock company in which to insure themselves, hoping thereby to get lower rates.

In California, there is a good deal of complaint that the rates under the workmen's compensation act are materially higher than under the common law and employers' liability act, even with the defenses abrogated; and consequently many employers have not elected to come under the former. This complaint is also made in other states, notably Wisconsin, where, however, mutual companies are being organized under the encouragement of state authorities; and Ohio, where the stock insurance companies are making as strong a fight as possible to keep the business from going to the state insurance fund. The Michigan and Massachusetts acts have not yet taken effect.

In the state of Washington a compulsory insurance act took effect on October 1, 1911, requiring all employers to whom the act applies to insure with the state insurance fund. For the purpose of the fund they are divided into a good many classes, each of which must pay its own claims. In consequence, a few classes already show a deficit, but most of them show a surplus. The total premiums collected amount to about $500,000, the payments and reserves for sums payable hereafter on account of claims already arising amount to about 30 per cent, and expenses to about 15 per cent. The Washington law differs from the other laws in one other respect, *viz.*, that the amount payable in event of disability, *viz.*, from $20 to $35 per month during disability, and to the widow for herself and children, from $20 to $35 per month, varies not according to the wages, but according to the number of dependents.

In Montana, an act is in effect providing for certain rates of compensation to be paid to miners through the medium of compulsory insurance in a state fund, each employe, however, or the dependents of an employe killed by accident, having a right to elect, after the accident occurred, whether to accept this compensation or proceed under the common law or employers' liability law.

In the state of Nevada, notwithstanding the decision of the Court of Appeals of New York, an act was passed, requiring, subject to reduction of amount in event of "contributory negligence," all accidents occurring while at work which are not compensated under the common law or employers' liability law, to be compensated to the amount during disability of 60 per cent of the wages for a time until a maximum amount of $3000 is paid, and in event of death, a minimum of $2000 and a maximum of $3000.

Recommendations of Commissions

In addition to these plans, which have already gone into effect, bills have been introduced upon the recommendation of commissions, as follows:

In Congress a bill has been introduced to do away with liability at common law and under the employers' liability act, and to substitute a workmen's compensation act, calling for compensation for all accidents occurring while at work, without regard to fault. This will apply to railways only.

In Maryland a bill has been introduced by the commission which also seeks to repeal the common law, and employers' liability act, and to hold employers directly liable for compensation for all accidents occurring while at work, without regard to fault. This bill also makes provision for transferring the liability to mutual or stock insurance companies, and provides that if this is not done, all employers with less than $150,000 resources over and above all liabilities, or employing fewer than 1000 men, shall be required to insure in a state insurance fund. Provision is made for the compulsory insurance feature to apply to all employers in case the portion of the law, holding the employer directly liable, should be declared unconstitutional.

During the past year, the question of the constitutionality of some of these acts has been before the courts and decisions have been rendered as follows: In Massachusetts, the matter was submitted by the legislature before the act was passed, to the Supreme Judicial Court—which may be done in that state—and the proposed act was held to be constitutional. In Ohio the elective insurance act has been before the Supreme Court and has been held to be constitutional. In Washington, the compulsory state insurance act has been before the Supreme Court and has been held constitutional. In Wisconsin, the elective workmen's compensation act has been passed upon by the Supreme Court, and has also been held to be constitutional. In New Jersey, the lower court has passed upon the law and found it to be constitutional.

In Montana, the state insurance act, applying to coal miners, was upheld as constitutional in all respects but one, *viz.*, that it was discriminatory, and in violation of the rights of employers as depriving them of property without due process of law, in that, although an employer might have paid his premiums, his employes and their dependents might, at their own free will, sue him at common law and under the employers' liability act, and hold him responsible so that he would not receive any benefit from the insurance for which he had paid.

The benefits provided under these various acts vary as follows: Temporary disability, from 50 per cent of the weekly earnings, with a $4 per week minimum, and $10 per week maximum in Massachusetts, to 66 2/3 per cent of the weekly wages in Ohio, with a $5 minimum and $12 maximum. Six of the states fixed the percentage at 50 per cent, one at 60 per cent, two at 65 per cent and one at 66 2/3 per cent. The term of payment varies from 300 weeks in New Hampshire and New Jersey to the entire period of disability in Illinois (where the amount payable after eight years, however, is reduced), Ohio and Washington. The maximum amounts of total disability compensation when named in the laws, range in the neighborhood of $3000, except where compensation is payable throughout the disability, when no such limit applies.

In two states, New Jersey and Wisconsin, the employer, if under the workmen's compensation act, has no other liability. In other states his additional liability ranges from "intentional violation of a safety law" in Illinois, or "serious or willful misconduct of employer or his superintendent" in Massachusetts, to liability in all cases where the "employer is liable for damages under other liability laws" in Nevada. The employe is excluded from right to benefit on account of willful misconduct only in California, Illinois, Kansas (where it is limited to certain acts of misconduct), Massachusetts, Ohio and Wisconsin. In New Hampshire, intoxication also excludes, and in Nevada, wherever "contributory negligence" was solely responsible for the accident, that is, where it was wholly the fault of the employe injured.

In one state, Washington, where there is compulsory state insurance, compensation is payable from the first day. In California, Illinois and Ohio the first week is excluded and in Wisconsin also unless disability lasts longer than four weeks, in which case the first week is also included. In Kansas, Massachusetts, New Hampshire and New Jersey, the first two weeks are excluded and in Nevada the first ten days, unless the disability last longer, in which case apparently the first ten days are also paid for. In all the states excepting New Hampshire, where to recover under the act calls for an action in equity (not requiring a jury) instead of an action at law, and New Jersey, where the court is directed to decide the matter "in a summary manner," an accident board is set up or a provision is made for arbitrators to make an award before the matter can be taken to the courts.

In the following states commissions have been appointed and are now at work upon bills to be introduced in the next legislatures, *viz.* Pennsylvania, Colorado, North Dakota, Missouri, Iowa, West Virginia, Nebraska, Connecticut, Rhode Island and Delaware. It is said that the Missouri commission has abandoned the task, no appropriation having been made. In Texas the governor was asked to appoint a commission to report to the legislature at its then session, but no appointment was made.

In Canada, all the provinces have now adopted workmen's compensation acts excepting New Brunswick and Ontario. In New Brunswick the employers' liability act was much extended in 1909 by modifying the defenses. The Canadian workmen's compensation acts hold the employer directly liable. In Ontario, the Chief Justice of the High Court has been appointed a sole commissioner to report a bill. The Canadian Association of Manufacturers and the representatives of workmen's associations have been before the commission and have joined in recommending a system of compulsory mutual insurance, through funds covering all sickness as well as accident during the early weeks, to which both employers and employes would contribute, and a fund covering death and disabilities beyond the first few weeks, due to occupation accidents only, to which employers will alone contribute. The Commissioner has just handed in a preliminary report, expressing favor for this plan.

European Laws Changed

In Switzerland, where for more than ten years past employers have been held directly liable for negligence, with the defenses abrogated, a compulsory insurance act has been passed, submitted to the people at a referendum and adopted by them. It provides for insurance against sickness as well as accident, covering the first few weeks, to which both employers and employes contribute, and for insurance covering death or disability beyond the first few weeks, due to occupation accident, to which employers only contribute. The state, however, makes contributions either directly or by meeting certain expenses in connection with each of these.

In Great Britain, no change has been made in the workmen's compensation act, which holds employers directly liable for the consequences of all accidents and some occupation diseases "arising out of and in the course of the employment;" but the principle of compulsory mutual insurance has been accepted with much favor, practically all the representatives in both houses of both the political parties voting for it, in the form of two laws, one requiring workmen to be insured against sickness and invalidity, and the other requiring them to be insured against unemployment. Toward these mutual insurances, the employers and employes both contribute, and the state also makes a contribution.

The main lines of the German system are as follows:

That accidents (during the early weeks of disability) should be compensated as well as all sickness, through sickness insurance societies to which employers and employes both contribute, and subject to their joint management.

That disabilities beyond the first thirteen weeks and all deaths due to accident while at work should be compensated through mutual associations of employers, to which employers only contribute and which are managed by them.

That as to both of these classes of associations, no more should be collected than is necessary to meet the requirements for the payments currently falling due, plus what is required for expenses, and a moderate amount in addition for the purpose of establishing a reserve, not intended to take care of future payments on account of claims already approved, but only to be called upon in event of a great and widespread disturbance of industry, so that many employes would be out of work and the payrolls of the employers low, in which case, if there were no such provision, obviously the rate of assessment might be very high.

The superiority of this system in economy of management, general efficiency, special efficiency in regard to prevention and the all-important respect of putting upon industry the smallest possible burden currently, was strongly supported both by representatives of employers and of employes, as well as by practically all who, from official or private viewpoint, have carefully investigated the matter.

It is proper here to say that none of the insurance plans so far introduced in the United States are of the same character. Thus the plan adopted in Washington, while dividing the employers into classes, leaves the management in the hands of a state commission. Moreover, the aim is to collect a sufficient amount to set up capitalized values for death claims and presumably, though not avowedly, also to hold sufficient reserves for payments thereafter to be made upon other claims. Certainly there is no indication that an "assessment" system, calling for no more money than is actually required for current payments, was in any sense intended.

The same is also true of the state insurance plan in Ohio. The law there does not require in definite terms the setting up of capitalized values, but from the nature of the system adopted, this is strongly implied. In Massachusetts, a distinct provision is made in the law for setting up capitalized value reserves and charging the state insurance fund with its unearned premium reserves, in the same general manner as would be applied to a private insurance company, whether mutual or stock. Under the state insurance laws of Montana and Maryland relating to coal miners, no special provision was made.

All of these appear to look for the plan to go into full effect from the outset, that is, the full burden falling upon industry from the beginning. Under the German plan, on the contrary, the idea was that the cost would be small at the outset, because only persons who were injured that year would be drawing money. It would be larger the second year, because then persons who were injured the first year and persons who were injured the second year would be drawing money, and in this way the cost would continue to increase for several years until an equilibrium was struck, which, if the risk remain precisely the same from year to year, would not be until from 25 to 50 years had passed.

This condition might be—and in many cases has been—very greatly modified by the introduction of excellent prevention, offsetting this natural increase by reducing the number of claims. A good illustration in steam railways, which started the first year at a cost of 0.39 per cent of the payroll, was 0.79 per cent the second year, 1.26 per cent the third year, and so on, reaching 1.80 per cent in the eighth year. This resulted in prevention so remarkable in character that there was an actual recession of the rate for several years, going down to as little as 1.26 per cent, notwithstanding that they were paying for persons who had been injured (and for the widows of those who had died) in every one of the twelve years previous. Since then, the rate has again increased, but for six or eight years past it has been about 1.80 per cent of the pay-roll—not higher than fifteen years before.

* * *

Calbraith P. Rodgers, the noted coast-to-coast aviator, was killed April 3 by a fall from his aeroplane, resulting from the attempt to perform a difficult spectacular evolution in the air over the beach at Los Angeles, Cal. Rodgers started for the Pacific Coast, September 17, 1911, from Sheepshead Bay, Long Island, and covered 3220 miles after many mishaps and accidents, but too late to win the $50,000 prize offered for the performance of the feat. Rodgers is the seventeenth victim of aviation this year, and the one-hundred and twenty-sixth since Lieut. Thomas E. Selfridge, the first, was killed near Washington, D. C., September 17, 1908.

DIES FOR RAISED LETTER NAME PLATES*

By CHESTER L. LUCAS†

Aside from the manufacture of the Sweetland chuck, for which the Hoggson & Pettis Mfg. Co., New Haven, Conn., is well-known, there is another line of work carried on in its factory that is of interest on account of the high degree of manual skill required to produce it. This work is the cutting of artistic steel stamps, a few impressions of which are shown in Fig. 1, and the making of dies for raised letter name plates, such as are shown in Fig. 3.

While it is the purpose of this article to treat especially of the methods used in the making of the name-plate dies, some of the stamp impressions shown are of considerable interest. It is difficult to illustrate such work to advantage. Of the impressions shown in Fig. 1, all of the script lettering is very difficult to cut in steel, for, of course, it must be cut "reverse," still maintaining its style. Monograms like some of those shown present difficulties of their own, for the various lines must cross and re-cross without breaks or deflections from their true directions. The "Old English" style of lettering is also difficult to produce in steel, and when the letters of a stamp are minute, as well as of difficult shape, like the small "Tannewitz" stamp near the center of Fig. 1, the troubles of the workman are not imaginary. The illustrations of the stamp impressions shown are considerably larger than the originals. Fig. 2 shows a workman engaged in making one of these stamps.

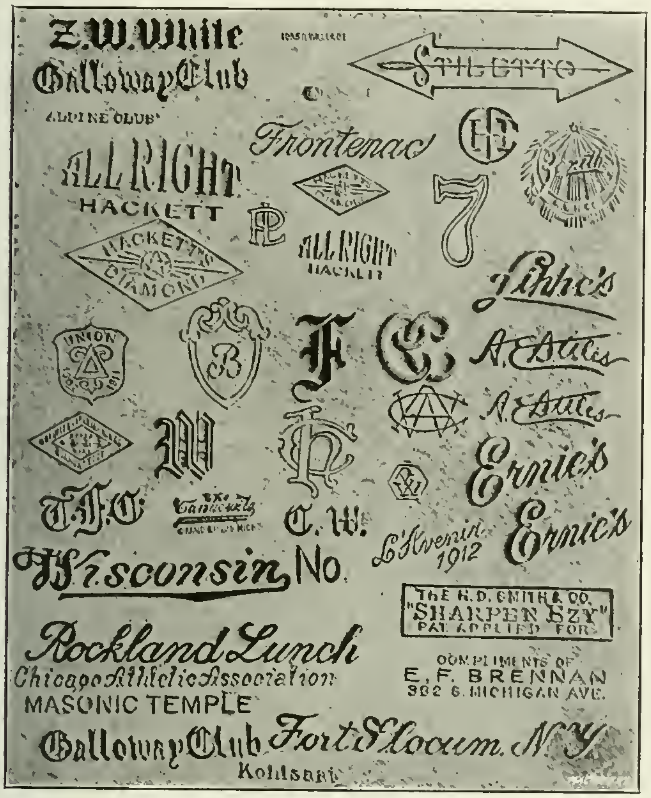

Fig. 1. Impressions of Artistic Stamps

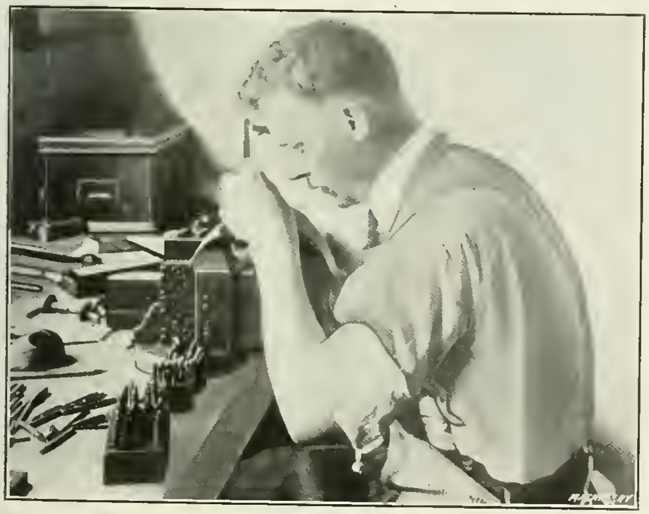

Fig. 2. Making Steel Stamps

The name plates or brass labels, as they are sometimes called, are usually made of very thin brass or aluminum, approximately 0.005 inch thick. They are used as name plates for light machinery, such as graphophones, sewing-machines etc., and for fire extinguishers, tanks, etc., to which they may be soldered. Still another use is in connection with the molding of rubber articles such as hot water bottles, when it is desirable to have lettering appear on the finished surfaces. As in other classes of die-work, the tools used for embossing these name plates comprise two parts, *viz.*: the die and the "force." In the majority of cases machine steel is employed for the dies, tool steel being used only for those dies which have a great deal of small detail or from which labels of thick material are to be made. If the die has been made from machine steel, the forcer, or force, as it is usually called, is made from soft white metal, but if the requirements of the work call for a hardened die, the force should be of brass or steel. Usually, however, machine steel dies and white metal forces is the combination employed. If the labels are to be used in mold-making, the reverse side of the plate must be

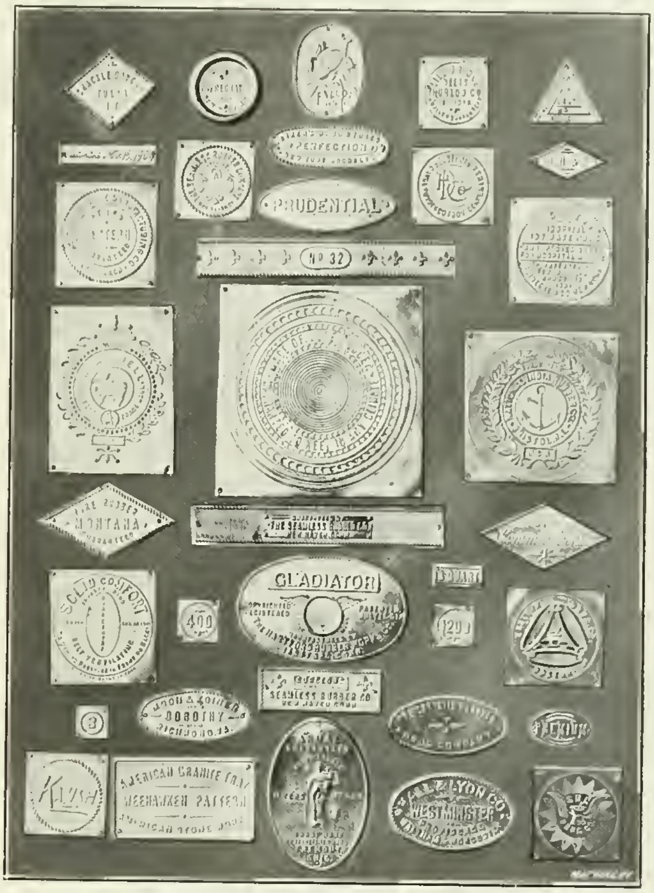

Fig. 3. Specimens of Raised Letter Name Plates and Labels

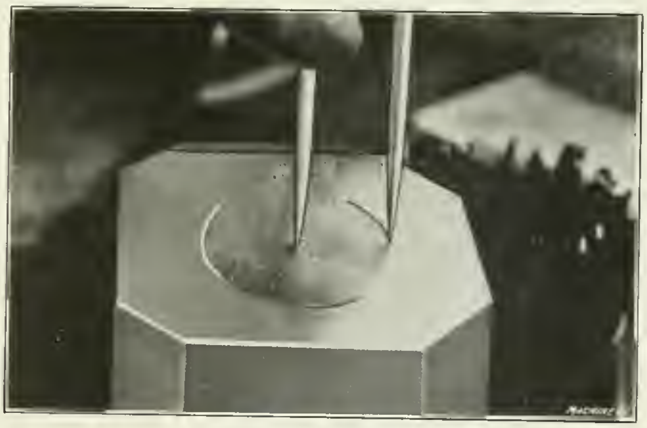

Fig. 4. Using the Cutting Dividers

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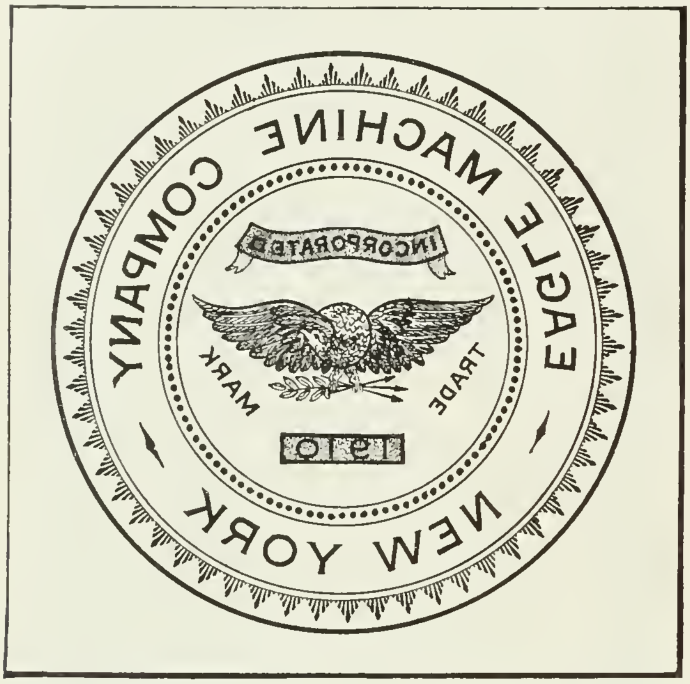
* For articles on kindred subjects, see MACHINERY, April, 1912, "Brass Engraving by Machinery"; January, 1912, "Steel Letter Stamping Dies"; and June, 1909, "Coin and Medal Dies."

† Associate Editor of MACHINERY.

just as good as the front side, for the letters are formed on the rubber by means of its contact with the reverse side of the label.

Making the Die

The steel block from which the die is made is first faced off carefully and its surface coppered or blued, so that the laying-out lines may be easily seen. Let us assume that we are to make a die for the design shown in Fig. 5. The reason for selecting this particular design is that it involves a number of the different methods of die-sinking that are not often employed on one design.



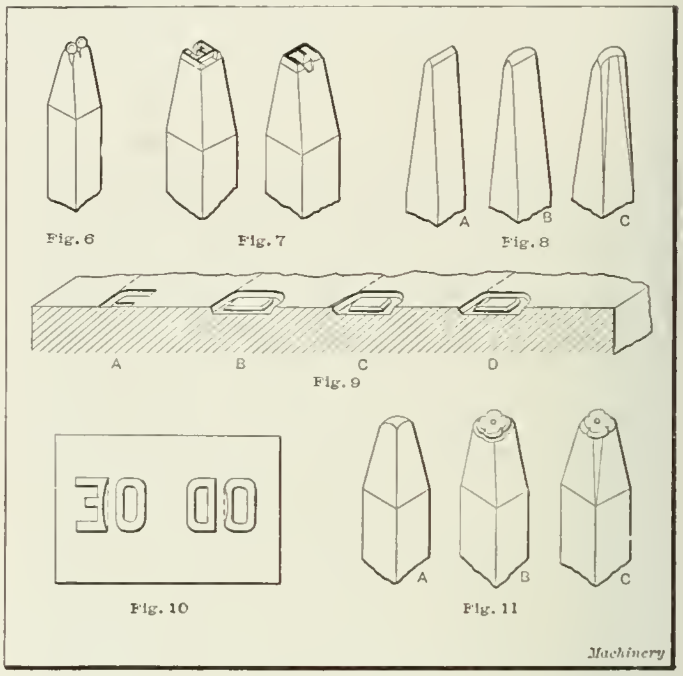


Fig. 5. The Face of a Name-plate Die. Fig. 6. A Double-bead Punch. Fig. 7. Comparison between a Die Letter and an Ordinary Stamping Letter. Fig. 8. Three Types of Lining Tools. Fig. 9. Illustrating Points in Stamping. Fig. 10. How Close Stamping displaces the Steel. Fig. 11. Three Steps in Making a Punch

After the main lines of the design have been laid out on the die, faint circles are scribed with cutting dividers to guide the die-sinker in stamping the fancy border near the outer edge and the bead border between the lettering and the design. This operation is shown in Fig. 4. The cutting dividers are merely an old pair of dividers, one leg of which has been ground with a cutting lip. This tool is very convenient for cutting grooves. The plain line borders and other circles are not cut at this time.

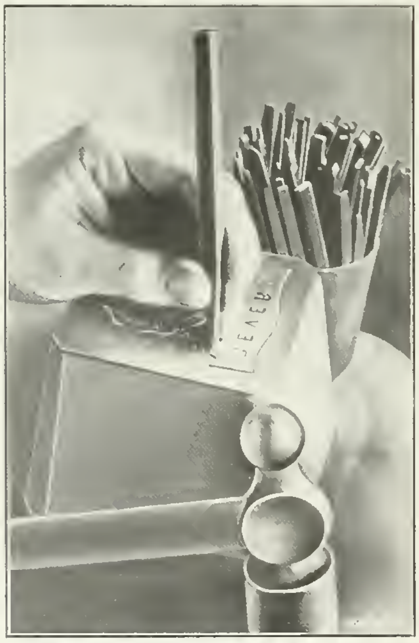


Fig. 12. Stamping the Lines of a Design

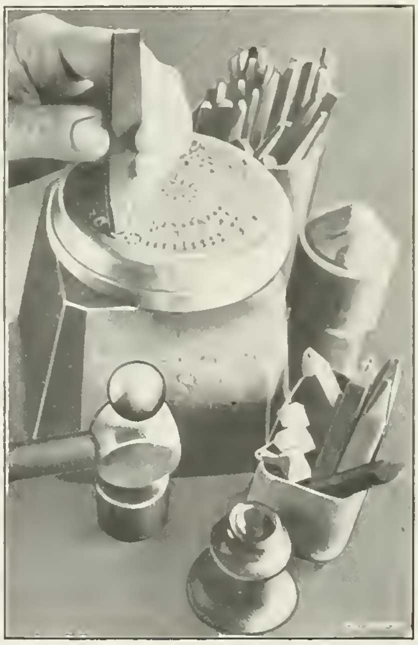


Fig. 13. Making a Punch from a Master Block

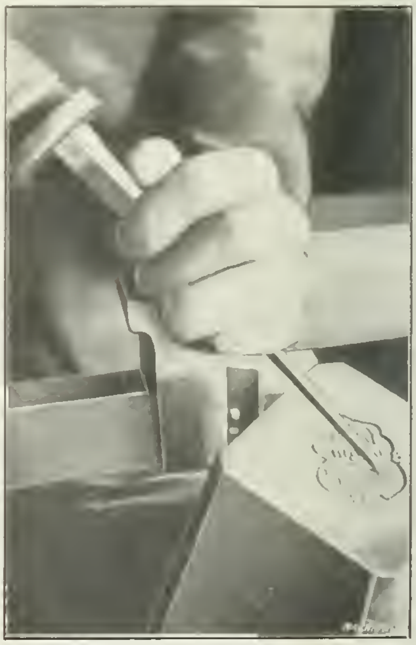


Fig. 14. Chipping out a Panel in a Name-plate Die

In stamping a bead border like the inner border shown, a double punch is made use of. One of these double punches is illustrated in Fig. 6. The object in making the punch with two stamping units is to provide a means for properly spacing the impressions. After the first two impressions, but one impression is stamped at each blow, half of the punch being used as a spacer, after the manner of a spacing center-punch. As soon as the entire border of beads has been stamped in, a single beading tool is used to go over the impressions, leaving each bead perfectly shaped. After each of these two stamping operations, the burr raised by stamping is faced off with a file.

Often the design is surrounded with a plain line-border. If the design is circular, such a border may be cut with the cutting dividers, but if rectangular or of other than circular shape it must be punched in with a lining tool or a straight-line punch in the manner shown in Fig. 12, the punch being moved ahead half its length after each imprint. Should it be necessary to have a wide flat border, it is best to chip out most of the metal, and then smooth up the lines by means of a punch of the right width.

Next in order comes the outside border which in this instance is made by stamping with the single border tool around the border line, using the faintly cut line as a guide. A good many die-sinkers use only a scribed line to which to stamp a border, but some border tools are very difficult to use, unless a deeper guiding line is provided. It is essential that the border shall “come out even,” that is, that it shall be spaced uniformly at every part of the circle. It is customary to employ double punches only for bead or rope borders, because the units of other borders are so much larger that trouble would arise in spacing the last few units. Nine out of every ten borders of name plates are, however, either plain, beaded, or of rope pattern.

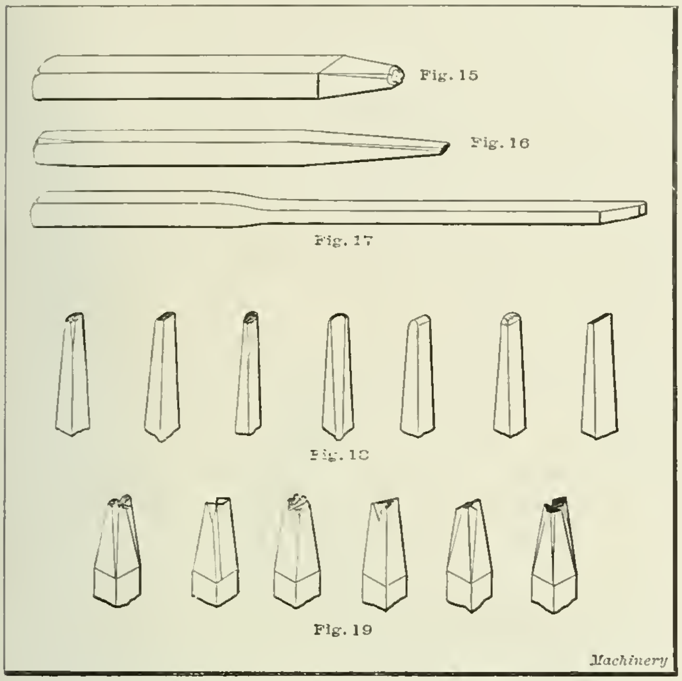


Fig. 15. Proportions of a Punch 3 1/2 inches Long. Fig. 16. Proportions of a Chasing Tool 4 inches Long. Fig. 17. Proportions of a Chisel 6 inches Long. Fig. 18. Various Styles of Chasing Tools. Fig. 19. Various Border Tools

Before stamping the last few units of a fancy border, the die-sinker usually measures the remaining space with his dividers and compares it with a section already stamped, to see if it will be necessary to space the remaining units differently in order to make them “come out even.” Sometimes the last few units must be spaced either closer or farther apart to avoid having half a unit left over. This half-unit of blank space would be very noticeable if not distributed over several units. Referring to the design, Fig. 5, it will be noticed that the border has been spaced very evenly except between the points directly over the “L” in “Eagle,” and the “H” in “Machine.” Within this short distance the six units have been slightly spread to make up for the half unit that would otherwise have been left over. This slight discrepancy in spacing is not noticed by those not familiar with die-making. Samples of border tools are shown in Fig. 19.

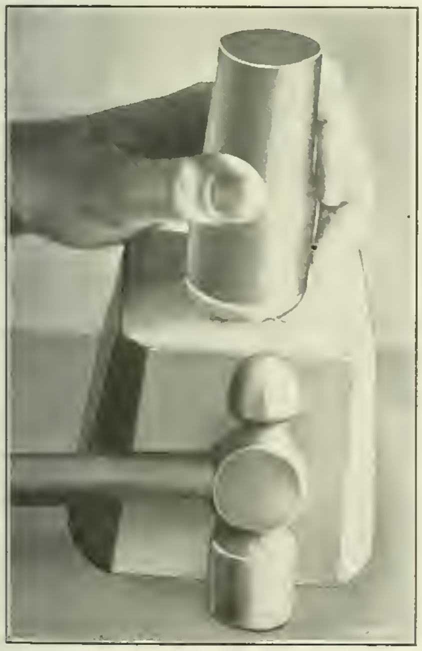


Fig. 20. Taking a Wax Impression to get the Effect of the Finished Work

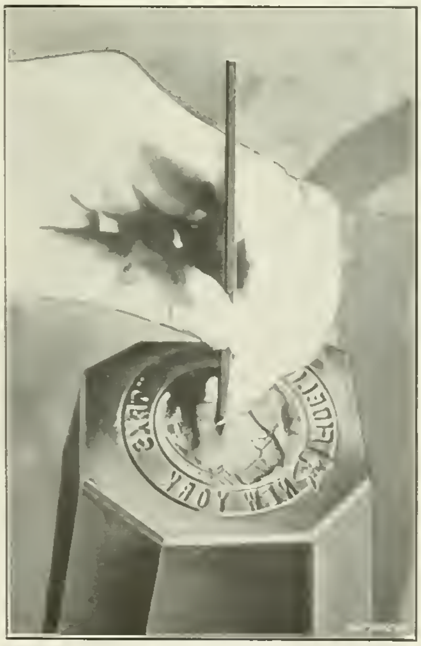


Fig. 21. Working on the Design—Using a Chasing Tool

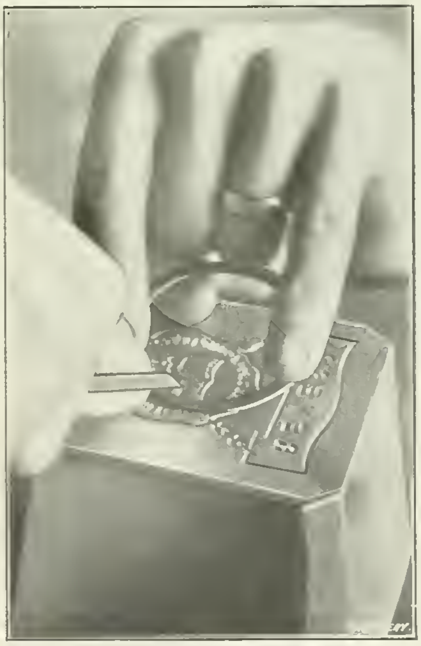


Fig. 22. Working on the Design—Using an Engraving Tool

Stamping in the Letters

The borders being successfully stamped in, attention is directed to the lettering. From the center point of the design, if circular, limiting circles for the letters are scribed. While great care is taken to make the limiting circles for the letters of correct dimensions, the letters themselves are only roughly spaced. If the lettering is different from any that the die-sinker has previously stamped, it is well to first stamp the letters lightly upon cardboard, although a very common way is to merely count the letters and spaces, and start the stamping with the central letter upon the central dividing line of the design, which in Fig. 5 runs through the “I” in “Machine.”

In stamping in these letters, the eye is almost entirely depended upon for getting their positions right. The faces of the letters on the stamps are made different from ordinary stamping letters, in that they are not reversed and also that they are not sharp-faced, but have narrow flat faces. A comparison between steel stamping letters and die letters is shown in Fig. 7. In stamping, the stamp is held with the bottom half of the letter even with the line, being tipped slightly toward the stamper. After striking the stamp lightly in this position and having found it to be in the proper location relative to the line as illustrated at *A*, Fig. 9, it is refitted into the lightly stamped impression, tipped up straight and the other half of the letter struck in, the result appearing as at *B*, Fig. 9. If, however, the first impression is not in line or is crooked, it may be corrected by the stamp being moved slightly in the proper direction. Two of these corrected impressions appear at *C* and *D*, Fig. 9. The lighter that the preliminary stamping is done, the better. After all of the letters have been lightly stamped, they should all be driven in to a uniform depth of 1/64th inch, taking care to have all parts of the lettering of even depth.

All stamping of any kind displaces the stock immediately surrounding the letter stamped. Some of the metal rises above the surface of the die in the form of a burr, and some is crowded away at the sides, often distorting a letter that has been previously stamped. Especially is this true when the lettering is closely spaced. To overcome this trouble, it is best, after stamping a letter, to go back to the preceding letter and re-stamp it lightly. This will throw the displaced steel upward in a burr. If, however, the letters are very closely spaced, this re-stamping will simply push the metal back into the new impression, and to avoid this, the displaced steel should be cut away, as indicated by the dotted lines in Fig. 10, after which a tap with the stamp will finish the work.

As already mentioned, those lines which are not circular arcs must be stamped or traced with a straight-line punch or a lining tool. Lining tools are of three distinct varieties, shown in Fig. 8. *A* is for straight lines; *B*, for slightly curved lines; and *C*, for very sharp curves. If the faces of these lines must be flat or curved, special lining tools may be made to suit the work. The panels in the central part of the design shown in Fig. 5, may be outlined and the two dashes at the ends of "New York" may also be stamped. Other parts like the arrows and the leaves may also be easily stamped by making one or two special punches, thus saving considerable time that would otherwise be spent in hand-engraving this part of the work.

Making Special Stamping Tools

Special stamping tools should be made of Jessop's steel, if possible, using square bar stock for all standard punches except those that are very large. Generally speaking, these stamping tools, exclusive of those for the die letters, may be divided into two classes: punches and chasing tools. The general proportions of these tools are shown in Figs. 15 and 16, and although every die-sinker has his own ideas, those shown will be found to be of about the average type. Moreover, while every die-sinker would like to have his tools of standard lengths, they are constantly subject to breakage, and if redressed are consequently shorter, until, if care is not taken, chasing tools and punches will be of "all lengths." The chisel in Fig. 17 is six inches long.

Chasing tools, a box of which is shown in Fig. 12, should be made about four inches long. They should be of various shapes, a few of which are shown in Fig. 18, and there should be several sizes of each shape. The sides are filed with very little bevel as they are made to do very little work, their chief use being in smoothing up the design in the die. These tools should be hardened and drawn to a dark straw color.

Punches should be made about three and one-half inches long and of much heavier steel than chasing tools, as they have to be driven into the die. While many designs must be originated, a good deal of time can be saved by using a master block like that shown in Fig. 13, to aid in making special tools. This block is hardened. A blank punch is filed so as to have its face slightly convex as shown at *A* in Fig. 11; it is then driven into the proper impression which will form the design on the end, leaving it in the condition shown at *B*; and lastly, the steel around the design is filed away to the proper bevel and the punch, as shown at *C*, is ready to be hardened. After hardening, the temper should be drawn to a medium straw color, unless the design is deep, when it may be drawn still more.

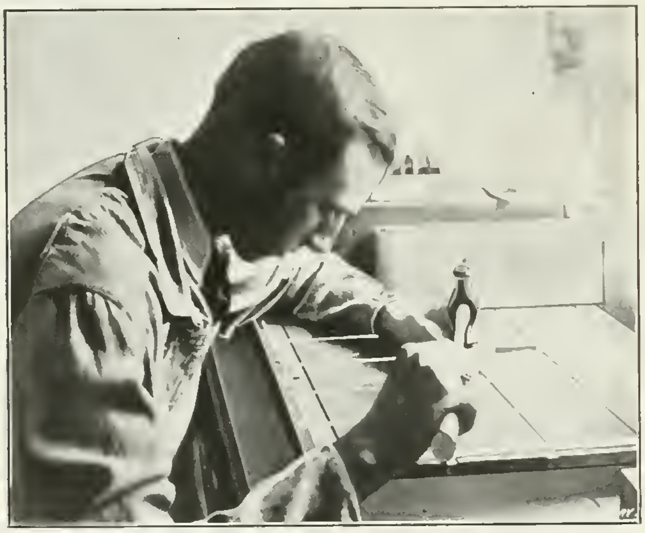


Fig. 23. Lettering a Mold for Rubber Heels

Fig. 20 shows a die-sinker taking a wax impression of his work, in order to see how it is going to look on the finished name plate. The best and cheapest way to obtain this wax is to purchase a pound cake for thirty cents; a pound will last for years. Receipts for making this impression wax are given in MACHINERY'S "Shop Receipts and Formulas." The wax is used on the end of a short block of wood. The die-sinker cleans out the die, breathes on its face to form a film of moisture, and then drives the wax into the impression. Upon gently removing the block, the wax is removed and every detail of the work may be plainly seen. While stamping in the lettering, impressions are frequently taken to indicate those letters which are uneven in depth or crooked, so that they may be corrected.

After the stamping of the letters, borders and other parts has been finished, the next step is to cut any rings or grooves like those shown in the design in Fig. 5. If there are a large number of these rings, or if they are deep, it is best to set up the block in the lathe and turn them, but for dies that have only two or three such rings, they can be cut more easily with the cutting dividers. The reason for leaving the cutting of these rings until after the stamping has been finished, is to avoid distorting them by displacing the metal during the stamping.

Engraving the Design

The most difficult part of the making of a die of this character consists in engraving those parts that cannot be stamped. In the design shown in Fig. 5, this part is, of course, the eagle. The first step consists in facing off the surface of the steel very smoothly, after which the design is very carefully drawn. The outlines are then cut lightly with an engraving tool, and if the design is deep, chisels are employed for cutting out the bulk of the steel, as shown in Fig. 14. The general proportions of these chisels are shown in Fig. 17, and the shapes most often used are the flat and half-round. The final finishing of the details is accomplished by means of chasing tools used as shown in Fig. 21, and by engraving tools as shown in Fig. 22.

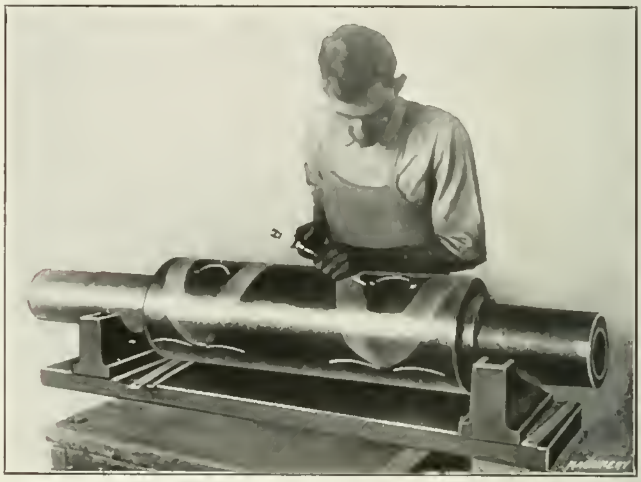


Fig. 24. Cutting the Pattern on a Calender Roll

Engraving tools of various shapes and sizes are employed for the different angles and curves of the design. The ring used in Fig. 22 protects the design from the under side of the tool, and is especially useful in sinking deep dies. Frequent wax impressions are taken to aid the die-sinker in perfecting the details of the design.

The very last step in the work consists in "matting" such places as the panels shown in the design in Fig. 5. Matting tools are varieties of chasing tools used in pebbling or matting parts of the die in order to form a contrast with the smooth parts. After matting, no filing can be done on the surface of the die, as this would injure the delicate finish left by the matting tools.

Specimen labels may be struck from the die before the top die, or force, has been made, by placing the die under a small drop press, or a screw press, laying the blank name plate upon the die, and placing either a piece of sheet lead, ⅛ inch thick, or a piece of leather belting, over it. By striking several blows upon this soft backing a good specimen of the work that will be produced by the die will be obtained.

Should the die require hardening, it should be done in the manner described in the article "Coin and Medal Dies" that appeared in MACHINERY for June, 1909.

Making the White Metal Force

While the most difficult part of the die is the engraving of the lower block, it is just as essential that the force which is used be fitted properly and that it fill the design in every detail, so that it will be possible to strike up labels or name plates that will be perfect on the reverse side as well as on the face side. This is important on dies of this character, because the metal from which the labels are made is very thin and will not be forced into the design unless it is backed up in every detail by the force.

White-metal forces are made by first fitting the face of the die with a temporary wall, usually made of pasteboard. Into this enclosure molten white metal is poured until it has reached the depth of approximately ⅜ inch. The white-metal force is then struck into the die under a drop or screw press, after which it is ready for use.

The labels themselves are struck up by holding the die in the screw press, the die block being held by screws in a bedplate, and the white-metal force being held to a flat block in the ram of the press by means of the contact secured by a thin film of beeswax. The thin brass is cut into squares large enough to make the labels, and each of these squares is in turn laid upon the die and the ram of the press brought lightly down so as to force the brass into the design of the die.

If the work is of such a nature that the die must be hardened, the force should be of copper or steel, and as the making of such forces involves many different processes, this phase of the matter will be described in a later number of MACHINERY.

Figs. 23 and 24 illustrate phases of die-sinking operations in connection with rubber mold work. In Fig. 23 the workman is lettering a mold for rubber heels, the work being done in the same manner as the die work just described. Fig. 24 shows the way in which the outlines of rubber shoe patterns are cut on a calender roll with chisels. Afterwards the lines are smoothed with punches, and the surface of the roll filed smooth. Thus, when the plastic rubber is rolled under one of these calender rolls, the rubber sheet emerges from the other side of the roll with the patterns outlined on it, ready to be cut out and put together.

* * *

SPECIAL MEETING OF THE A. S. M. E.

A special meeting of the American Society of Mechanical Engineers was held in the auditorium of the Engineering Societies Bldg., New York, April 9 in honor of the commission of the German Museum of Masterpieces of Natural Sciences and Technical Arts, visiting America. An illustrated lecture prepared by Dr. Oscar Von Miller on the work of the commission, was read by Mr. Charles Whiting Baker. The lecture described the German Museum at Munich, Bavaria, its aims and methods. The method of the German Museum is to correlate and arrange machinery, apparatus, architecture, processes, industries, etc., in order of development and thus produce progressive historical presentations of the arts and sciences to date. This admirable conception has been carried out with characteristic German thoroughness, and the views illustrating the lecture, showed the arrangement of interesting mechanical groups, chemical apparatus, astronomical instruments, etc. Of special interest was the reference to means by which visitors can demonstrate the working of a machine or a chemical reaction by simply pressing a lever or knob.

The importance of preserving in convenient locations the progressive developments of the arts, can hardly be overestimated. The history of inventions thus shown in concrete form should serve in many cases to prevent inventors and manufacturers from making serious mistakes by developing old ideas over again and thus wasting time and effort needlessly. Museums developed on these lines become educational institutions of high order instead of show places for jumbled and unrelated things.

* * *

According to *Eastern Engineering*, screws are still made in India just as they were made hundreds of years ago, that is by winding two soft wires side by side around a mandrel. The wires are then carefully separated and one of them is soldered to the inside of a tube, which then will form the nut, while the other is soldered to a mandrel or rod. All the screws are left-handed, because they are wound over and over by the right hand.

* * *

Owing to the limited knowledge of many draftsmen as to the qualities of materials used in machine construction, there seems to be a tendency to specify better materials on drawings than are actually necessary for the part. Thus, frequently, tool steel is called for where machine steel, casehardened, would serve the purpose equally as well—and sometimes better.

DIFFERENTIAL MECHANISM ON GEAR HOBBING MACHINES*

By WILLIAM NATISCH†

The writer has read many articles relative to gear cutting machines of different constructions, but has not seen any comparison made between a hobbing machine with differential mechanism and one without it. A great number of mechanics do not know how important it is to have a differential mechanism—or simply a "differential"—on gear hobbing machines. If we take time-saving and accuracy into consideration, a differential mechanism which combines the indexing and helical feeding movements of the table is absolutely necessary. We would not need this extra adjustment for the helical movement if there were no prime numbers between one and ten million.

When generating helical gears on hobbing machines without differential, the required ratio which combines index and feed gears must be calculated at least with 7 decimals, as otherwise a large error will result which will impair the accuracy of the gears. It frequently happens that the required ratio consists of prime numbers, especially when cutting right- and left-hand gears with one hob. To produce correct helical gears with their axes standing parallel to each other, the errors for the right- and left-hand spirals must be absolutely the same, otherwise there will not be a bearing on the whole length of the teeth. In fact, exactly the same conditions exist with helical gears as with spur gears. If, for instance, the teeth of one of two spur gears stood at an angle of only 5 seconds with its axis, the bearing would be at one end of the teeth only.

Furthermore, if the hobbing machine has a differential, it is not necessary to have a right- and left-hand hob when cutting any angle up to 30 degrees; on the contrary, a higher efficiency is obtained when using only one hob for both right- and left-hand spirals. The reason for this is very simple: if there is any distortion in hardening, the right-hand hob will be different from the left-hand.

It has been mentioned before that the ratio must be calculated to at least 7 decimals when cutting the gears on machines without differential. The belief of many mechanics that the ratios and errors obtained by formulas are alike for all hobbing machines, with or without differential mechanism, is entirely erroneous. There is a great difference between the two ratios. In the one case the ratio represents the value of the indexing and the helical movement, and the slightest change of the "driver," *viz.* numerator, will cause a great error if the "driven," *viz.* denominator, is not also changed in the same proportion. In the other case, *i. e.* with the differential, the ratio obtained refers to the angle or helical movement only, and adds or subtracts itself automatically to or from the ratio of the indexing gears. The indexing gears required for cutting helical gears are given on a chart and can be read off the same as for spur gears. This is impossible without the differential. The difference between the two ratios is explained in the following example.

Example:—Gear, 48 teeth; 10 pitch; 20 degrees; 1/16 inch feed per revolution of table.

Gear ratio of machine with differential for 20 degrees = 1.2052784.

If we deduct 1 from the third decimal which is 5, and omit the rest, we have 1.204 = ratio for 19 degrees 58 minutes 42 seconds; *i. e.*, 1 minute 18 seconds difference.

This shows how slight the error would be if we were to change the third decimal; in practice the change is made on the fifth decimal, and the error almost eliminated.

For the same pitch, number of teeth, angle and feed, the gear ratio for one of the machines without differential equals 1.2517385. If here we were to deduct 1 from the third decimal and omit the rest, the result would be that instead of generating teeth the material would simply be milled off from the blank. This is explained as follows: Gear ratio for 20 degrees is 1.2517385. When deducting 1 from the third decimal we obtain 1.250, which is the spur gear ratio.

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* See MACHINERY, December, 1911, engineering edition: "Calculating Gears for Generating Spirals on Hobbing Machines."

† Address: Care of Schuchardt & Schütte, 90 West St., New York.

The Schuchardt & Schütte gear hobbing machines are provided with a differential which on the new type of machines is independent of the feed and indexing; in other words, when changing the number of teeth, or feed, or from right- to left-hand gear, no calculation is required. Thus the great advantage of the differential mechanism is that the helical movement is not disturbed whatever when the number of teeth is increased or decreased or the feed is changed. Suppose we intend to generate helical gears with 30, 40, 56 and 60 teeth, of which those having 40 and 60 teeth are left-hand, and those having 30 and 56 teeth are right-hand; the spiral angle is 15 degrees; the pitch is 10. The material is supposed to be cast iron; therefore, 1/16 inch feed per revolution of the table would be selected as the proper one. All the gears are to be cut with one right-hand 10-pitch hob. In calculating the change gears used when generating these gears on the Schuchardt & Schutte machine but a few minutes will be required, the following formula being used:

$$\frac{\text{Constant} \times \text{sine of angle} \times \text{pitch}}{1} = \text{ratio.}$$

$$\frac{0.3524 \times 0.25882 \times 10}{1} = \frac{912}{1000} = \frac{19 \times 48}{20 \times 50} = \frac{\text{driving gears}}{\text{driven gears}}$$

On machines not provided with a differential mechanism, every gear of the same pitch, with only a different number of teeth, must be calculated for separately, and the slightest change in the feed will require a separate calculation. A change in the formula must also be made, if right- and left-hand gears with the same number of teeth are cut with one hob.

The differential is also of great importance when cutting worm-gears with a taper hob. Worm-gears for worms with multiple threads ought to be generated with taper hobs if high efficiency is required. The writer believes that hobbing machines without differentials will disappear after the patent expires.

* * *

HANDLING A LARGE JOB OF MILLING ON A SMALL MILLING MACHINE

By CHESTER L. LUCAS

The casting shown upon the table of the Van Norman duplex milling machine that appears in the accompanying illustration is the main casting for a wood screw threading machine, designed and built by H. P. Townsend, Hartford, Conn. The casting was first milled on the under side to provide seats to receive the parallels. The piece was then set up as shown, and by means of the vertical attachment the tops of the boxes and several bosses and raised panels that were located between the bearing posts on the bed of the casting were faced off. Next the casting was clamped on the table of the machine in a position at right angles to the one shown and the end of the casting faced off, after which the casting was reversed and the opposite end machined. In this latter position the holes that may be seen through the end of the casting and the bearing posts were bored and counterbored by means of suitable boring-bars. When setting up for boring the holes which were farthest away from the head of the machine, it was found that the overhanging arm was not long enough to support the end of the boring-bar; consequently an improvised bracket was brought into use and clamped to the end of the casting. By means of a bearing hole, which was in line with the holes to be bored in the main casting, the end of the boring-bar was adequately supported and the job successfully finished.

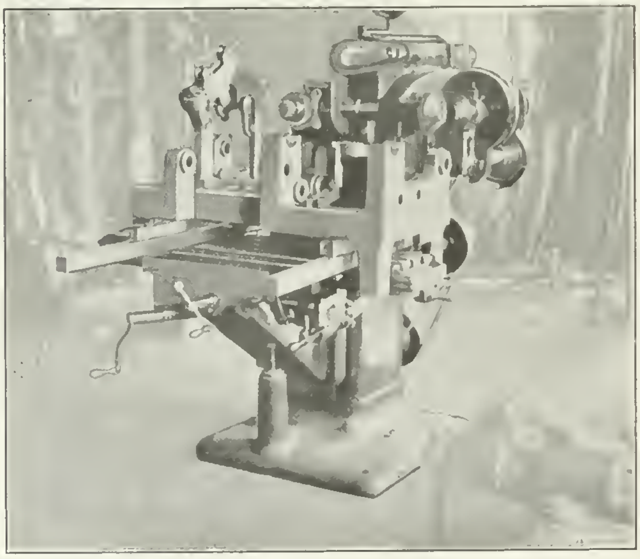

Fig. 1. The Work Set up for Milling the Tops of the Bearing Posts

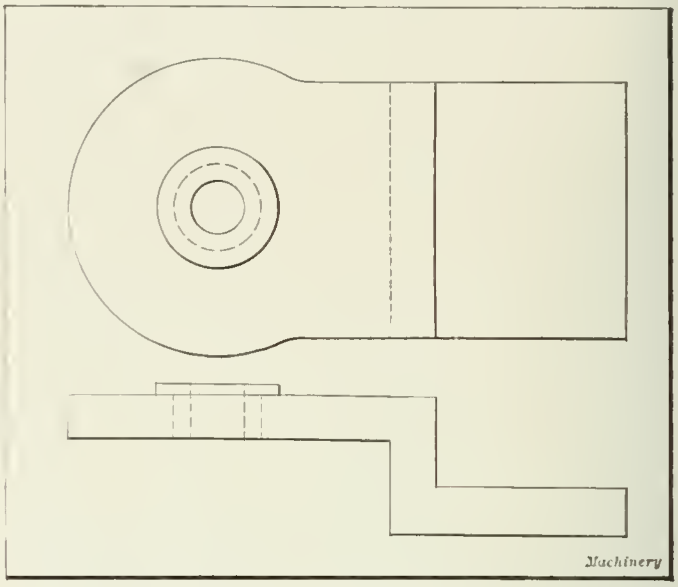

Fig. 2. The Bracket that was used to support the End of the Boring-bar when boring the Holes in the Bearing Posts

The fact that the table of this machine is wider and longer than that of other machines of its type, and that the table travel in both directions is also greater, together with the fact that the machine can be converted into a vertical milling machine in a few seconds, explains how this job was possible on so small a machine.

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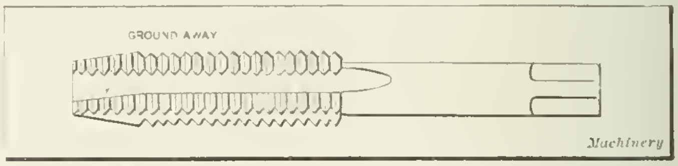
* Associate Editor of MACHINERY.

* * *

TAPPING HARD METAL

A useful kink for tapping hard metal is given in the *Practical Engineer* (London). When hard metal has to be tapped it is very common that the taps break; if the tap is ground, however, as indicated in the engraving, no difficulty will be experienced. The effect of the grinding removes the front part of the teeth, so that the cutting edge presented forms a different angle with the thread than on the section not ground away. This method of grinding the tap proved successful in tapping very hard rolled steel plates.



Method of Grinding End of Flute for Tapping Hard Metal

* * *

CATERPILLAR ATTRACTION

Mr. Hickman, the self-made man and "super" of the United Street Railways, was enthusiastically explaining the construction and merits of his new journal-box to a friend who had dropped into the super's office:

"But I don't see how the oil gets up to the journal," objected the caller.

"Oh, that's easy; it's done by caterpillar attraction. You see the oil climbs up these wicks just like a lot of caterpillars going up a tree. Simple ain't it?"

* * *

A very disagreeable feature about some foremen is that if a piece of work goes well, it is "I," but if anything goes wrong, it is "You."—*Exchange.*

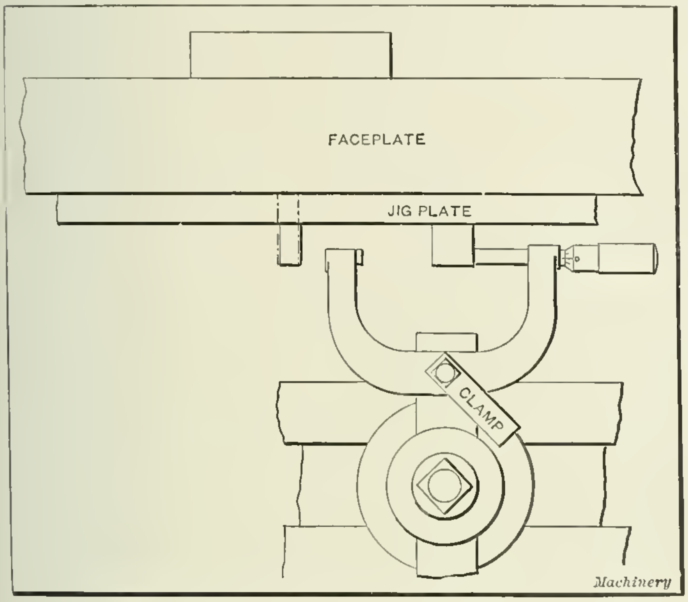
LETTERS ON PRACTICAL SUBJECTS

We pay only for articles published exclusively in MACHINERY

LOCATING HOLES TO BE BORED ON THE MILLING MACHINE—A COMMENT

In the April number of MACHINERY an article entitled "A New System for Locating Holes to be Bored on the Milling Machines" is published. The writer wishes to make some comments on the method there explained.

In doing any work, the fewer the liabilities of error the more accurate will be the results. The method referred to does not seem to fully take account of this indisputable axiom. In the layout, one begins with an edge on one side of the plate and then proceeds from a second edge which must be exactly at right-angles to it. If these two edges are at right angles, then the two lines *AA* and *BB* (shown in Fig. 1 in the April number) will be at right angles, but here is a possibility for an error at the very start.



Method of Adjusting Location of Center

The problem presented, as the writer understands it, is to locate with extreme accuracy the two centers *C* and *D* a given distance apart. There are two ways of locating a point; that is, by vision or by feeling, and in the method referred to the latter is adopted. Lines are scratched at right angles to each other; the three feet of the center locating punch are, by the sense of feeling, made to engage with these scratched lines, the center thereby being located at the intersection of the lines. Here, again, are chances for errors. The center plunger may not fit closely, its center may not be ground exactly concentric with the body of the punch, or the feet may not be exactly in their right positions. Furthermore, the punch may not be placed exactly as required. It is admitted, however, that the form of point used for scratching the lines seems to be very good, and the two lines scratched by it would show a very clear point of intersection.

The writer also fails to see the value of the indicator illustrated and questions the advantage of a hole and plug over the visual system. Of course, the taper hole in the milling machine spindle may be perfect, but it is not likely to be, except when the machine is new. In using the indicator, the writer would revolve the milling machine spindle, and not the sector as explained, in order to be more likely to have the center of revolution of the spindle established in so doing.

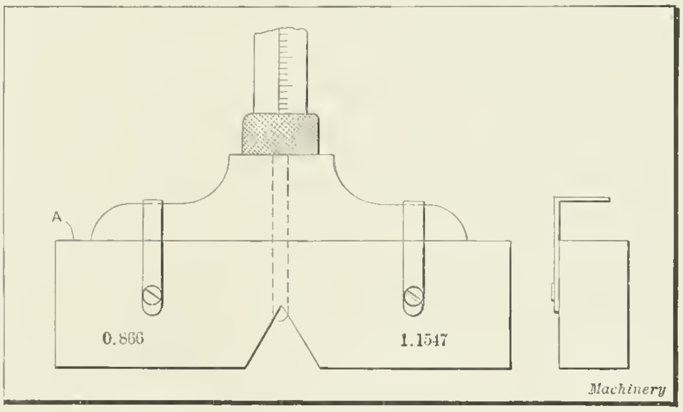
If the piece of work were, say, 10 inches long and square, the writer would locate and bore the hole in the lathe. The faceplate would first be trued off; that should be done at a time when the job could be finished before night, as for very accurate work the escape of oil in the bearings of the lathe over night will affect the accuracy. Should it be required to have the point *D* located a given distance from side *F*, line *AA* could be laid out by means of a try-square, the accuracy of which is easily determined, allowing about 0.005 inch for grinding after the two holes were bored. Line *BB* could be drawn with a height gage.

After locating point *D* by means of a common center indicator, a parallel should be bolted to the faceplate so as to allow the sliding of the plate along it after the first hole is bored. Assume that the two holes are 2 inches apart and each is to be ½ inch in diameter; before boring the first hole set a pair of dividers to 2 inches, and from center *D* scratch a line across *BB*, so as to approximately locate point *C*; then bore the first hole to gage and fit it with a plug, the plug projecting say ½ inch. Now loosen up the holding clamps or bolts and slide the plate along the parallel and with the indicator locate the second hole *C* and bore it to ¼ inch diameter; then fit a plug into this hole and measure with a micrometer the distance over the outside of the two plugs. If the reading should be 2.375 this would indicate that the setting is exact, but this would seldom happen, and the error found may be 0.005 inch over this dimension, which means that center *C* is located 0.005 inch too far away from *D*. The error being known, it can now be corrected without further trial, and to do this the micrometer is clamped to a tool held in the toolpost, as shown in the accompanying illustration. The reading of the micrometer is brought to zero and the point of the micrometer screw is brought into contact with the ½ inch plug. Then loosen up the clamps and feed the plate 0.005 inch by means of the screw, reclamp the plate, and bore the second hole to a ½ inch diameter. The centers now will be located exactly 2 inches apart. If there be any errors they will be found rather in the production of the holes than in the locating of the centers.

It may be merely a personal peculiarity, but the writer always trusts the "feel" of a pair of calipers rather than a stiff gage or a micrometer; but the great advantage of the latter lies in that it tells exactly how great the error is instead of merely denoting that there is an error. NEW LONDON

TOOL FOR MEASURING THE WIDTH OF THE POINT OF U. S. THREAD TOOLS

The accompanying illustration shows a tool for measuring the width of the flat at the point of U. S. thread tools. The device consists of a block of steel, say, 1 inch by ½ inch, with a 60-degree V-groove, and a hole for the rod of a depth gage. There are also two flat springs to hold the depth gage to the block. In making the block, a ¼-inch plug gage is laid in the vee, and the top surface *A* of the block on which the depth gage base rests, is ground until the gage, when in contact with the plug, reads 0.625 inch. To measure the width of the flat of a tool point, set the gage at zero, slip it under the springs, and run the rod out ½ inch. Now insert the tool to be measured in the vee and measure to its point with the depth gage. The amount that the gage reads over ½ inch, multiplied by 1.1547, equals the width of the flat of the thread tool. If it is required to set the tool for any desired width,



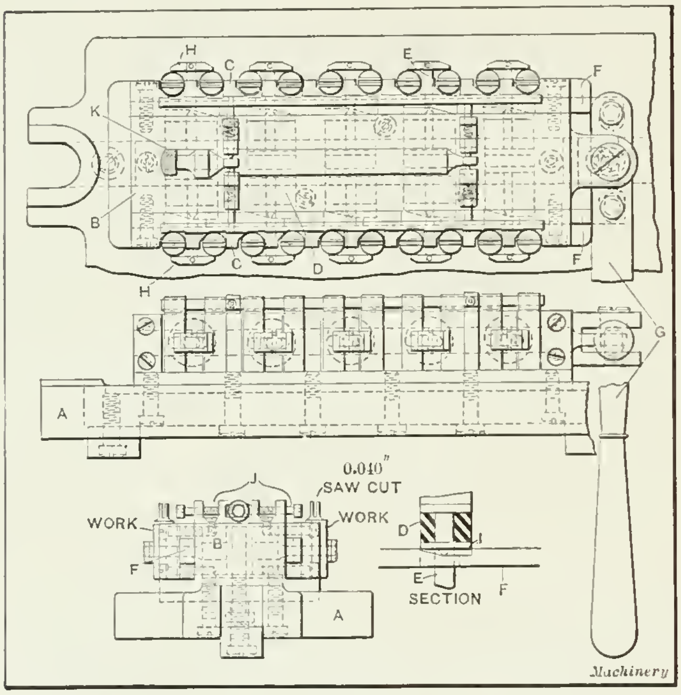
Tool for Measuring the Width of Flat on Thread Tools multiply this by 0.866 and set the tool to ½ inch plus this product.

Revere, Mass. GUY H. GARDNER

[The accuracy of the rules given above for setting this tool can easily be ascertained by anyone who knows the first principles of the solution of triangles. A tool similar to the one described, but somewhat more elaborate in its design, and intended exclusively as a thread gage for the width of flat on thread tools, was illustrated and described in MACHINERY, April, 1907.—EDITOR.]

A MULTIPLE MILLING FIXTURE

The milling fixture shown in the accompanying illustration was designed for holding the small pieces illustrated, which were made from a cast composition. As the parts produced were not of exactly the same size, it was necessary to provide some means so that the clamping members would hold all the parts rigidly. We had some rubber in our works which, upon testing, was found to have considerable resiliency; this gave me the idea that we could overcome the difficulties presented in clamping by using rubber collars as an equalizing medium to provide for the variations in the diameters of the work.



A Multiple Milling Fixture for Holding Pieces of Varying Diameters

The fixture shown in the accompanying illustration consists of a base casting *A* to which a central block *B* is held by screws. The two jaw strips *C* which are milled out, as shown, to fit the work are, in turn, fastened to the block *B*. This center block *B* is bored out to receive the rubber collars *D* and draw-in spindles *E*. The two sliding bars *F*, of rectangular section, are milled to fit a slot in the jaws *C*, and are operated by the handle *G*. The clamps *H* are pinned to the draw-in spindles *E* provided with a head against which the rubber collar *D* is compressed by the pressure plates *I*. These pressure plates are provided with projections which operate in the beveled slot in the sliding bars *F*.

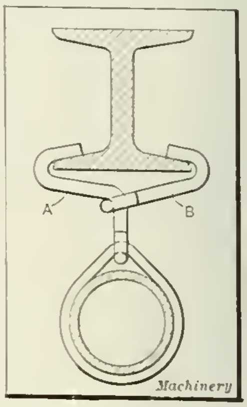
As the handle *G* is fulcrumed in the block *B* and is pivotally connected to the sliding bars *F*, it will be seen that by moving the handle *G* to the right, the sliding bars *F* are moved in opposite directions to each other. The resulting action of the tapered portion of these slides forces in the pressure plates *I*, compressing the rubber collars *D* against the collars on the draw-in spindles, and thus operating the clamps. It is, therefore, evident that by interposing these rubber washers, compensation is made for any variation in the diameters of the work.

The mechanism shown at *J* consists of two strips which extend along the entire length of the jaws, and is used for lining up the pieces parallel to the fixture after they have been placed at random in the jaws. To operate this device, the rod *K* is pushed in which forces the longitudinal strips against the work bringing them all in line, so that they can be clamped, and the cut taken. This fixture makes a very compact device and can be adapted to a large range of small work, which is difficult to hold in an ordinary fixture.

V. W.

SIMPLE PIPE HANGER

About two years ago the writer was requested to design some pipe hangers for a 4-inch steam pipe supported from an I-beam in the factory. The hanger as shown in the accompanying engraving is very simple, as it is made entirely from ¾-inch iron rod. The clamp grips the beam more strongly, the greater the weight that is applied to the hanger. Being made without bolts, it is simpler to put in place than many of the pipe hangers one sees regularly about the shops, and there are no holes to drill. Part *B* should be made short enough so that it will act as a fulcrum for hook *A*, as otherwise the hooks will not grip the I-beam properly. This is really the most important point to be considered in the making of this simple hanger.

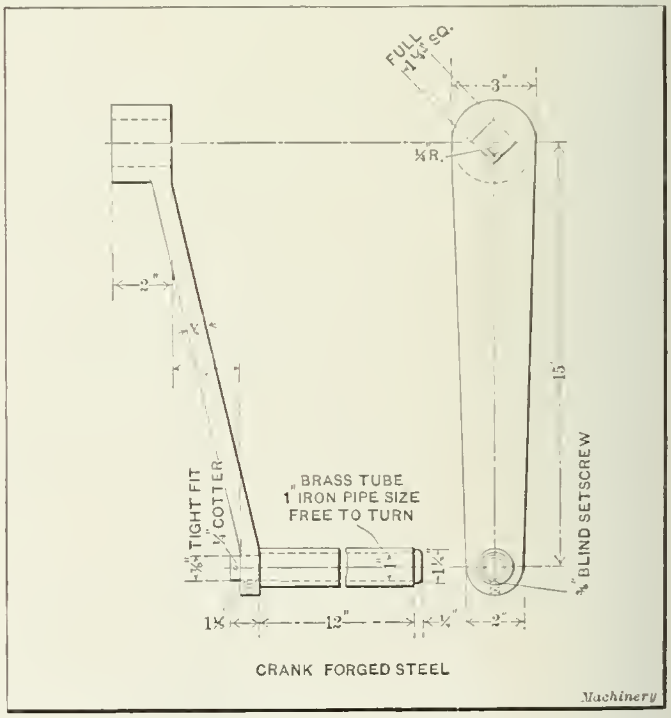


Simple Pipe Hanger

S. Boston, Mass. JOHN WALSH

PROPORTIONS OF HAND-CRANKS

The proportions of hand-cranks given in the December number of MACHINERY, interested me very much. While not attempting to criticize the proportions and design there given, I would like to submit a more suitable crank for out-door work. Hand-cranks are used in all climates and under various conditions, and are subject to much abuse. A handle twelve inches long is about right for a one-man affair, but who can tell whether one or two men will operate the crank? Twenty-five pounds is a good "all day" allowance as a working load for one man, but it is an easy matter for him to exert seventy pounds for a short time.



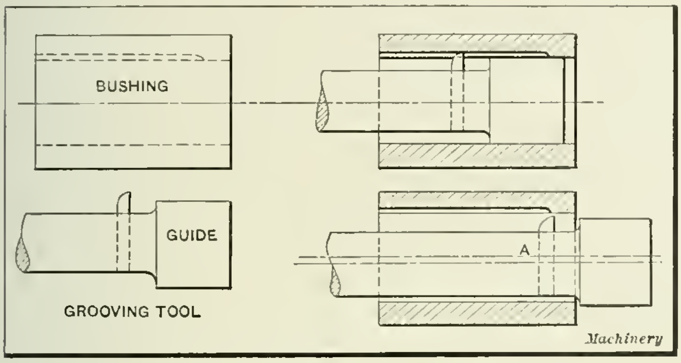
Proportions of Hand-cranks for Out-door Work

In general, the class of men who use hand-cranks, do not know what good judgment is, and too often use the handles of hand-cranks as seats when tired. To prove the lack of knowledge displayed by men of this class, I will cite an instance that came under my notice. A hand-lever of the walk-around type, with a five-foot lever arm, was used for opening and closing a valve. One man was all that was needed, but three men were crowded onto the handle to raise the valve. Not knowing that the valve was raised to the full travel, they continued to work until the valve struck a positive stop, and thinking the stop a nuisance, pushed still harder and snapped the chains.

Another good point is to have the handle offset a slight amount; this places the man's body away from the end of the crankshaft, and lessens the liability of jamming it at every turn of the crank. A piece of brass pipe makes a good grip, as exposure to inclement weather will not cause it to split or warp. When it is necessary to use two men on a crank, it is preferable, if possible, to have two cranks placed 180 degrees apart. This gives a much steadier action at the other end than if two men are placed on one crank. C. P. W.

CUTTING OIL-GROOVES IN BUSHINGS

The tool shown in the accompanying engraving is used to cut oil-grooves from one end to within $\frac{1}{4}$ inch of the opposite end on the inside of the bushings. A good clean job is secured in a very short time. The illustration indicates how the work is accomplished. The tool consists of a piece of machine steel, one end of which is turned to fit the hole in the bushing, this end acting as a guide. The other end is turned smaller in diameter, and in it is inserted the cutter used to cut the groove. Three cuts with three different settings of the cutter were required to complete each bushing. The cutter is made a drive fit in the hole in the arbor. The tool is pushed through all the bushings to be grooved after each setting. The distance from the end of the guide to the cutter determines the distance that the end of the groove will be from the end of the bushing, the illustration showing at *A* how the tool is relieved from the cut before the groove has been cut clear through the bushing. The whole job was done on an arbor press.

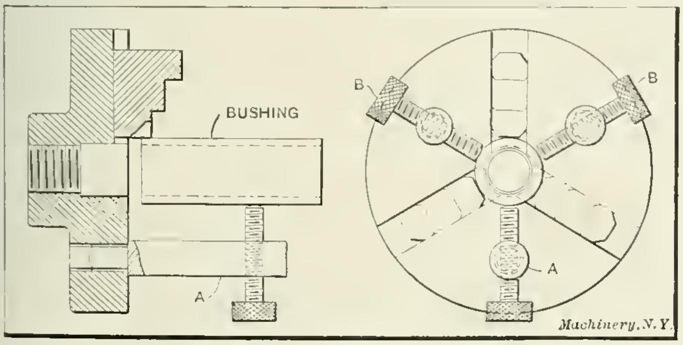


A Convenient Method of Cutting Oil-grooves

Springfield, Ohio. A. J. DeLille

GRINDER CHUCK FOR HOLDING LONG WORK

A chuck which can be used for holding long bushings when grinding them internally is shown in the accompanying illustration. This is an ordinary three-jawed chuck in which three holes are drilled and tapped through the body for holding three studs *A*. Screwed into these studs are three knurled screws *B*, which are used for supporting the work.



Chuck for Holding Long Bushinge when Grinding Internally

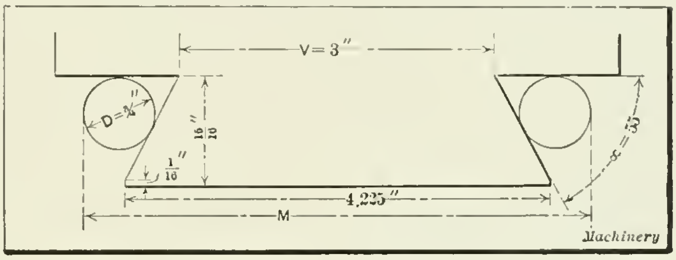
In operation, the bushing to be ground is chucked in the regular way by letting the jaws of the chuck grip $\frac{1}{4}$ inch from the end, thus leaving sufficient clearance for the wheel to pass through the bushing. The three knurled screws *B* are then brought to bear lightly on the work, so that they will hold the bushing securely without springing it. The outer end of the work can be trued in the chuck by operating these knurled screws. When the studs are not necessary for supporting the work, that is, when the work is not very long, they can easily be removed. William H. Vockell

Cincinnati, Ohio.

FORMULA FOR GAGING DOVETAIL SLIDES

The following rule may be used for finding the dimensions over the wires or plug gages when measuring dovetail slides as indicated in the accompanying illustration:

Add 1 to the cotangent of one-half of the dovetail angle, and multiply by the diameter of the plug gage. Add the product obtained to the "vertex" distance of the dovetail. The sum is the required micrometer reading.



Notation used in Formula for Gaging Dovetail Slidee

Expressed as a formula this rule takes the following form (see illustration for notation):

$$M = (1 + \cot \tfrac{1}{2}a)\, D + V.$$

In the example indicated by the dimensions in the illustration, we find:

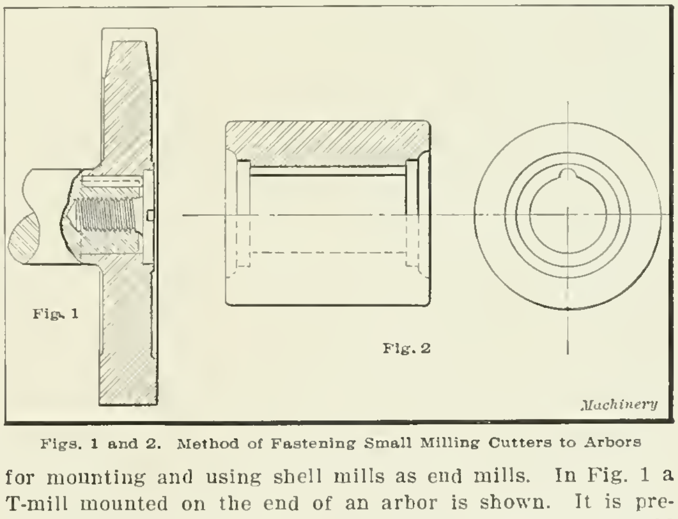
$$M = (1 + \cot 27\tfrac{1}{2}°)\ \tfrac{3}{4} + 3 = 5.191 \text{ inches}$$

The derivation of the formula is based on the first principles of trigonometry, and anyone familiar with this kind of mathematics can easily prove it for himself.

Revere, Mass. Guy H. Gardner

FASTENING SMALL MILLING CUTTERS TO ARBORS

In the article in the February issue, "Device for Fastening Threaded Milling Cutters to Spindle," a very good and satisfactory method is described. In the accompanying engraving is shown a method extensively used in the plant where the writer is employed, for fastening T-mills to arbors, and also for mounting and using shell mills as end mills. In Fig. 1 a T-mill mounted on the end of an arbor is shown. It is prevented from rotating on the arbor by a round key, and is held in position by the screw in the end of the arbor. This method was adopted after several other methods of constructing T-mills were tried. By making the holes in the cutters of standard size, and using a uniform length of hub, a large range of work can be covered with but few cutters and arbors. For instance,



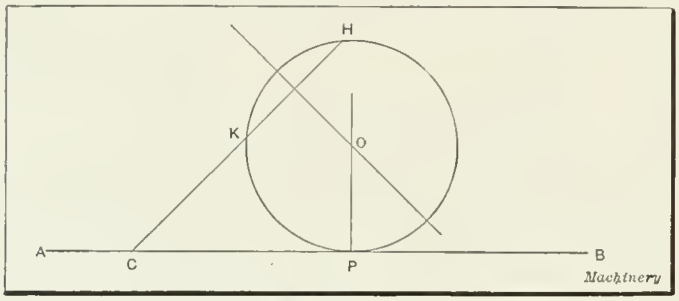
Figs. 1 and 2. Method of Fastening Small Milling Cutters to Arbors

the same cutters may be used on arbors having No. 9, 10 or 11 shanks; in fact, only a few sets of these arbors are used in the plant which the writer has in mind, while a large variety of mills are used, including regular shell mills, made as shown in Fig. 2. These mills are made alike at each end, thus giving a choice of a right- or left-hand mill. They are easier to grind than an ordinary end mill, and last twice as long, there being two ends to dull before grinding is necessary. Of course the arbors on which these shell mills are used are longer than those used for T-mills.
T. Covey

A GEOMETRICAL PROBLEM

In the March, 1912, number of Machinery appeared a brief article by Mr. C. W. Hinman entitled, "A Geometrical Problem." Below is given a solution of this problem which eliminates the construction of a parabola.

As will be remembered, the requirements are to draw a circle that is tangent to line AB and that passes through the points H and K. Draw a straight line through H and K and let C be the point of intersection between this line and the line AB; then the point of tangency P, is found in accordance with the well-known geometrical proposition that



Solution of the Geometrical Problem

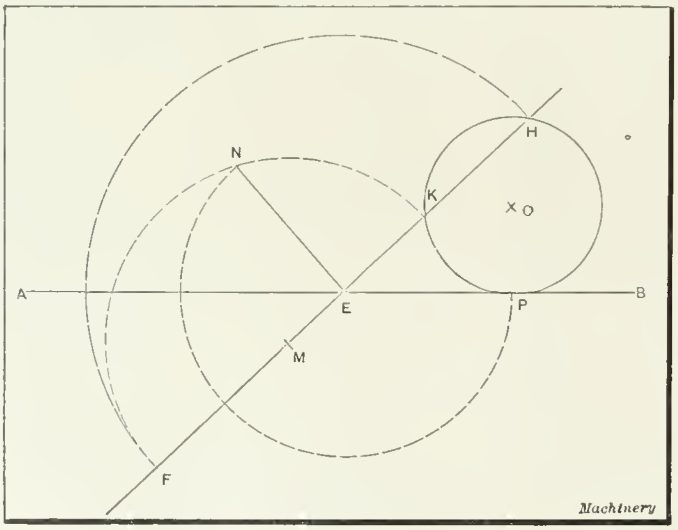
$$CK \times CH = CP^2$$

Hence, line CP should simply be made the mean proportional between CH and CK; this determines the point P. The required circle now must pass through the points H and K, and be tangent to AB at P. The center O of the circle is then easily found by means of well-known geometrical methods.

Moscow, Russia. R. Poliakoff

ANOTHER COMMENT ON "A GEOMETRICAL PROBLEM"

In the solution of "A Geometrical Problem" proposed by Mr. C. W. Hinman in the March, 1912, number of Machinery, the draftsman is confronted with the necessity of constructing a parabola before solving the problem. This makes the solution of little practical value to the ordinary draftsman, although it may be of interest mathematically. A simple and practical solution of the problem is, however, possible.



Complete Construction necessary for Determining the Mean Proportional

In the accompanying engraving let K and H be the two points through which the required circle is to pass, and AB the line to which it must be tangent. Draw a line through H and K and prolong it indefinitely, crossing line AB at E; make EF equal to EH; bisect line KF at M; with M as a center draw a half-circle FNK, and erect a perpendicular EN; then make EP equal to EN. Point P is now the point of tangency, and by any well-known method for describing a circle through the three points, the required circle can now be constructed.

The proof of the accuracy of this method is based on the fact that, according to a well-known geometrical proposition,

$$EK \times EH = EP^2$$

If, according to the construction, EP is the mean proportional of EH and EK, this requirement is filled. Now, EN is a mean proportional between EF and EK, or

$$EK \times EF = EN^2$$

But EF equals EH, and EN equals EP; hence,

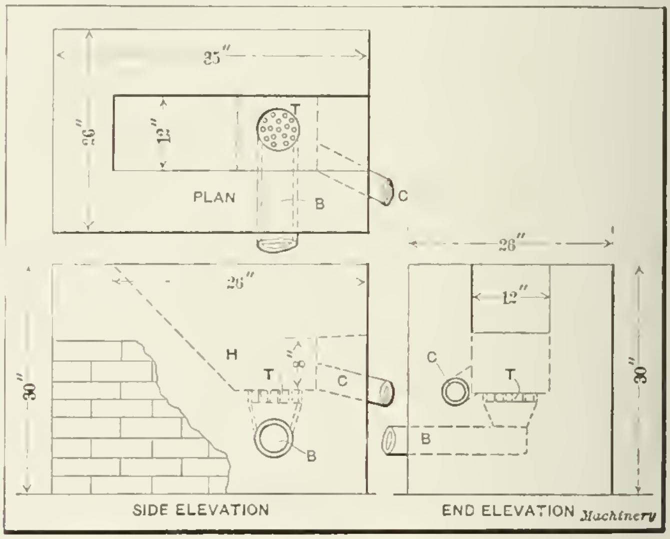
$$EK \times EH = EP^2$$

Consequently, P is the point of tangency with the circle passing through H and K, tangent to line AB.
A. M. S.

[A solution similar to that just given has also been submitted by Mr. George W. Burley, Sheffield, England; Mr. Samuel McAnally, Stratford, Ontario; and Mr. George W. Hammond, Manchester, England.—Editor.]

WELDING NICKEL-CHROME STEEL

The following is offered in reply to C. L. L.'s question in the February number of Machinery, relating to the welding of nickel-chrome steel. There are no physical or chemical reasons why nickel-chrome steel should give trouble in welding in an ordinary forge fire. There may be mechanical reasons for having difficulty with these steels, but these are wholly caused, and can be controlled, by the person doing the welding. Broadly speaking, nickel and chromium increase the susceptibility of the steel containing them, to heat treatment, which includes not only hardening and tempering, but forging and welding as well. It seems sufficient to say that these steels weld as readily as any carbon steels of the same "temper."



Blacksmith's Forge, especially Suitable for Heating Steel for Welding

It is generally recognized by all blacksmiths that the lower the carbon contents of steels, the easier they weld. That this is true is readily seen when two pieces of iron, which are free from carbon, are heated to the proper welding temperature and then brought into contact; they instantly weld perfectly. The carbon steels in general use, and with which the average blacksmith is familiar, usually contain about 0.25 per cent carbon. Nickel-chrome steels are made in grades of 0.08 to 0.15 per cent carbon, and 0.16 to 0.25 per cent carbon, and higher. The grades containing the higher percentages are seldom met with by the blacksmith, as these are generally used for structural purposes, though they too can be welded by carefully heating to slightly lower temperatures than used for carbon steels of the same carbon percentages.

With the lower carbon grades of nickel-chrome steels it can be readily seen from the carbon contents that these should weld without the slightest difficulty. In general, these steels should be heated to 2300 or 2400 degrees F., but the heating should be done slowly, because of the denseness of the grain and to insure an even distribution of the heat throughout the piece. The forge fire should be clean and of ample volume to completely surround the steel to be welded. Use care that a good bed of clean fire is kept between the tuyere and the steel. See that the air blast does not strike the latter directly, while heating, as under these conditions the steel will burn before the proper welding temperature is reached. More trouble is caused in welding with dirty coal fires than from any other reason.

The accompanying illustration shows a modified blacksmith's forge used for heating small pieces for welding; *B* is the blast pipe, *C*, the cleaning flue, and *T*, a small tuyere perforated with a number of one-half inch holes. The hearth *H* is made eight inches deep and the fire is always kept up to the top of this hearth. This insures a good, clean, clear fire at all times, and keeps the steel to be welded far enough away from the blast to prevent burning. Pea-coke is generally used in a forge of this kind. This forge can also be used for heating high-speed steel for hardening with excellent results. If the directions given are followed carefully, there should be no difficulty whatever experienced in welding nickel-chrome steels. E. D. ALLEN

Latrobe, Pa.

VALUE OF DIFFERENTIAL OR PLANETARY GEARING

Properly designed and properly made differential or planetary gears offer an excellent means of reducing the speed of rotating shafts. In the summer and fall of 1905 the writer designed a mechanism in which the main shaft made 120 revolutions per minute and was to drive another shaft at 12 revolutions per minute. To accomplish this, a planetary train of four gears was used, one gear of 48 teeth meshing with one of 20, and one of 44 teeth meshing with another gear of 20 teeth. These gears have been in almost constant use for the past six years, and the 20-tooth gears have in that time made over 230,000,000 revolutions. The most remarkable fact about this train is that it has run these six years as quietly as if it were a worm-gear arrangement, and has never given any trouble except once, through an accident, when a loose piece of metal fell into one of the larger gears breaking some teeth.

The gears with 44 and 48 teeth were of cast iron, while the 20-tooth gears were made of machine steel, but not hardened. The satisfaction derived from this drive speaks in favor of the use, in the proper place, of properly constructed planetary gears, as a simple speed reducing mechanism. To give such satisfaction, however, the gears must be properly cut so that they will run smoothly together, and retain the same distance between the centers. The diameters of the gears must be correct to within 0.0005 inch. One particular feature of this job was that the writer cut all of the gears with one gear cutter, cutting all the teeth to exactly the same depth. They were cut with a special cutter. The writer is of the opinion that if the gears had been cut with ordinary involute teeth, they would not have given the same satisfaction.

An improper method of making a planetary gear speed reducing device is to place the larger gears side by side and then make the driving pinion in one piece, so as to mesh with both, its length being equal to the total width of the two gears. This is a poor method even if the two large gears vary only one tooth, because the pinion will not be in proper mesh with both of the gears, and the drive is apt to be noisy.

Springfield, Mass. FRANCIS W. CLOUGH

"PATENTED" ON MACHINES

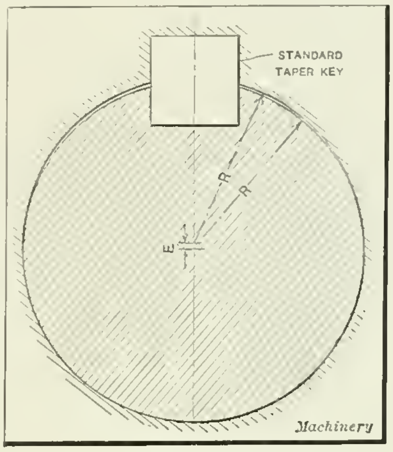
I am interested in your remarks on "Status of Patented on Machines" in the April number. A friend of mine in Wisconsin some years ago began to make slot machines such as were popular for some time for gambling purposes. The machines were going like "hot cakes," and he wanted to prevent anyone from imitating his machines, which were not patented and on which he did not expect to secure a patent. He used a Yale lock to fasten the door through which the owner of the machine was to secure access to the inside of the machine to remove coins, etc. Yale locks are patented. The locks were countersunk in the frames of the slot machines, only the keyholes showing. There was no chance to show the patent notice of the Yale locks, so the following was placed on the machines; "The locking devices on this machine are patented under Nos. ———."

This statement conveyed the impression that the slot machines were patented and avoided any interpretation of the patent law which would apply in marking as patented an article not patented. The impression lasted long enough for the manufacturer of the machine to prevent competition until such a time as the machines were adjudged gambling devices by the police and then destroyed. After that his competitors did not want to make the machines anyway.

Norwood, Ohio. ALBERT STRITMATTER

METHOD OF BORING HOLES IN KEYED PULLEYS

When large pulleys or gears are fitted to shafts in any other way than by a press or shrinkage fit, there must necessarily be some difference in diameter between the bore and the shaft. If a taper key is used, the shaft is always forced to one side of the bore, and the pulley or gear becomes eccentric. In many cases this may not do any harm, but it certainly is of no advantage; and unless the play between the bore and the shaft is small, it is likely to cause trouble. Furthermore, if there is too slight a difference between the bore and the shaft, the wheel will frequently stick, especially if it is to be pulled over a considerable length of the shaft. This condition is especially exasperating when making emergency repairs.



Fit between Shaft and Bore when Method outined is followed

The accompanying illustration shows a simple way of avoiding both difficulties. The idea is not new, but has been used by two or three companies to the writer's knowledge for more than ten years. Nevertheless, the method is one which is not generally known. After the pulley is bored, it is shifted in the chuck or on the faceplate, an amount as represented by *E* in the illustration; then, without changing the setting of the tool, the hole is rebored. The first hole should be exactly equal to the shaft diameter. Then, after the taper key is driven home there will be an exact fit on the lower half of the shaft, instead of a fit theoretically along one line only, which would be the case if the bore were circular, and larger in diameter than the shaft. The main reason for this method of boring the pulley is, however, the ease with which even a big heavy wheel can be put on or taken off.

The exact dimension *E* cannot be given, because it would vary considerably in different shops. It depends on the size of the shaft and the grade of the work. However, the writer would say that on heavy gears, pulleys, etc., 1/32 inch is not too much. There will be an open space between the shaft and the bore on the keyseat side anyway, and it is difficult to see why a 1/32 inch space at the top would be any more objectionable than a 1/64-inch space. The extra cost of this method of boring is small in comparison with the advantages obtained. Next to a press fit this method provides theoretically and practically the most satisfactory means for fitting a shaft to its bore. F. D. BUFFUM

Ellsworth, Pa.

ROLLING BLUEPRINTS

Trivial as it may seem considerable energy is lost by mechanics, engineers, architects, and others on account of the fact that blueprints are almost invariably rolled with the face in. A moment's consideration of the subject will convince the least observing of men that such is the case, but why it is so done is unanswerable except that it seems to be intuitive, just the same as putting money inside of a pocket-book instead of outside of it. The reason for putting money in a pocket-book is obvious, but protection in the case of blueprints is fallacious as the back of the paper is as necessary as the face.

The objection to rolling a print with the face in is that it is a very difficult matter to make it lie open properly when unrolled for reference. Weights or thumb-tacks, or four hands are then in demand, when if the print has been rolled face out it may be unrolled and placed on a board or held in two hands without trouble. Try rolling a blueprint both ways and be convinced. You will not be likely again to roll a blueprint face in. C. H. Casebolt

St. Louis, Mo.

[The same reason for rolling blueprints face out applies to the rolling of magazines for mailing. If rolled with the title page out when mailed, the unrolled copy will soon settle down and lie flat on a table with the title page up. Machinery has been mailed for the past few months with the title page rolled out.—Editor.]

DRAWING AN ODD-SHAPED CUP

In answer to the question on drawing an odd-shaped cup in the "How and Why" columns of the March issue of Machinery, the following solution is offered. By this method four operations would be required to complete the drawing of the cup and Fig. 1 illustrates the successive drawing operations. The first operation consists in drawing from the center of the blank a cup-shaped depression 5/8 inch diameter and 1/4 inch deep, as shown. The die for accomplishing this part of the work is shown in Fig. 3. This die is an ordinary drawing die with a spring blank-holder and needs no further explanation. The second operation consists in drawing the cup-shaped depression to the depth of 1/2 inch, and at the same time reducing the diameter to 3/8 inch. The tools for this work are shown in Fig. 2. While this is a somewhat unusual type of die, it has worked out very successfully on similar work. The spring blank-holder should be supported by very weak springs. The third operation consists in forming the central part of the shell by means of the dies shown in Fig. 4, and the same dies are used for the fourth operation of turning up the flange at the outside edge by simply adding the ring shown in Fig. 5.

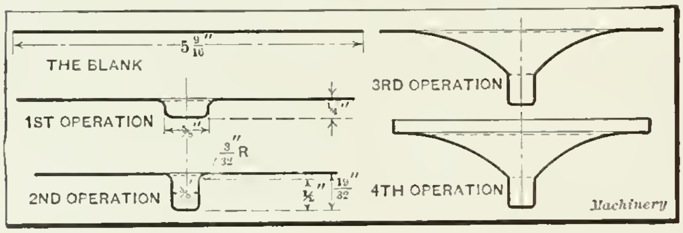


Fig. 1. Results of the Four Drawing Operations

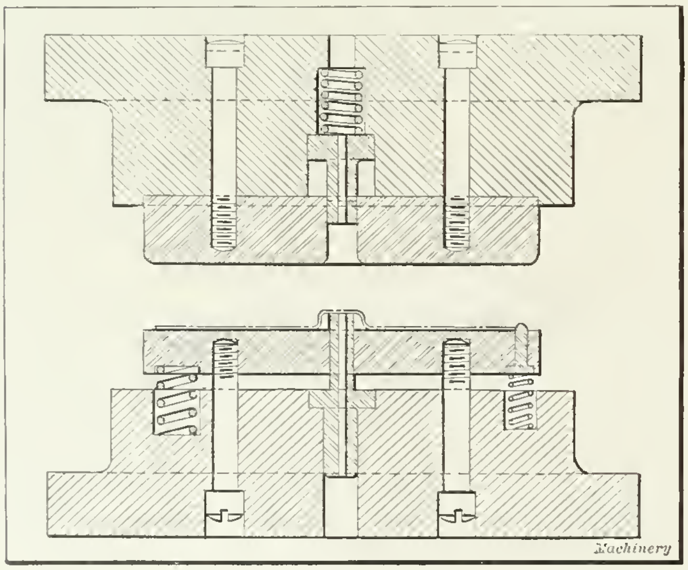


Fig. 2. The Second Operation Die

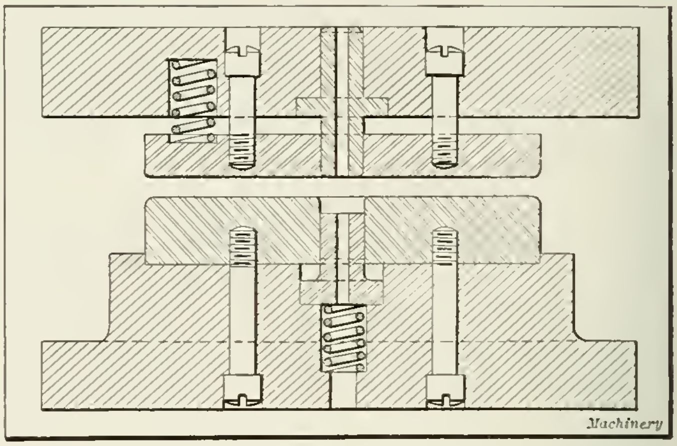


Fig. 3. The First Operation Die

This ring slips on over the lower half of the third operation die, and for this reason it is essential that the outside of this part of the die be absolutely concentric with the depression in this die.

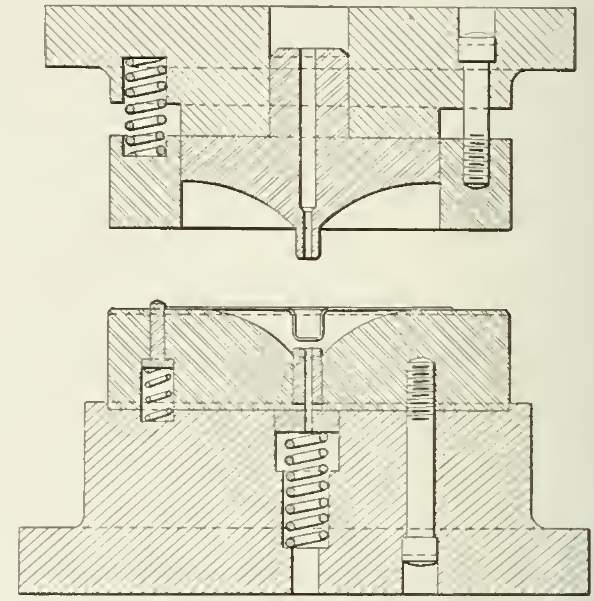


Fig. 4

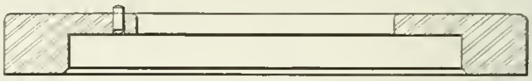


Fig. 5

Fig. 4. The Third Operation Die. Fig. 5. The Ring used on the Third Operation Die to perform the Fourth Operation

Thomas Alma

REMOVING BURRS FROM METAL PRODUCTS—REJECTED WORK

Referring to the inquiry of D. A. H. in the February number regarding economical methods of removing burrs from metal products, we break up discarded emery wheels and put them into a revolving iron cylinder having internal projections. We put in about an equal amount of sawdust with the broken emery pieces and then the parts from which burrs are to be removed. The tumbling of the parts with the sawdust and emery quickly removes all the burrs that should be allowed on any punched work.

On parts for electrical apparatus that are rejected by inspectors it is our practice to treat them individually so as to bring them up to the standard where it is possible. In a great many cases the stock is of so much more importance than the labor that we find it pays to treat the parts individually.

West Lynn, Mass. Thomas A. Wry

A REVOLVING-HANDLE SCREW DRIVER

The accompanying illustration shows a sectional view of a revolving-handle screw-driver which is found useful for assembling work. It consists of a crank shaped shank *A* made from drill rod, a brass sleeve *B*, a steel thrust button *C*, and a hard wood handle *D*. To assemble these parts the brass bushing *B* is slipped over the shank *A*, after it has been bent to the required shape; then the shank is upset on the end. Thrust button *C* is now slipped in place on the handle and the brass bushing with the shank in it is forced in. The hole in the handle should be deep enough to leave about 1-64 inch play between the end of the shank and the thrust button.

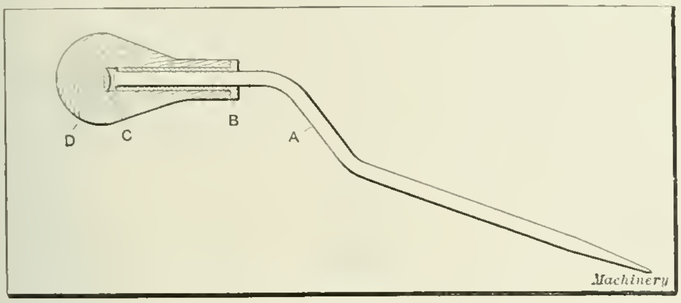


Fig. 1. A Revolving-handle Screw Driver for Rapid Assembling of Work

The screw-driver is operated by simply holding the knob of the handle against the palm of the hand and gripping the small portion of the shank with the fingers of the same hand and twisting it around without moving the wrist. After a few minutes' practice this screw-driver can be worked with great speed in both directions. J. E. U.

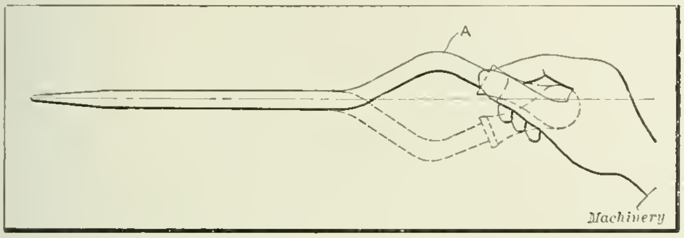


Fig. 2. Illustration showing the Method of Operating the Screw Driver

BALL AND ROLLER BEARINGS IN MACHINE TOOLS

In reply to your criticism in the February number of Mr. Henry Hess's remarks on the application of ball bearings to the main spindle of machine tools, it might be interesting to cite the fact that several eminent tool builders in England have already, with apparent success, put them to this use. Messrs. Kendal & Gent, of Manchester, are producing a hexagon turret lathe which takes bars up to 3 inches, the headstock of which is fitted throughout with ball bearings. They claim to have reduced the power consumption per unit of metal removed about 50 per cent. Messrs. Parkinson & Sons, of Shipley, are fitting ball bearings to milling machine spindles. Messrs. Alfred Herbert, of Coventry, are using them on the spindles of automatic chucking machines and turret lathes. This firm, before finally adopting ball bearings for the spindles, gave them a test extending over several years on some of the shop machines. The machines worked satisfactorily under heavy forming cuts.

The type of bearing used in every case is that known as "single track journal," which has, of course, no provision for adjustment. In the writer's personal experience, he has found that if a ball bearing is fitted, no adjustment is needed for the simple reason that a bearing of ample proportion practically does not wear, and ball-bearing makers are now turning out so perfect a product that the clearance between the parts of a journal bearing is only just sufficient to insure free running —not exceeding, at any rate, that of a well scraped bush bearing.

In the case of thrust bearings of the ball type, where thrust is taken by the balls in both directions, it is absolutely unnecessary to provide adjustment. If adjustment is found to be needed, this is only a proof that the proportions have been undercalculated, and the remedy, therefore, is obvious. The initial adjustment should be made in construction by the makers and in such a way that it cannot, by any means, be tampered with by the user.

Some months ago the writer designed a lathe headstock of the all-geared type, in which the journal pressures were entirely taken care of by the ball journal bearings, and the end thrusts, by double ball thrust bearings. The body of the headstock formed an oil bath, which was necessary to lubricate the gears. At the same time, the spray from the oil was sufficient to keep the ball bearings in good condition, rendering quite unnecessary the provision of other means for lubrication; in fact, the headstock was entirely without lubricators. In this particular case, the diameter of the spindle would have been excessive for the load and speed, and ball bearings gave a means of getting over a very troublesome proposition.

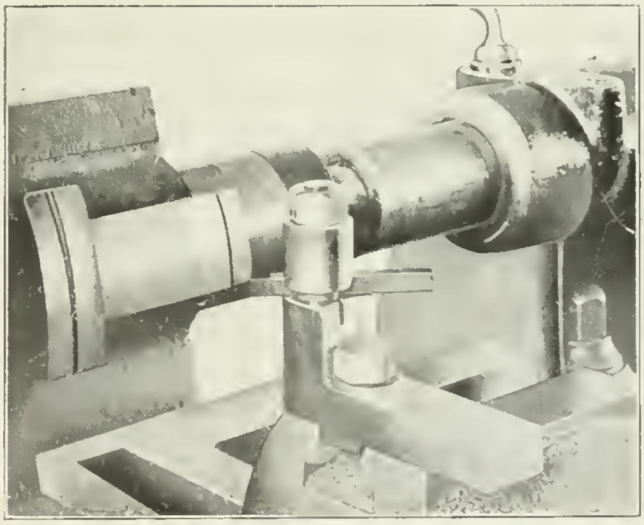
The writer has a very strong conviction that in ten years, so far as machine tools are concerned, practically every bearing of importance will be a ball bearing. The days of bronze and babbitt are numbered. A fifty per cent reduction of the power bill is not to be lightly considered, particularly in these days of coal strikes.

A method successfully applied in a grinder head was the fitting of a long bush behind the ball bearing, this bush having a little more clearance than the balls in the ball bearing. The idea was that the solid lubricant with which the shaft in the bush was oiled would act as a deterrent against vibration, for before vibration could take place, the grease would of necessity have to be squeezed out. A Supporter of Henry Hess

A TOOL-HOLDER FOR THE LATHE

The accompanying illustration shows a tool-holder which holds square turning tools or cutting-off blades made from high-speed steel. The holder consists of a stud held in the L-block which is fastened to the cross-slide, as shown. The cutting tool is retained by a collar, which, in turn, is acted upon by a nut. As can be seen, this holder is provided with a slot in which cutting-off blades can be rigidly held. Another good feature about this holder is that there is practically no overhang at all, thus enabling heavy cuts to be taken without chattering. Charles K. Tripp

West Lynn, Mass.



A Lathe Tool-holder of Rigid Construction

PACKING BOX NAILS

I have just seen what seems to be an improvement in the use of packing-box nails—*viz.*, the employment of paper disks about ¼ inch thick under their heads. These disks or washers are used in order to lessen the jar on the contents of the box, and to prevent damage to the box itself during transit. When opening, the ordinary pliers or the special nail-pulling devices draw the nails without mauling the box cover. The disks are furnished perforated ready for use.

Dresden Germany Robert Grimshaw

HOW AND WHY

DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST

Give details in full and name and address. The name and address will not be published with the answer.

ORIGIN OF COTTER-PINS

A. C. C.—I am desirous of securing information in regard to the origin of the use of cotter-pins as well as the derivation of the word itself. How far back does the use of cotter-pins date? In what country did they originate, and wherein lies the significance of the word cotter-pin?

This question is submitted to the readers.

DIAMETER OF STEEL BALL

A. J. C.—Please give a formula for solving this problem: If a steel ball 0.718 inch diameter weighs 380 grains, what must the diameter of a ball be to weigh 383 grains?

A.—The cubic contents of spheres are to one another as the cubes of their diameters. Therefore, the relation between two balls is expressed by the proportion $x^3 : y^3 = a : b$, in which x and y represent the diameters of the balls and a and b the given weights. From this we obtain the expression $x^3 : 0.718^3 = 383 : 380$; clearing for x yields

$$x = \sqrt[3]{\frac{0.718^3 \times 383}{380}} = 0.720 \text{ inch},$$

the required diameter.

PORTABLE BORING BAR

J. H.—I am foreman of the machine shop of a large factory manufacturing tinware and sheet metal goods, and have a number of stamping presses to keep in repair. I have now the job of repairing a broken crankshaft. The bearings for the shaft are badly worn and need reboring. I wish to rig up a boring bar and bore out just enough to true up the bearings, which are about 3 inches diameter and 18 inches apart. Can you refer me to the design of a simple boring bar that can be rigged up for the purpose of boring out the holes in the press frame while in position?

A.—The situation described is typical of many repair jobs requiring the reboring of two or more holes dead in line. The regular portable boring bars designed for reboring engine cylinders are generally too heavy and cumbersome for machinery repair work, and even if a given situation is such that an an engine boring bar could be used, the cost and time required to obtain one are generally prohibitive for emergency repair work. Suggestions are invited describing simple portable means which can be provided by almost any machine shop for efficiently boring holes from 2½ inches diameter up, and employing a traversing bar or traversing tool head.

DESIGN OF DROP-FORGING DIE

A. C. F.—I desire to make drop-forging dies for the piece shown in Fig. 1. This piece is to be a steel forging, and the principal point on which I require information is the proper shaping of the breakdown in order to distribute the stock so that the raised projection at the center may be brought up easily; also advise me what size bar steel to use and to what lengths the bars should be cut for forging.

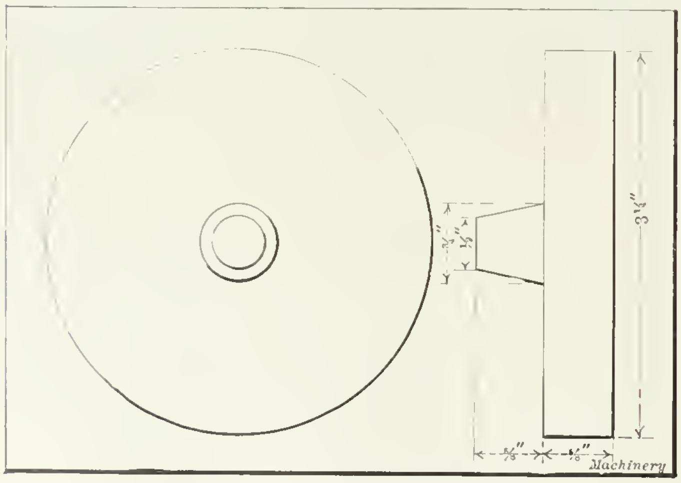


Fig. 1. The Forging to be made

Answered by J. W. Johnson, Revere, Mass.

A.—The drop-forging of the piece shown can be easily accomplished by making the breakdown in the manner shown in Fig. 2 The outline of the breakdown should be laid out about ⅛ inch smaller than the finished forging is to be, and the corner should be well rounded at the parting line. The face of the breakdown should be wider than it is ordinarily made, in this instance being two inches wide in order to facilitate the rapid breaking down of the stock. In cutting the face impression in the die it should be remembered that the impression that is to form the projection on one of the faces of this piece should be cut in the upper die on account of the fact that the metal is more easily forced up than down into a depression.

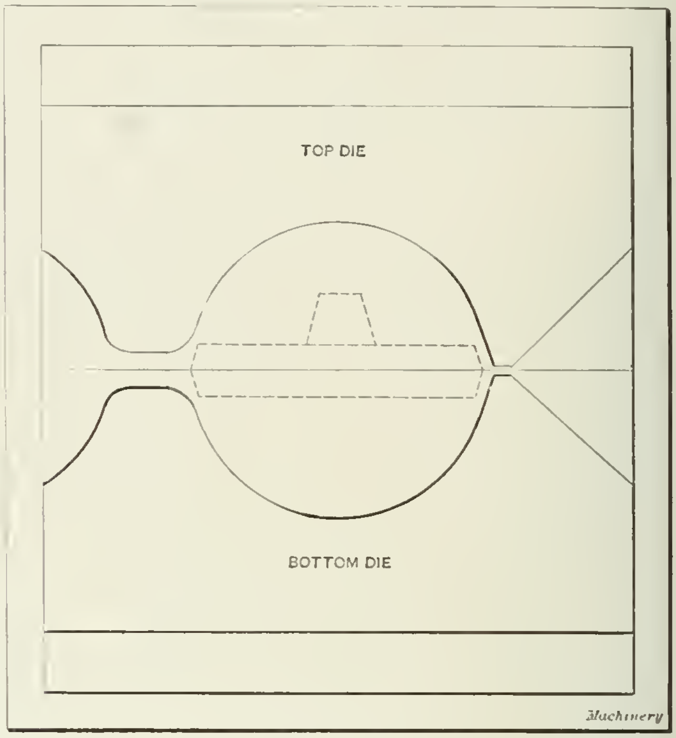


Fig. 2. Showing the Outline of the Breakdown

The dimensions of the stock should be very close to 3 inches by 1 inch, and in cutting the bars for forging, the lengths should be just long enough to make four pieces. The first piece forged will leave the bar in the condition shown in the upper view in Fig. 3. It will be noticed that the gate to the breakdown is cut away so that one-half of the outline of the second piece is forged at the same time as the first. At the completion of the second forging the first forging has been cut from the bar, the second forging formed, and half of the third forging outlined. After completing the third forging, which will leave the bar in the condition shown in the lower view in Fig. 3, the stock is reversed and held in a pair of tongs which grasp the forging itself, and in this manner the last forging is finished.

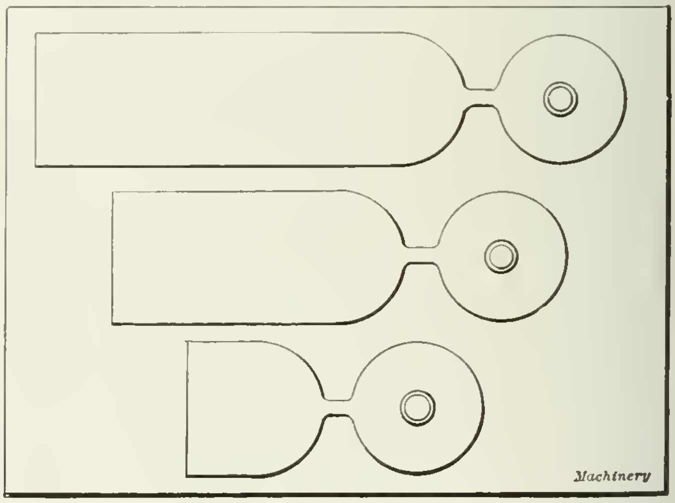


Fig. 3. The Way the Bars are forged

NEW MACHINERY AND TOOLS

THE COMPLETE MONTHLY RECORD OF NEW DESIGNS AND IMPROVEMENTS IN AMERICAN METAL-WORKING MACHINERY AND TOOLS

THE FELLOWS HELICAL GEAR SHAPER

Spur gears with helical teeth have long been used in Europe in place of ordinary straight-tooth spur gearing. They are also coming largely into use in this country, particularly for automobile engine gears. The advantage claimed for them is that they run more quietly than old-fashioned spur gears. The difference in the action of the two forms is this: With the spur gear the tooth makes contact with its mate instantaneously along the full width of the face. With helical-tooth gears, on the other hand, the teeth do not come into engagement with each other for the full length at once. Contact is made at one end of a pair of teeth first, then a little further in from the end, then a little further still, and so on to the other end of the tooth; and by this time the next pair should be making contact at the front end. Thus it comes about that the teeth are making contact all the time and are going out of contact all the time, the engagement being continuous instead of intermittent. This tends to make the action smooth and regular.

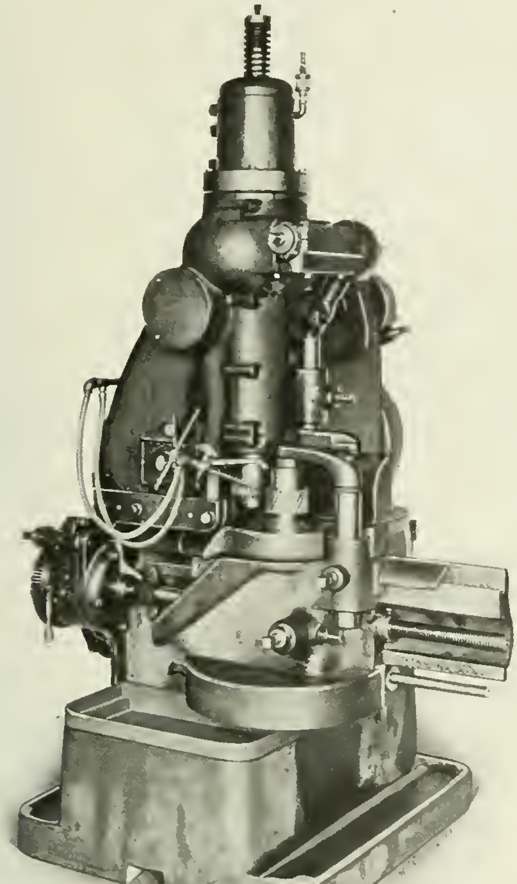


Fig. 1. Helical Gear Shaper built by the Fellows Gear Shaper Co.

The Fellows Gear Shaper Co., 25 Pearl St., Springfield, Vt., some time ago began a series of experiments and investigations on the problem of a simple and accurate process for cutting these helical gears. As the result, a helical gear shaper and a hardened and ground helical gear shaper cutter, have been produced, which extend the accuracy and output of the gear shaper process, to the cutting of helical gears.

Principle of the Helical Gear Shaper

The principle of the shaper's operation is identical with that of the regular gear shaper for spur gearing. Fig. 3 shows a helical gear of steel or other metal rotating in engagement with a blank made of putty, wax or some other plastic substance. It is evident that the teeth of the generating gear will mold, in the plastic blank, teeth of the proper shape to engage with it or with any other gear of the same pitch and helix angle. If the plastic blank could then be hardened, it would be a serviceable gear for use in an actual machine. The practical problem, of course, is to adapt this molding process to the cutting of hard metal gears. This may be done as shown in Fig. 4 where the generating gear is of high speed steel with the tooth outlines sharpened to a cutting edge. This gear, or gear-like cutter, is rotated with the metal blank as if they were in mesh with each other the same as in Fig. 3. In addition, the cutter is given a cutting stroke with a helical motion, which sweeps its cutting edge through the exact space occupied by the tooth surfaces of the generating gear in Fig. 3, and the cutter generates helical teeth in a metal blank, in exactly the same way that the gear molded teeth in the plastic blank; any gear so generated and having twelve teeth or more, will mesh with any other gear of twelve teeth or more, cut by the same cutter.

Special Features of the Machine

Two views of this new helical gear shaper, are shown in Figs. 1 and 2. The only change in the design, as compared with the gear shaper previously built by this company, is the provision of a helical guide for giving the twisting motion to the cutter spindle as it is reciprocated up and down for the cutting and return strokes. Fig. 5 shows the cutter spindle, guide and cutter removed from the machine. The guide, as may be seen, is a solid block of cast iron, which is planed by special machinery to a helix of the proper lead. The mating guide (see Fig. 6) is seated in an enlarged hub bolted to the face of the index wheel. It is of large dimensions and has planed and scraped helical surfaces. It is split in the middle

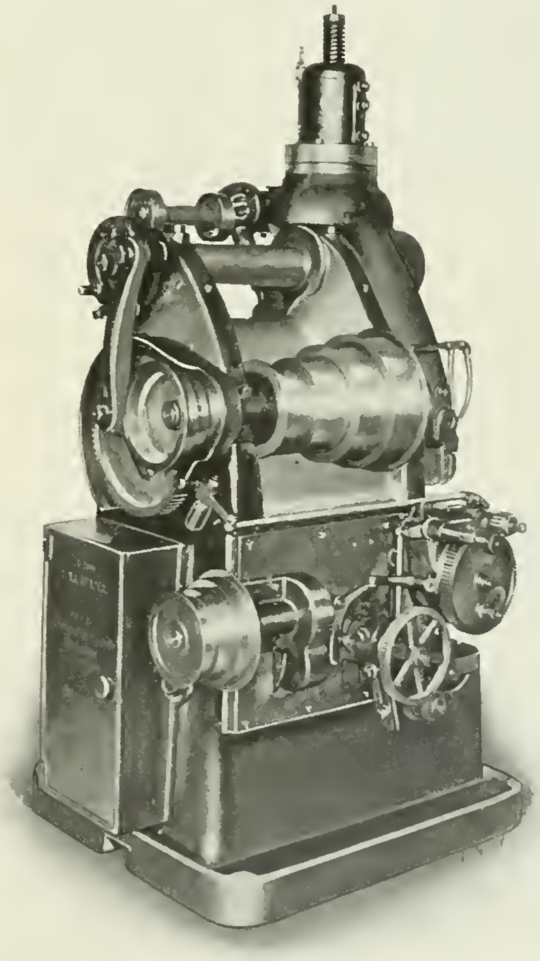


Fig. 2. Rear View of Helical Gear Shaper

and is provided with an endwise adjustment for taking up the wear. The bearing surfaces are so generous, however, that the wear is negligible. The location of the helical guides in the machine is plainly shown in Fig. 8, where the internal member is seen projecting beyond the hub in the upper index wheel.

This guide mechanism is worthy of particular study. Change gears have been invariably employed for obtaining the desired helix angle in previous designs of commercial helical gear-cutting machines. This is convenient where constant changes in helix angle are to be made, but it is a disadvantage as a manufacturing proposition. The control of the motion is elastic and complicated. Furthermore, the change gears usually have to be reset for each new number of teeth cut, even though there may be no change in the helix angle, and often the machine is so designed that a change of feed cannot be made without a re-calculation of the helix change gears. The result is that it may be impossible to do more than approximate the desired helix angle, so that two gears of different numbers of teeth will be found to have slightly different helix angles when the attempt is made to run them together, this being due to approximations in the gearing for the two cases that were different in amount or direction.

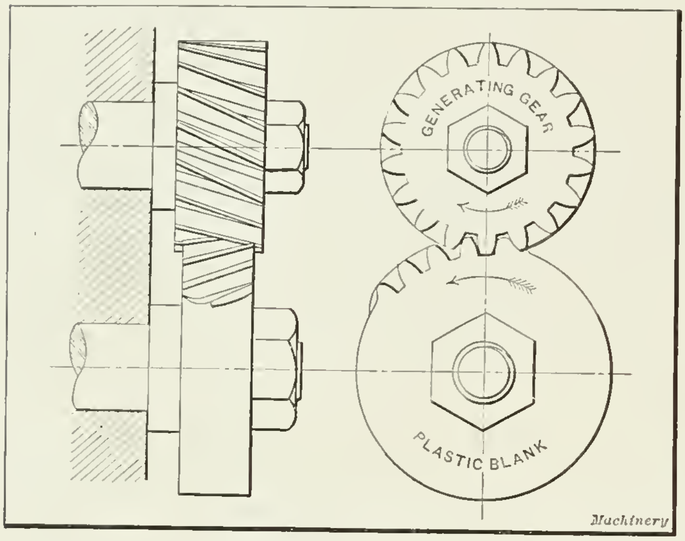


Fig. 3. Diagram illustrating Molding-generating Principle

With the helical guide mechanism of the helical gear shaper, the cutter is directly connected through the spindle to the guide which determines the lead of the helix. The control of the motion is direct, rigid and positive. The mechanism is independent of the feed, cutting stroke, indexing or any other function of the machine. It is made of the exact helix desired in the first place and never changes. By means of special machinery, any number of guides of any angle can be made, all exact duplicates of each other. The helix angle of the gears likewise never changes, so that this source of error is removed. Only ten or fifteen minutes is required to change cutters or guides when changing from one helix to another or from a right-hand to a left-hand gear.

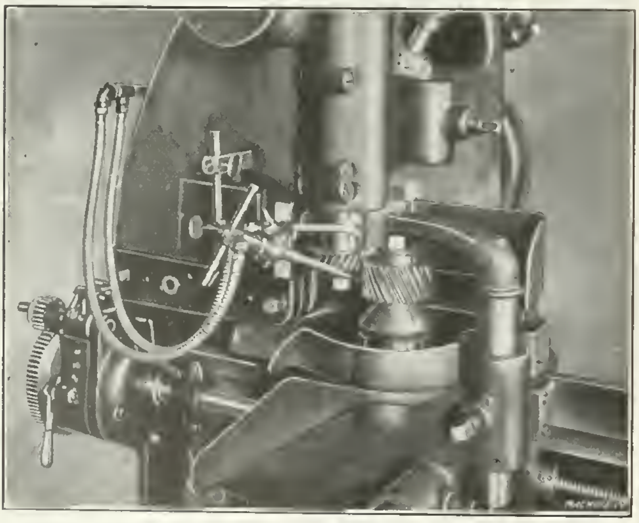


Fig. 4. Detail View of Helical Gear Shaper

A pair of helical cutters used on this machine, is shown in Fig. 7. Like the straight, spur-gear shaper cutter, the helical cutter is hardened before finishing the tooth outline, so that all error from change of shape in the fire is avoided; and it is ground to shape by a generating process after hardening. Every curve on these cutters is a generated curve that is not copied in any way and is formed without the use of templets or master tools. With original curves generated in place on the cutter after hardening, great accuracy is secured.

General Description of the Machine

Aside from the special features previously referred to, the machine is practically a No. 3 Fellows gear shaper of the well-known design. The machine is naturally divided into the following parts: The cutter drive; helical guides; relieving mechanism; index and feed mechanisms. The separate sections will be described briefly.

The cutter drive is operated from the four-step cone pulley seen in Fig. 2. A pinion at the rear end of the cone pulley shaft meshes with a large gear shown at *A* in Fig. 9, which is provided with a graduated crank slot for crankpin *B* operating connecting-rod *C*. The upper end of *C* is pivoted to a wrist-pin in casing *D* which has bearings for worm *E*. This worm engages worm-segment *F* keyed to rock-shaft *G*. The rock-shaft at its other end carries spur gear segment *H* meshing with rack teeth cut in spindle sleeve *J*, Fig. 11. By means of these connections the cutter spindle *K* and cutter *L* are reciprocated. Adjustment of crankpin *B* in the graduated slot, adjusts the length of the stroke to agree with the graduations. The turning of worm *E* adjusts the position of the stroke to agree with the location of the face of the gear being cut, and screw *Y* clamps this adjustment.

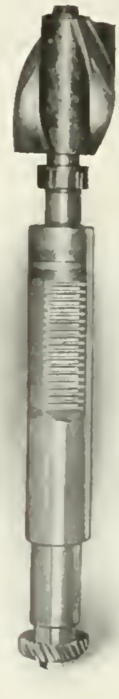


Fig. 5. Cutter-spindle and Helical Guide

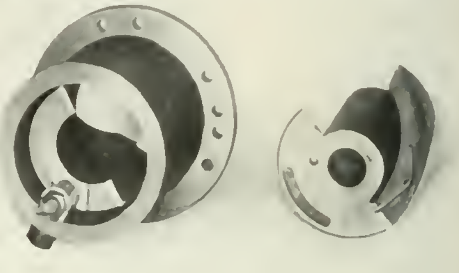


Fig. 6. Mating Helical Guides for Cutter spindle

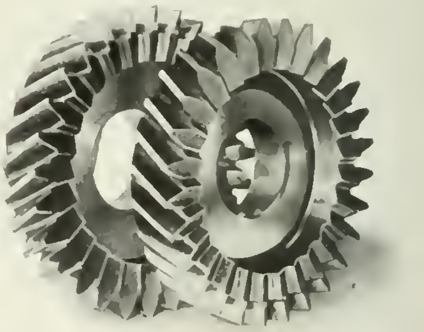


Fig. 7. Helical Gear Cutters

The helical guides, illustrated separately in Figs. 5, 6 and 8, are shown in place in Fig. 11. The fixed guide *M* is seated in the extended hub *N* of the upper index wheel *O*. The movable guide *P* is keyed to cutter spindle *K*. Guide *M* is split into longitudinal sections adjustable on each other by means of screw *Q*. This allows the adjustment to give the proper closeness of fit.

The relieving mechanism operates as follows: Crank gear *A* is keyed to shaft *R* which extends through to the front of the machine where it carries a double-throw cam *S*. Cutter spindle *K* and all the attached mechanism is mounted in the head casting *T* which, as shown most plainly in Fig. 9, is free to swivel through a short arc about the axis of shaft *G*. At the beginning of the cutting stroke, cam *S*, bearing on roll *W* (see Fig. 11), throws this cutter head forward into the position shown for cutting. On the return stroke, the cam bears against spring support roll V on the left, swinging head *T* free and relieving the cutter from the work. On the cutting stroke, the head is swung against positive stop *W* which brings it always to the same position.

As explained in connection with Figs. 3 and 4, the cutter and work are revolved in mesh with each other as if they were a pair of gears. Index wheel *O* for the cutter, and the work index wheel, revolve continuously during the cut, a single revolution of the latter sufficing to complete the work in ordinary cases. They are connected by change gears set for the desired number of teeth.

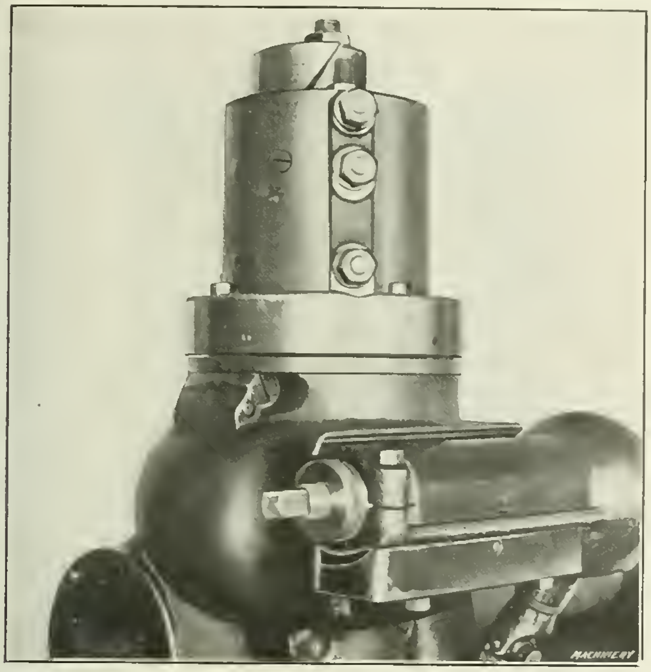


Fig. 8. Detail View of Hub containing Helical Guides

Four points should be noticed with reference to this index motion: First, it is continuous, steady and slow in movement; second, there is but one revolution per cut, which greatly increases the life of the index mechanism; third, the index worms revolve so slowly that it is possible to make them self-locking so that the helical thrust of the cutter does not disturb their connection; and fourth, the index mechanism is independent of either the cutter drive or helix mechanism, and is thus free from the irregular action of the former or the complication inherent in the usual design of the latter.

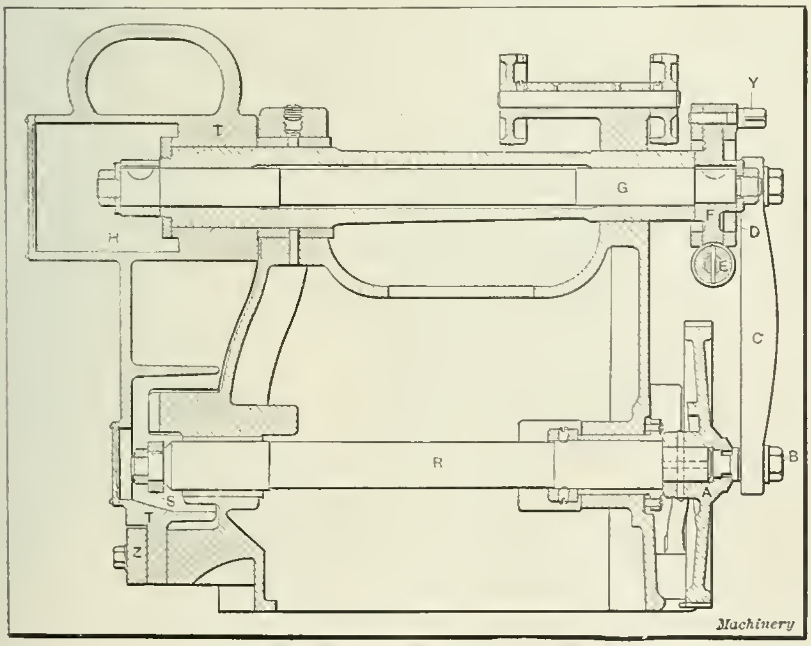


Fig. 9. Vertical Section, showing Drive for Cutter-spindle and Relieving Mechanism

The standard reverse taper work arbor of the gear shaper is retained, thus tying the work, arbor and spindle into a solid whole and giving the entire structure great rigidity. As shown also in Figs. 1 and 4, an outboard support is provided for the work arbor as well as a work support clamped directly to the main frame of the machine. These provisions hold all work firmly, support it against the thrust of the cutter, and permit the machine to "get out" of the cutter all there is in it. Two heavy streams of oil are directed on the cutting edge, cooling the tool and giving a fine, smooth finish on steel work.

The feed mechanism is identical with that of the regular gear shaper. It comprises the rotary motion for the index mechanism, together with means for feeding the cutter in to depth at the beginning of the cut and stopping the feed when the cut is finished. It is entirely automatic in its action.

The double-cut mechanism furnished with every machine, is invaluable when the coarseness of the pitch or the hardness of the material makes it necessary to take a roughing and a finishing cut. The adjustment of a clamp-screw in a graduated slot, determines the amount of stock left for finish. When set for the double cut, with the feed thrown into operation, the following sequence takes place automatically: First, the cutter is fed in to roughing depth. The work then makes one full revolution with the cutter at roughing depth. The cutter next feeds in to finishing depth, and the work makes one full revolution at this depth. Finally, the feed is stopped and a bell rings to call the operator.

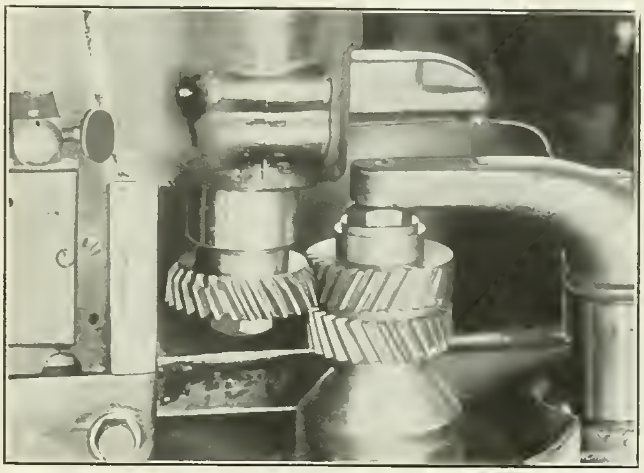


Fig. 10. Cutting a Herringbone Gear

Cutting Special Forms of Helical Gearing

The helical gear shaper, like the spur gear shaper, will cut teeth in to a narrow recess. It is therefore easy to cut teeth to a shoulder or to cut cluster-gears with two or more diameters on the same piece. This same feature makes it possible to cut solid, double helical or herringbone gears. With this design of gearing, it has been necessary hitherto to leave a wide space between the two sections for the cutter to run out into, or else the gear has been made in two pieces which are cut separately and fitted and fastened together afterwards. One of these expediencies wastes space, the other time. With the helical gear shaper, a herringbone gear can be made in one solid piece with a narrow groove between the two sections. One-quarter or five-sixteenths inch will do, depending on the pitch or helix angle. The teeth are cut in to this narrow recess from either side. Fig. 10 shows such a gear with the right-hand teeth already formed, and the cutter at work on the left-hand teeth. Where the mating gear is to be cut in the same way, a simple locating fixture brings the teeth on each side of both gears, into position so that a full bearing is obtained on each side of the recess.

Specifications of No. 30 Helical Gear Shaper

The maximum capacity of this machine for cutting helical gears is as follows: Outside diameter, 18 inches; face width, 4 inches; diametral pitch in cast iron, 6; diametral pitch in steel, 8. It can also be arranged for cutting regular external spur gears, having a maximum outside diameter of 24 inches; face width, 4 inches; diametral pitch in cast iron, 6; diametral pitch in steel, 7. The strokes per minute are 45, 64, 100 and 140. The strokes per inch of pitch diameter of the gear blank are 216, 286, and 418.

In the construction of the machine, particular attention is paid to such vital parts as the index wheels and worms, guides, cutter ram, work spindle, bearings, etc. The materials used are carefully selected for the service required of them. The cutter spindle is hardened and ground. The fast running bearings are lined with phosphor-bronze.

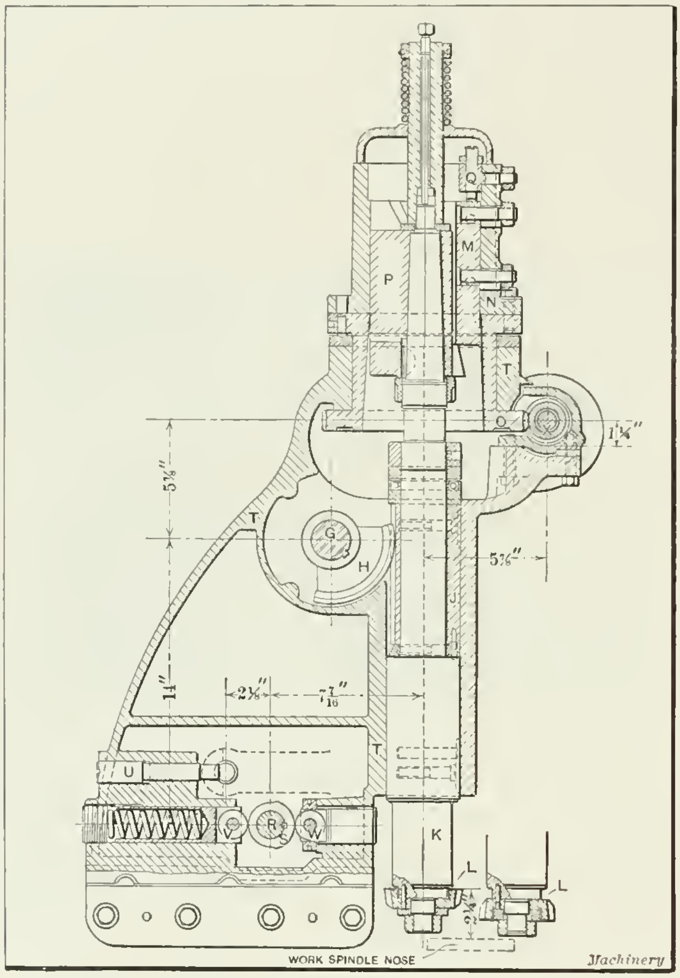


Fig. 11. Section through Cutter-spindle

In addition to the machine, the following equipment is furnished: Oil pump and all connections; flexible tubing; two oil nozzles; countershaft complete with tight and loose pulleys; change gears for spacing all numbers of teeth from 12 to 50, and from 50 to 450, excepting the prime numbers and their multiples; one pair of right- and left-hand helical guides of any helix angle specified, up to 30 degrees; all necessary wrenches, etc.

DETROIT SWITCH WITH SAFETY LOCK

Those who read Professor Hutton's article in the April number on the "Prevention of Industrial Accidents," will recall the reference to a safety lock for electric switches, to prevent the unauthorized closing of a switch when repairs are being made along some part of the circuit. The Detroit Fuse & Mfg. Co., 1400 Rivard St., Detroit, Mich., has just brought out an "ironclad" fused switch which is equipped with a padlock for locking the switch in the "off" position, to prevent a circuit from being closed at the wrong time.

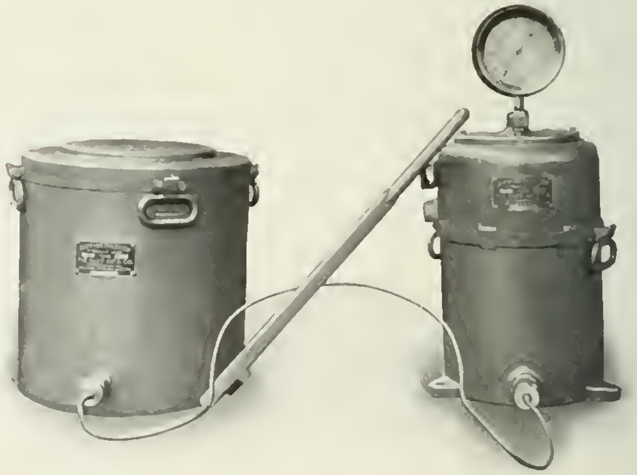
The switch is operated by means of a plunger-actuated mechanism with rods projecting through the cover of the box. This mechanism is controlled by a handle on the outside of the switch, and it carries the fuses. The mechanism is attached to the inside of a rubber-gasketed hinged door, and the fuses may be replaced by opening this door. All current-carrying parts are "dead" when the door is open, and the "live" connections are all at the bottom of the switch box, so that it is impossible to make accidental contact with them.

The cover of the switch can be clamped shut by an eye-bolt and wing-nut which engages lugs as shown. A drilled rivet is fastened to the cover, and by running a car seal through this rivet and a hole in the wing-nut, the switch can be sealed to prevent tampering with the fuses. By means of the padlock and clamp shown, the box can also be locked in the "off" position. This feature makes the switch ideal for the control of elevators, special machinery or any electrical service where it is desirable at times, to prevent an unauthorized person from closing a circuit. When repairs are being made to a motor, power circuit or lighting circuit, the one making them can lock the switch in the "off" position and secure absolute protection. The padlock and clamp are attached to the switch cover by short brass chains.

Switch with Padlock for Locking it in the "Off" Position

POWERFUL HYDRAULIC JACK

The United States government has recently purchased from the Duff Mfg. Co., of Pittsburg, Pa., a hydraulic jack capable of lifting a load of 500 tons. This jack is to be used in the Washington Navy Yard. It is of the independent pump type and is composed of two separate parts, one of which contains the water reservoir with its pump chambers, and the other the ram or lifting mechanism.



Duff-Bethlehem 500-ton Hydraulic Jack

Flexible copper tubing capable of withstanding a pressure of 10,000 pounds per square inch, connects the two members as the illustration shows. With this arrangement, the ram can be placed in any position where there is room enough for it, while the pumping mechanism can be located at a sufficient distance to allow the operator plenty of working room.

The pump is an improved duplex type, providing an accumulative stroke on the upward motion of the pump piston, and a working stroke on the downward movement. The pump is so arranged that a light load can be lifted five times as fast as a heavy load. This differential speed is automatically spring controlled, and requires no regulation of valves by the operator. The high speed is used for loads up to 35 per cent of the jack's capacity. In lifting loads greater than 35 per cent of the total capacity, the spring controlled valve automatically opens at the predetermined pressure per square inch, and the pump becomes single acting, working on the down stroke only.

Another feature of this jack is the gage, which shows the exact lifting pressure that is being applied. This gage acts as a scale and registers in tons the weight that is being lifted. The jack is simple in construction and has no parts to get out of order.

CLAMPS FOR MACHINE TOOLS

The clamping of castings or forgings to the table of a planer, milling machine or other tools, frequently requires more time than the actual operation of machining the work. Furthermore, a great deal of unnecessary time is often consumed because of the lack of proper clamping facilities, as every machinist knows. Schuchardt & Schütte, Cedar and West Sts., New York, have placed on the market the different styles of clamps shown in Figs. 1, 2 and 3, which are designed to reduce the time required for setting up work.

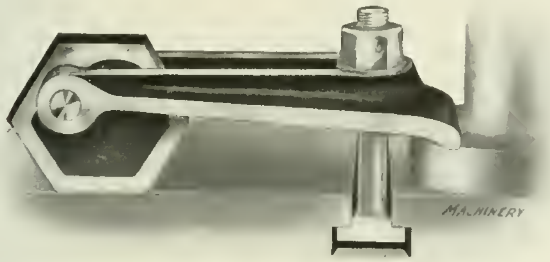


Fig. 1. Clamp Eccentrically Pivoted to Hexagonal Block

The construction and application of these clamps is so clearly shown by the illustrations that a description is scarcely necessary. The type illustrated in Fig. 1, has a clamp or claw which is pivoted eccentrically to a hexagon block, with the advantage that six different heights may be obtained by simply rotating this block. The design illustrated in Fig. 2 is intended especially for side clamping, whenever the nature of the work is such that clamps on top would interfere with the movement of the tool. This clamp has two bolts, one of which holds the base while the other tightens a hinged upper member which wedges a hinged claw at the end against the side of the part to be machined. The clamp illustrated in Fig. 3 may be used for side clamping, as indicated to the left, or for top clamping as shown in the right-hand view. This clamp is, in some respects, a combination of the two types previously referred to. The outer end of the clamp is pivoted to a rectangular packing block, in such a way that four different heights are available. These clamps are made in a number of different sizes.

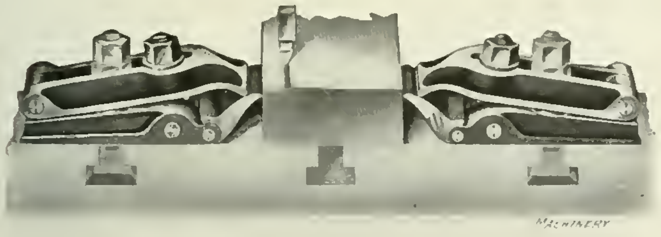


Fig. 2. Type used for Side Clamping

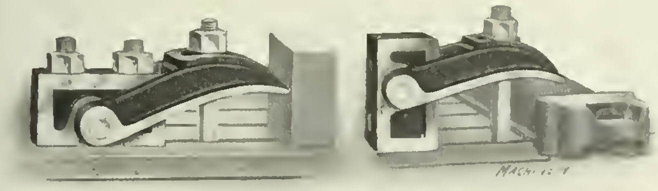


Fig. 3. Combination Clamp for Side and Top Clamping

MAGNALAMP FOR MACHINE TOOLS

Operators of machine tools frequently have trouble in adjusting an electric lamp so that the light falls on the right spot. The device illustrated in Fig. 1 is designed to overcome this difficulty, as it can be attached to the machine (as shown in Fig. 2) or work by means of an electro-magnet which contains an ordinary incandescent light bulb. It can be applied to iron, steel or any structure that is entirely or partly composed of iron and steel, and the magnetism causes it to stick tight enough to withstand considerable pull. The light bulb extends either from the end of the cylindrical magnet, as shown in the view to the left, or radially from the side, as indicated in the right-hand view, and its position can easily be changed. The same current supplies the lamp and magnet, although the latter consumes a very small amount of energy. The current is controlled by a quick-acting switch operated by a knurled disk which forms the central pole-piece of the magnet. When this knurled pole-piece is turned in a clockwise direction, the switch is opened or closed with each snap. This switch cannot be operated when the magnet is in use. After the current has been turned on and the lamp is lighted, the magnet can be de-energized (so that the lamp may be placed or removed) by pressing the little push button seen extending from the side of the casing above the magnet. By releasing this button, the magnet is instantly brought into service again. After the lamp has once been lighted, it remains lighted, irrespective of whether the magnet is energized or not; consequently, it is never necessary to be without light.

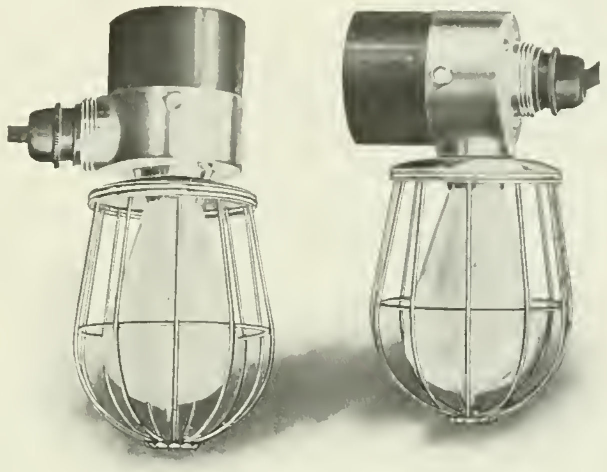


Fig. 1. Electric Light with Magnet for Attaching it to Machine or Work

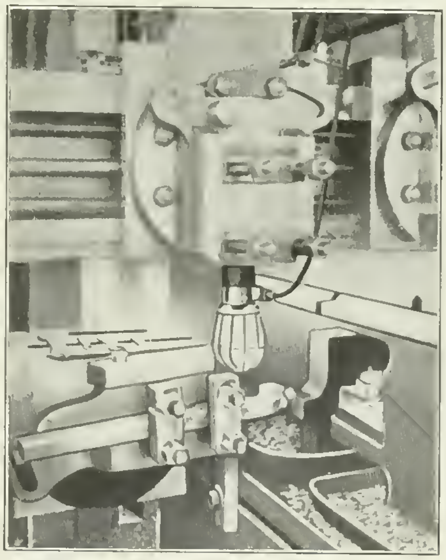


Fig. 2. Magnalamp attached to Planer

This lamp should be supplied with direct current, and it is furnished for the two standard voltages of 110 and 220 volts. This lamp is also supplied with a counterbalance device when it is to be used as a permanent lighting fixture. With this equipment, it serves as an ordinary drop-light when not attached magnetically, and it can be quickly adjusted to the required height. The magnalamp is made by the Sachs Laboratories, Inc., 103 Allyn St., Hartford, Conn.

LODGE & SHIPLEY HEAVY FORGE LATHE

The Lodge & Shipley Machine Tool Co., Cincinnati, O., has recently designed a lathe for taking very "heavy" cuts in connection with the rough turning of shafting and forgings. The power and cutting capacity of this machine is shown by a recent performance, which is said to be safely within the capacity of the lathe for continuous service. A 0.45 carbon steel axle was reduced 1½ inch in diameter by a single cut, with a 9/64-inch feed per revolution, and a surface speed of 63 feet per minute. The lathe is unusually massive, as the accompanying illustrations show, so that it will withstand continued service of the most severe nature.

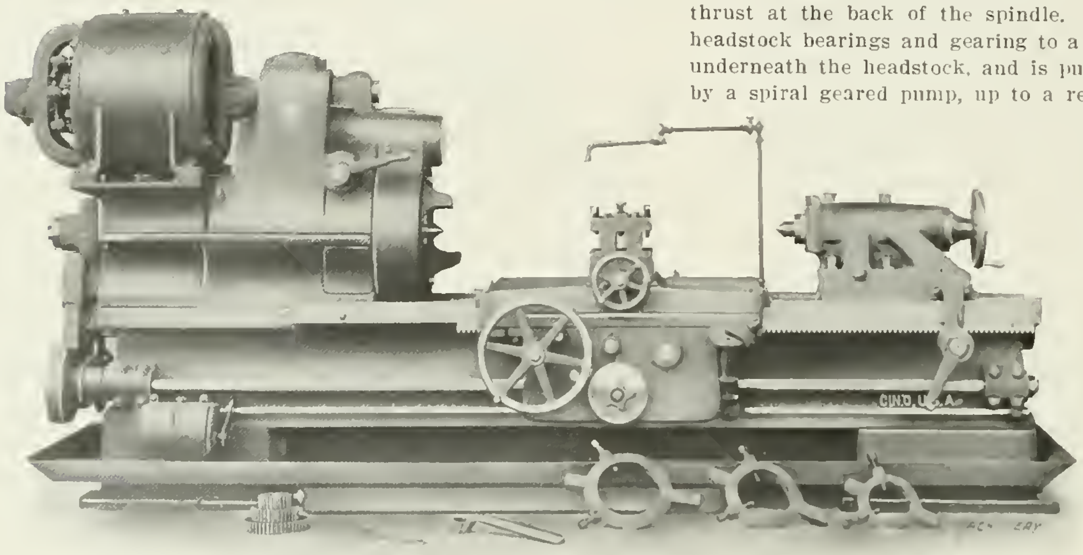


Fig. 1. Powerful Motor driven Lathe built by Lodge & Shipley

The actual swing over the carriage is 15 inches, and the swing over the bed 30½ inches. The arrangement of spindle speeds is such that the lathe is adapted only for turning work between centers; that is, the speed range suits only diameters which will swing over the carriage. The spindle speeds provide for turning at a rate not to exceed 140 feet per minute on 3-inch diameters, and not less than 61 feet per minute on 15-inch diameters.

The headstock is designed to receive a 30-horsepower direct-current, variable-speed motor, having a speed range of from 400 to 1200, but any type of motor can be applied and of any horsepower up to 40. There are two gear ratios, which, with the motor range of 3 to 1, give spindle speeds varying from 15.6 to 173 revolutions per minute. Any ratio of gearing may be provided to accommodate motors of higher speeds or to give the driving spindle any desired slower speed. The reducing of the spindle speed will, of course, increase the gear ratio. The driving gears within the headstock are of steel, and are hardened and heat treated. The lightest driving gear is 4 diametral pitch. The front spindle bearing is of large diameter and gives a projected area of 60 square inches.

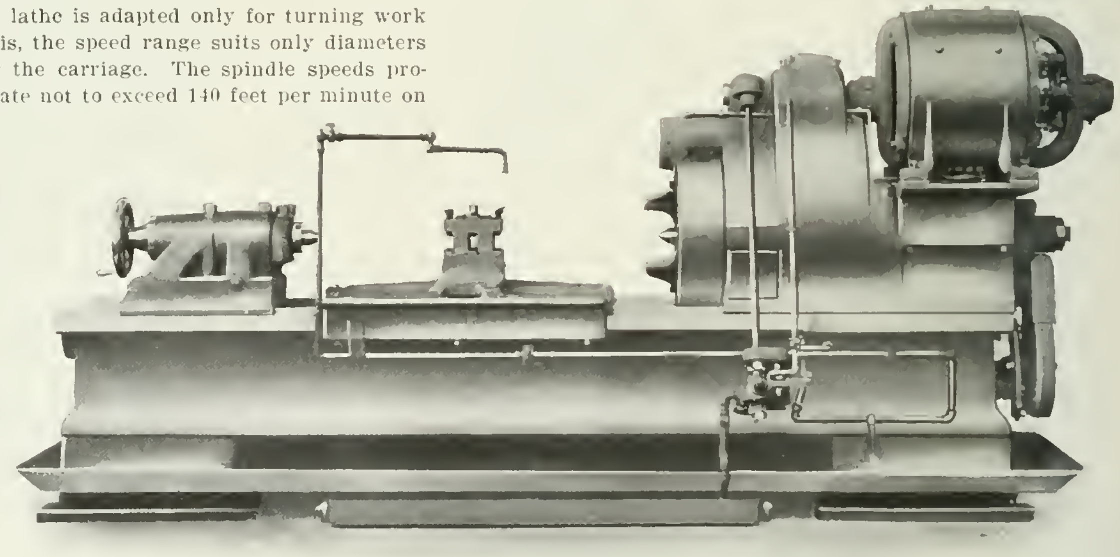


Fig. 2. Rear View of Forge Lathe showing Separate Pumps for Oiling Headstock and Supplying Lubricant to Cutting Tool

The spindle bearings are of standard composition metal. All other headstock journals are bronze bushed. The back spindle bearing is also of large diameter and gives a projected area of 47 square inches. The machine is provided with a compensating faceplate drive. The faceplate is 22 inches in diameter and is made of steel, as are the dogs which act as drivers. These drivers can be adjusted radially on the faceplate to accommodate driving dogs of various capacities and lengths. The driving shafts within the headstock are supported on both sides of the gears, thus eliminating all overhang.

Forced lubrication is provided for all of the driving gears and journals, including the main spindle bearing and the thrust at the back of the spindle. The oil drains from the headstock bearings and gearing to a reservoir cast in the bed underneath the headstock, and is pumped from this reservoir by a spiral geared pump, up to a reservoir at the top of the head, from which it is piped to the various bearings and gears. The spindle is solid, and runs against a solid, hardened steel plug at its back end, to oppose the tremendous thrust.

The centers are No. 6 Morse taper, and the one in the headstock is fitted into a hardened steel bushing forced into the spindle. The headstock is 48 inches long overall, and has covers which entirely enclose all the driving gears. The machine will deliver, with a 30 horsepower motor, about 19,500 pounds pull on an 8-inch shaft, and with a 30 per cent overload of motor, about 25,000 pounds. This would ordinarily create a pressure of 400 pounds per square inch on the spindle bearing, but the driving pinion is so placed that the pressure of the cut is opposed by the driving pinion itself; consequently this amount of pressure per square inch is greatly reduced.

The tailstock arbor is of large diameter and length, and is reamed for No. 6 Morse taper. It is made of tool steel. The tailstock has a long bearing on the bed, and a locking pawl engages a rack cast inside the bed.

The smallest gear in the apron is 3½ inches in diameter, and the finest pitch used, 5 diametral pitch. The smallest face of any gear in the apron is 1½ inch wide. All apron gears are of steel, and all bearings are bronze bushed. The friction for locking the feed is placed on the outside of the apron to insure close inspection of friction faces at all times. The apron is double webbed, giving support at both ends of all studs. A rear view of the apron is shown in Fig. 3. The handwheel is 18 inches in diameter, and is geared so that one turn moves the carriage about ⅞ inch.

The carriage is very long, and the entire length bears on the bed. The total area of bearing surfaces on the bed is 245 square inches. It is gibbed both front and rear, and also under the inside V's. The bridge is extremely wide and strong, the tool-block is steel, and rests on a cast-iron cross-slide. It has one center slot to accommodate tools 1¼ inch by 2½ inches, and two open sides for tools of the same dimensions. Serrated and hardened tool-steel plates are secured to the tool-block to give the tool a long bearing. The cross-slide is very long, and has 168 square inches of bearing surface on the top of the carriage. The cross-feed screw is of large diameter, and is placed as high as possible to resist the action of the cut. There is an oil trough cast entirely around the carriage, and this trough is placed below the inverted dovetail so that the lubricant from the cutting tool will not flood around the sliding surfaces. The carriage drains at the four low corners, back into the drip pan under the bed.

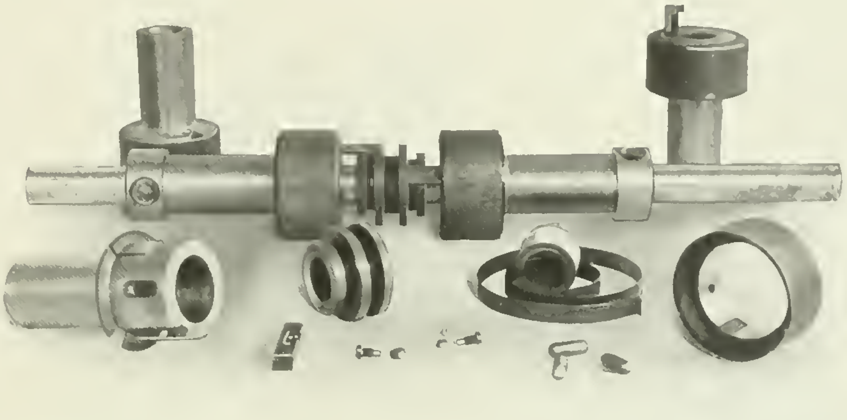


Fig. 1. View showing Single and Double Bicknell-Thomas Clutch and Component Parts

A separate and very substantial pump is provided for the cutting compound, which is geared positively from the headstock, and this pump will deliver a ¾-inch stream of lubricant to the cutting tool at the rate of 16 gallons per minute. Instead of the usual flexible tubing there is telescopic tubing, (see Fig. 2) with proper stuffing boxes to take care of the longitudinal traverse of the carriage.

The bed is very wide at the top and unusually deep. It is mounted on cabinet legs, and has a heavy steel oil pan the entire length. This oil pan does not rest upon the floor, but is high enough to permit a cast-iron drip pan, mounted upon rollers, to be run under it. The lubricant from the chip pan is drained directly into the cast-iron pan and is pumped from this again to the cutting tool. This method separates the chips from the lubricant, and the chip pan itself is always comparatively dry.

The feed rod is of large diameter, and has two keyseats diametrically opposite for driving a steel bevel gear in the apron. The rod is driven by plain change gears, and four changes of feed are provided as follows: 1/16, 3/32, 9/64 and 3/16 inch per revolution. The feed gears are steel, of wide face, and coarse pitch. The motor controller rod extends along the front of the bed, and is operated by a handle near the top of the carriage.

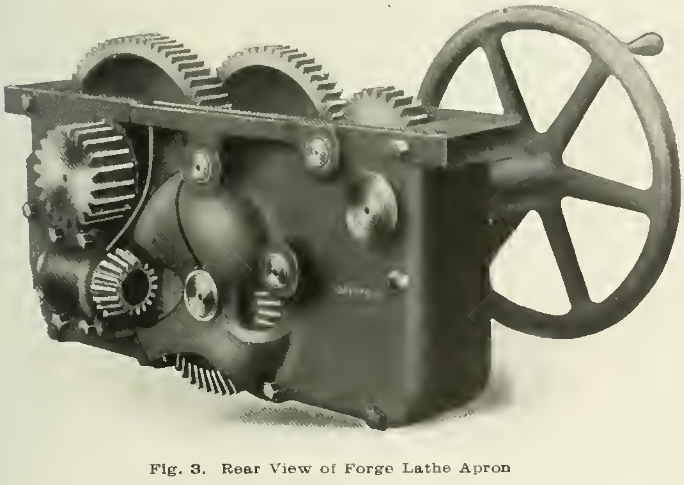


Fig. 3. Rear View of Forge Lathe Apron

BICKNELL-THOMAS CLUTCH

The Bicknell-Thomas Co., of Greenfield, Mass., is now manufacturing a roller grip clutch which contains few parts and is self-adjusting for wear and varying load conditions. It requires a small amount of space and is easily engaged. The construction of the clutch is shown in Figs. 1 and 2. Inside of the body *A*, which is free to rotate upon the shaft, there is a hardened steel bushing *B*, which is keyed to the shaft. A hardened steel cam-ring, which may be seen to the right in Fig. 1, is loosely mounted on the end of the clutch body. Fitting into slots in the body *A* and interposed between the cam-ring and bushing *B*, are three hardened steel rolls *D*. One end of a flat coil spring *E* is attached to body *A* and the other end to the cam-ring, which is held onto the body by a screw and roll *F*. On the inside of the cam ring and directly over the rolls, there are cam surfaces. The clutch is operated by shifting slide *G* which causes the coil spring *E* to slightly rotate the cam-ring upon the clutch body. As the result of this rotary movement, rolls *D* become wedged between the fixed bushing *B* and the cam-ring, thus causing the clutch and shaft to rotate as a single unit. A single clutch is composed of only sixteen parts, including the oil cup, shifter, thimble and collar, and all parts are interchangeable.

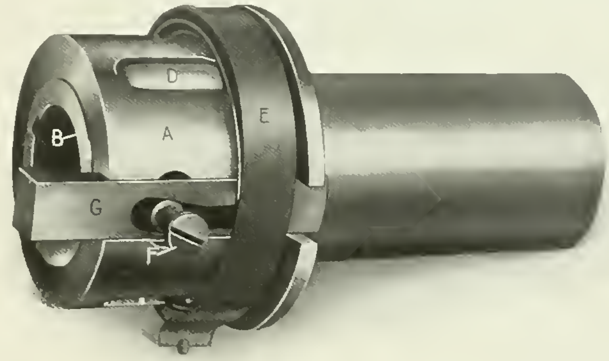


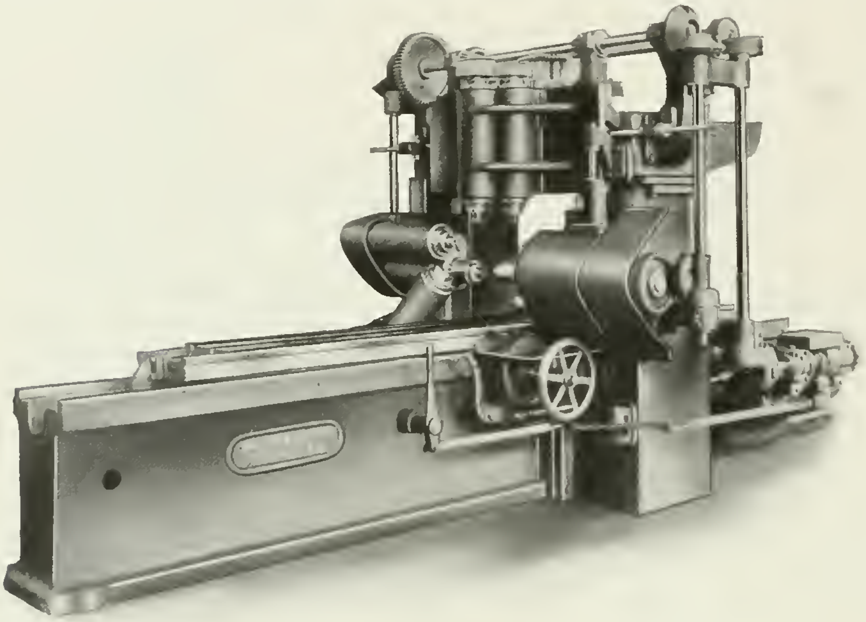
Fig. 2. Single Clutch with Cam-ring Removed

BEAMAN & SMITH NINE-SPINDLE MILLING MACHINE

The nine-spindle milling machine illustrated herewith is a special design recently built by the Beaman & Smith Co., Providence, R. I., for automobile manufacturers. This machine finishes, in one operation, three sides of as many "T-head" cylinder castings as the table will accommodate, thus greatly increasing the rate of production and giving a uniformity to the work that is impossible when each casting is machined separately.

The construction of the machine is similar, in many respects, to the regular planer or horizontal type, except for the arrangement and number of cutter spindles and the necessary changes in the driving mechanism. A saddle on each upright carries three spindles, five of which are in a horizontal position parallel with the platen, whereas one is at an angle of 45 degrees with the platen, as the illustration shows. In addition, three vertical spindles are carried by the saddle on the cross-rail. The saddles on the uprights have vertical movements and the one on the cross-rail, a horizontal movement.

The work-table has a maximum traverse of 10 feet, 10 inches on the bed, and it is 17 inches wide and 10 feet long. It has quick power movements in either direction, varying from 3½ to 14½ feet per minute. The table is operated by a screw which engages a revolving bronze nut, and the thrust is taken by ball bearings. An automatic stop is provided, and the feeds are so arranged that the desired rate can be secured for any spindle speed. The feed movements are positive in either direction, being transmitted through gearing contained in a conveniently located feed box. Nine changes are available, varying from 1 to 6 inches. The spindles are of crucible steel and run in hard bronze boxes. The 45-degree spindle has a 2-inch endwise adjustment and the others have a 1½-inch adjustment. The ends of the spindles are made to fit cutters according to specifications. The spindles all operate in unison and the speeds vary from 17 to 69 R.P.M. The front bearings are 3 inches in diameter, 4 inches long, and means are provided to compensate for wear. The rear bearings are 2½ inches in diameter and 4½ inches long.

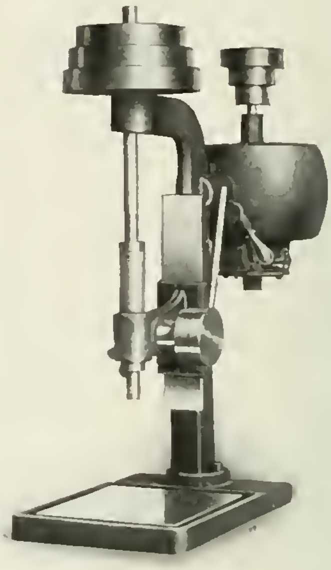


Special Beamen & Smith Nine-spindle Milling Machine

This machine is driven by a 7½-horsepower motor through gearing having a ratio of 23 to 1. The distance between the uprights is 31 inches and the maximum and minimum distances between the ends of the horizontal spindles are 15 3/8 inches and 5 7/16 inches, respectively. The minimum distance from the top of the table to the ends of the vertical spindles is 18 1/16 inches and the maximum, 19 9/16 inches. The distances between the centers of the spindles in each saddle are fixed, the positions of the spindles being governed to suit requirements. The weight of the entire machine is approximately 20,000 pounds. All fast-running shafts have bronze-lined boxes; the bearings are finished by grinding; the sliding surfaces are scraped, and all the gears, many of which are of steel, are cut from the solid.

WILLEY 12-INCH SENSITIVE DRILL

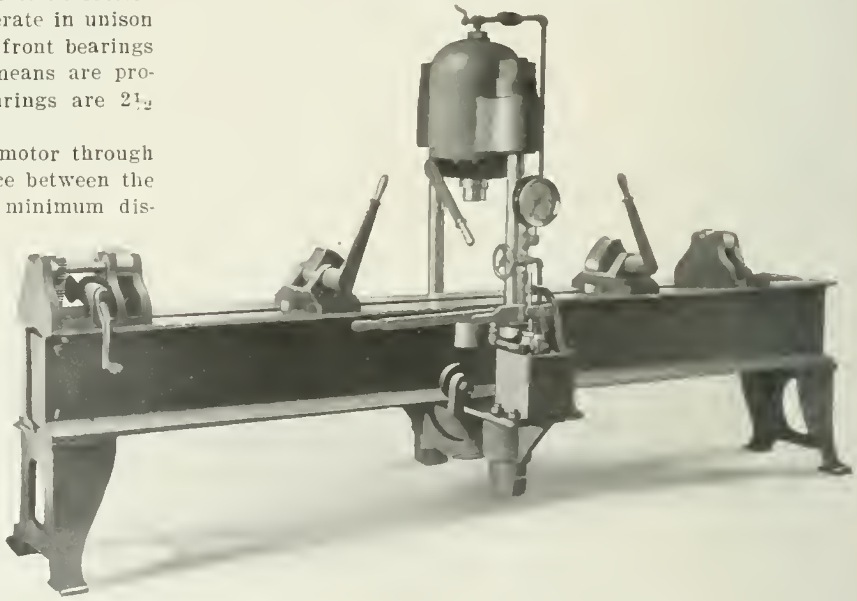
The Willey Machine Co., Jeffersonville, Ind., has brought out a new design of 12-inch sensitive drill. This machine is of the bench type and is driven by a motor which connects with the spindle by a belt operating on the three-step cone pulleys shown. Three changes of speed are available. The motor is adjustably mounted for varying the belt tension. The starting switch is within the motor frame. The motor can easily be detached and exchanged for another, in case it is necessary to use a different voltage or an alternating current. The motor is mounted high enough on the column to be out of the way of dirt and chips. The sliding head has a movement of 8 inches on the column, and the machine drills to the center of a 12-inch circle. The greatest distance from the spindle to the table is 11 inches, and the traverse of the spindle is 3 inches. The total height of the machine is 26 inches, and its weight, 90 pounds. The maximum power of the motor is ¼ horsepower.



Twelve-inch Motor-driven Bench Drill

HYDRAULIC BAR STRAIGHTENER

An improved hydraulic bar straightener has been designed by the Hydraulic Press Mfg. Co., 84 Lincoln Ave., Mount Gilead, Ohio, for use in machine shops, automobile factories, garages, etc. This machine will quickly bend or straighten bars, shafts or axles and it is adapted to various sizes of stock. The construction is simple and a powerful pressure can easily be exerted on a bar or axle.



Hydraulic Bar-straightener built by the Hydraulic Press Mfg. Co.

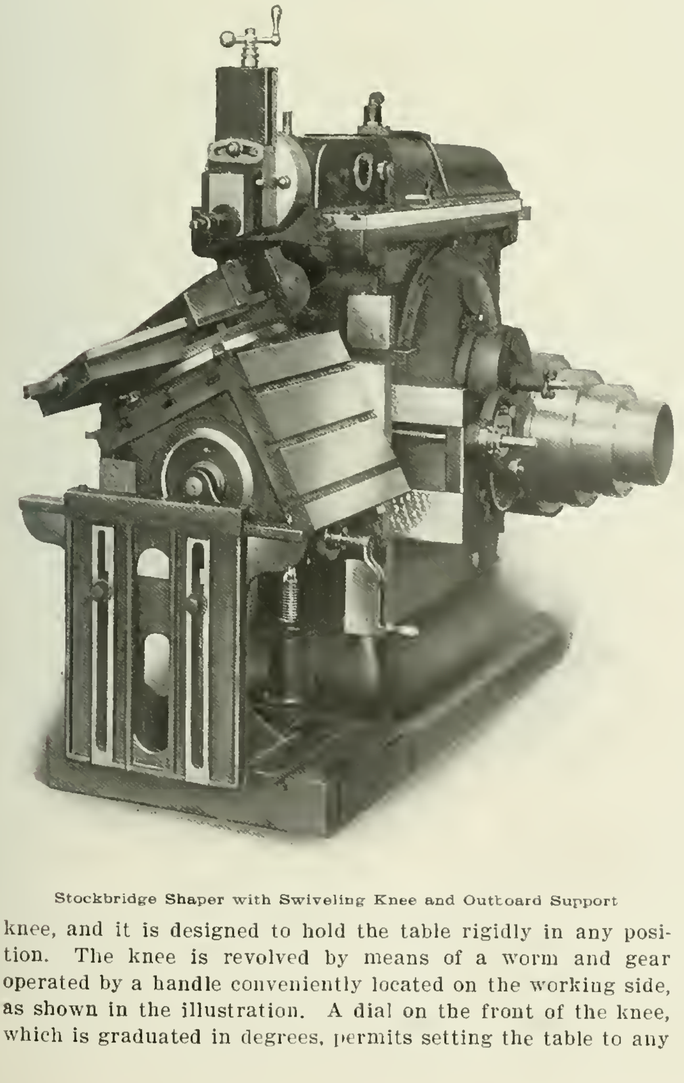
The press frame is formed of two steel I-beams having rigid stands at the ends, and the press itself is mounted on a carriage which rolls along the lower, outer flanges of the I-beams. A bracket on the carriage supports the pump and water-box, as the illustration shows. The cylinder strain rods are extra strong and have a large factor of safety. A pressure gage and safety valve are provided to eliminate all danger from overstrain. The upper surface of the I-beams is machined, thus providing a true surface upon which the bending blocks and the tail roller center can slide. By means of the roller centers, axles or shafts can easily be turned to the required position by the hand crank shown. The press can be rolled to either end of the frame with one hand, thus permitting the work to be placed in position without pushing it in endwise.

When the press is in use, the axle or shaft to be bent is placed on the roller centers and turned to the required position. The levers of the bending blocks are then thrown back, thus lifting the axle from the roller centers. The ram is next lowered to the proper position by a hand-lever attached to it, which operates through a rack-and-pinion movement. Everything is now ready for applying the pressure. The pump is operated by hand, and as it is provided with a 30-inch extension handle, pressures up to 125 tons are easily obtained. A pressure of 75 tons is sufficient to bend a solid iron bar 4½ inches in diameter, with the supports 30 inches apart, whereas a pressure of 125 tons will bend a bar 6 inches in diameter with the supports 36 inches apart. It is evident, of course, that larger bars can be bent by increasing the distance between the supports. The ram has a movement of 4 inches, but by using extension blocks which can be attached to it by a set-screw, the advantage of a longer travel can be secured. This makes it possible to straighten large or small bars.

This type of straightener is made in various sizes, having a beam length of from 9 to 25 feet, and with pressure capacities varying from 75 to 125 tons. In addition to the roller centers, the machine may also be equipped with spring centers, both forms being interchangeable.

STOCKBRIDGE SHAPER WITH SUPPORT FOR SWIVELING KNEE

The Stockbridge Machine Co., Worcester, Mass., is now equipping shapers of the swiveling knee type with an outboard support. This support is similar to the type used previously on the shapers built by this company having a standard stationary knee, and it is designed to hold the table rigidly in any position. The knee is revolved by means of a worm and gear operated by a handle conveniently located on the working side, as shown in the illustration. A dial on the front of the knee, which is graduated in degrees, permits setting the table to any angle when planing bevels. One side of the knee can also be equipped with a tilting top, thus making it possible to plane compound angles.

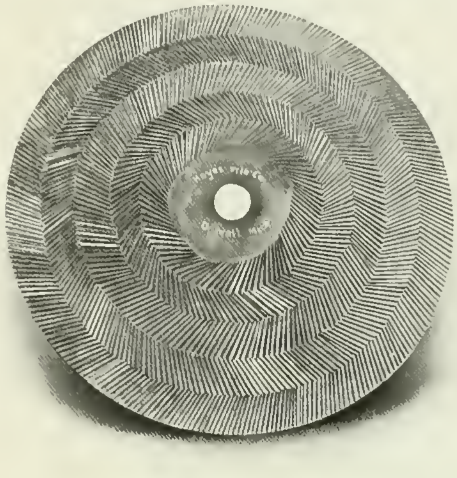


Stockbridge Shaper with Swiveling Knee and Outboard Support

This swiveling knee support is now applied to the 16-, 20- and 24-inch back-geared shapers, and the 18-inch all-geared type. The machine illustrated is a 24-inch size. The necessity for supporting a knee of the swiveling type is just as great as, if not greater than, for a stationary knee, as shapers having the former design are frequently used for planing parts requiring considerable accuracy.

HAYES CIRCULAR FILE

The circular file shown herewith is intended for filing aluminum, solder, babbitt, and other soft metals. The particular file illustrated is 14 inches in diameter and 1 inch thick. There are teeth on both sides of the file and these are cut by hand. When the file is in use, it is mounted on a stand like an emery-wheel and is rotated at a speed of 200 revolutions per minute.



Circular or Rotary File for Filing Soft Materials

The Ford Motor Car Co. uses a file of this type for filing connecting-rod caps, the babbitt on these caps being "surfaced" by simply holding them against the side of the revolving file. This file is manufactured by the Hayes File Co., Detroit, Mich. It can be obtained in any diameter desired, and either the thickness or grade of cut is varied to meet individual requirements. The file does not clog, and it is especially valuable for finishing soft metals such as those mentioned.

BLISS DOUBLE-DRAW PRESSES

Double-draw presses are the latest development for producing cupped articles or shells by the drawing process. They differ mechanically from the ordinary double-action press in having three, instead of two moving slides, and, therefore, might appropriately be called triple-action presses. The primary object sought in the double-draw press, is to save time and increase production by making two drawing operations on a single article with one stroke of the press, or to draw and re-draw, or re-draw twice in a single operation. It will be seen that this type is, therefore, particularly adapted for articles that require more than one drawing operation to bring them to required dimensions.

The economies effected by this method of drawing, are not due to the simplicity and rapidity of mechanical production alone, but also to reduced handling of shells and the smaller space occupied by the machinery and partially finished product. In addition, the annealing of shells between operations is unnecessary. With the double-draw press, annealing is avoided, as one drawing operation immediately succeeds another, and the heat generated in the first drawing remains in the shell. As annealing involves much expense in the maintenance of furnaces, handling and cleaning annealed shells, etc., the economy, in this respect, is important.

The double-draw presses illustrated herewith are two of a line of six sizes built by the E. W. Bliss Co., 5 Adams St., Brooklyn, N. Y. The performance of these machines is said to be very satisfactory. The presses range in drawing capacity for blanks up to 25 inches in diameter, and the material varies from 1X tin to steel 1/16 inch thick. Shells have been produced having depths up to 10 inches. The smaller sizes are of a somewhat different construction than the larger, being arranged for dies with cutting edges, in order to cut blanks, draw and re-draw in one stroke. The larger sizes (beyond a 12-inch diameter blank capacity) are not adapted for the use of dies with cutting edges.

The slide movements in these presses operate the dies as follows: A double die with the blank on its top, is brought in contact with a blankholder. A tubular punch then descends into the top section of the die, making the first draw. The tubular punch then stops and dwells, thus acting as a blankholder during the second draw. The second draw is performed by a punch that descends through the tubular punch into the lower section of the die, the second draw beginning immediately after the first is completed.

Fig. 1 shows a machine used for cutting blanks up to 12 inches in diameter, from brass sheets or strips up to No. 22 gage thickness, and performing two drawing operations on them. In this machine, the die bed is fixed and rigid and the blankholder carrying the top cutting edges, moves in long adjustable guides. The moving parts are mechanically balanced, as far as possible, and are started and stopped by means of a combined, toggle friction-clutch and brake, either automatically or by hand. The blankholder is actuated by toggles that receive their motion from a cam. These toggles produce a perfect blankholder dwell during the drawing period and receive the blankholder pressure, thus relieving the cam of pressure during that time. The first draw punch slide is actuated by a crank and toggle motion, and the second draw punch by a simple crank motion.

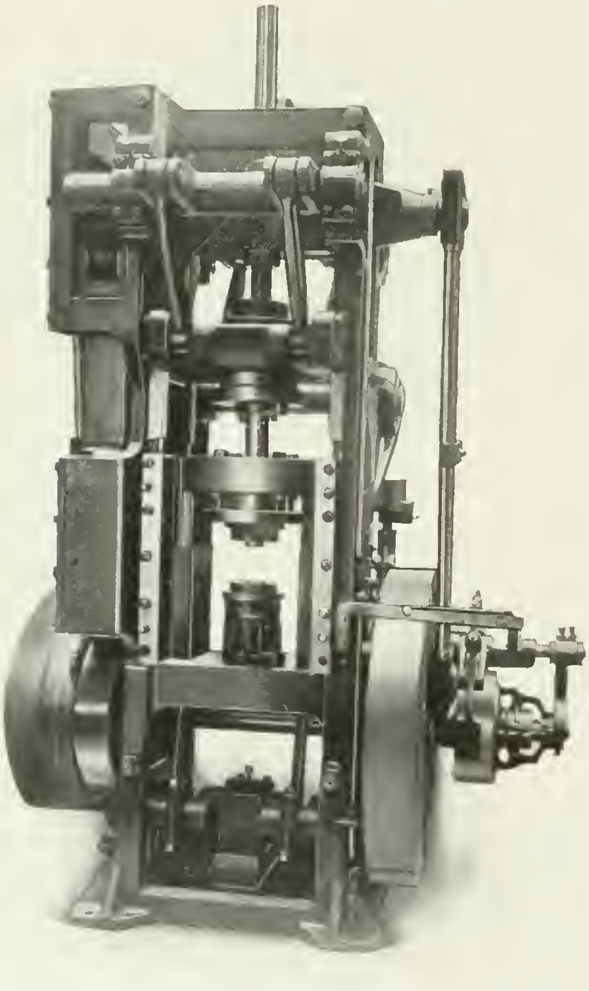


Fig. 1. Double-action Press arranged for Cutting and Drawing

Fig. 2 shows a machine that takes blanks up to 21 inches in diameter and of steel to No. 20 gage thickness. It will receive first draw punches up to 14 inches in diameter and produce shells up to 8 inches final depth. In this machine, the lower dies are fastened to a table that has motion and are brought up against a stationary adjustable blankholder. The table is moved up and down by toggles actuated by a large cam groove in the main gear. The toggles take all the pressure due to the blankholder and the descent of the punches, so that the cam only moves the table up and down. As the table is counterbalanced, its work is very light, which eliminates wear.

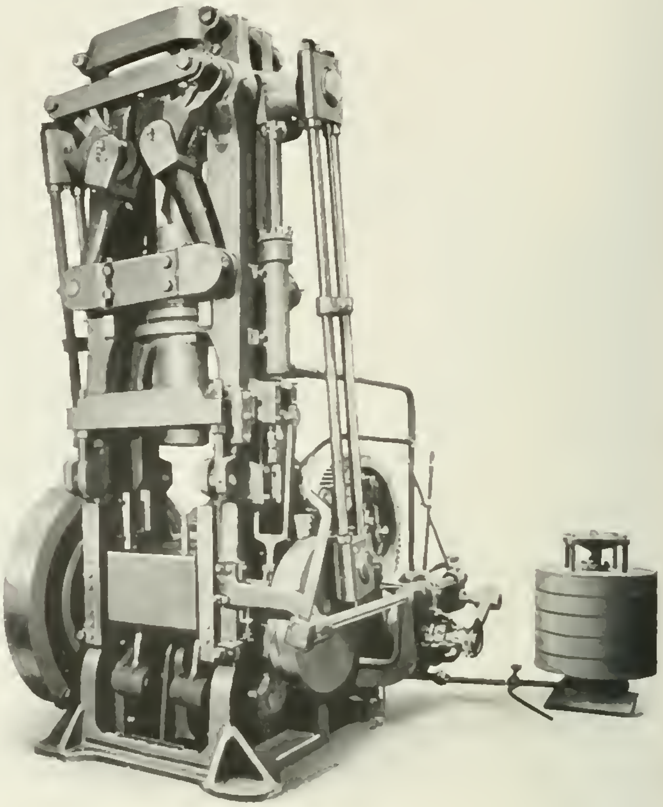


Fig. 2. Double-action Press for Blanks up to 21 Inches in Diameter

The first draw punch slide receives its motion through toggles from the second draw punch slide. These toggles provide a fine dwell for the first draw punch, during the drawing period of the second punch. All the moving parts mentioned, are counterbalanced during their up and down movements by a hydraulic plunger and accumulator system, which makes the starting of the press easy, certain and safe. The hydraulic accumulator can be placed in the most convenient position, either below or above the floor line. The machine is driven and controlled by means of a powerful combined, friction clutch and brake fitted with both hand and automatic control. Larger machines have hand control only. Convenient adjustments are provided for the first and second draw punches and stationary blankholder.

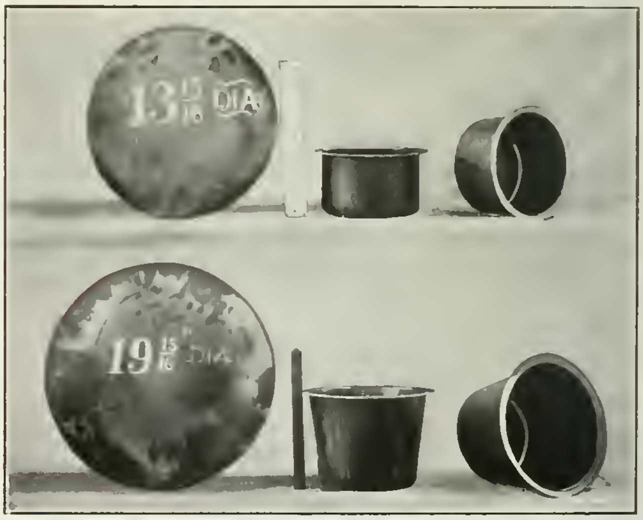


Fig. 3. Blanks and Shells produced from Flat Blank in one Operation on Bliss Double-draw Press

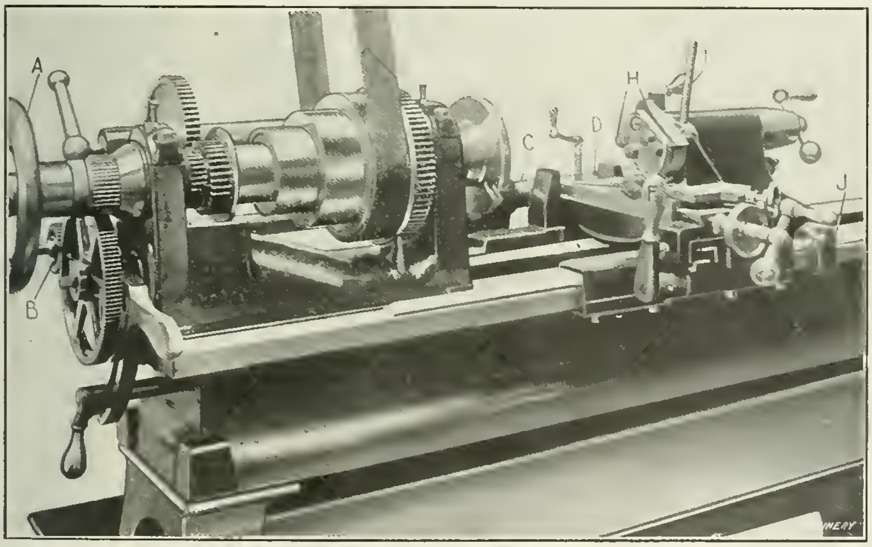
These machines embody many improvements in detail, resulting from a long experience with drawing presses of this type.

BICKFORD SPECIAL THREADING LATHE

The Bickford Machine Co., Greenfield, Mass., is now building a threading lathe designed with special reference to the needs of tap makers. The general construction of this lathe is similar to an ordinary engine lathe, there being a regular back-geared headstock and a divided tailstock having a lateral adjustment for taper work. The bed has short legs and is mounted in an oil tank base. The spindle is hollow and is provided with a draw-in collet attachment operated by handwheel *A*. The capacity of the largest collet is 1 inch. The lathe swings 13 inches over the ways, 4 inches over the compound carriage, and takes 28 inches between the centers. This lathe is so designed that threads can be cut in a comparatively short time.

The lead-screw *C* is mounted in a bracket at the rear of the bed and it can be adjusted to any position. Motion is transmitted to this lead-screw through change gears and a telescoping shaft, and it is driven at the ratio of 1 to 1; 1 to 2; 1 to 3 or 1 to 4. With these ratios, a 4-pitch lead-screw can be used to cut a 4, 8, 12 or 16 pitch thread. The change gear on the lead-screw is shown at *B*. The carriage is so divided that the upper part slides across the lathe and carries a half-nut *D* which can be meshed with the lead-screw. This part of the carriage is operated by raising lever *F*, which not only engages the nut with the lead-screw, but is used as a handle for returning the carriage to the starting point. This lever moves to a "dead center" position, so that the cutting tool does not tend to crowd away from the work. The lead-screw thread is of the buttress form, and there is a simple clutch dog at one end, so that the screw can easily be replaced with another of different pitch. The half-nut is also easily detached.

The roughing and finishing thread chasers *H* are of the Landis or milled type. These are held by holder *G* which, in turn, is supported on a compound slide. The chasers are fed in nearly to the required depth by this slide so that the benefit of an angular shear cut is obtained. The chasers are clamped to the holder by lever *I*. The maximum length of thread that can be cut at one setting is 10 inches, but the convenient adjustment afforded by the compound rest for aligning the chasers, makes it feasible to cut a length of 10 inches and then slide the lead-screw along for threading another section. A positive stop *J* is provided for the carriage.

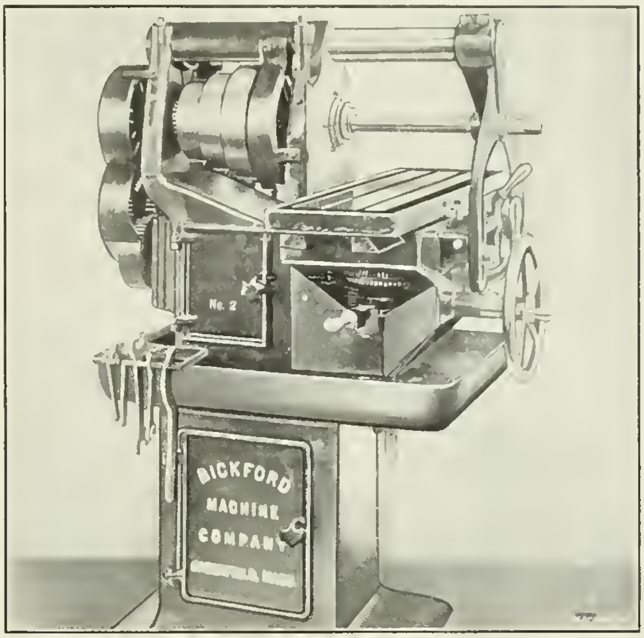


Bickford Threading Lathe of Special Design

BICKFORD PLAIN MILLING MACHINE

The milling machine shown in the accompanying view is built for plain manufacturing operations, in connection with which a rigid design is more desirable than one possessing a wide range. The knee and saddle are formed of one solid casting, which gives the table a rigid support. The table has a bearing 24 inches long and 8 inches wide. The feed is of a rack-and-pinion type. By means of a special clutch and gear device inside the knee, a handwheel at the side of the machine can be connected to operate the knee up or down, or the table in either direction. This change is made by simply moving a lever at the front of the table, to the right or left.

The spindle is of crucible steel and runs in phosphor-bronze bearings. The front bearing has a taper hole in which the spindle is held from end motion by a special clamp collar. This bearing may be adjusted a distance of ¾ inch through the main housing to which it is splined and held by a nut at each end. The front end also has a graduated collar provided with a clamp screw for setting it back to zero from any position. The cone pulley runs free on the spindle and has a small gear which drives the back-shaft, and the latter drives the main gear on the spindle. The ratio of this gearing is 6 to 1. The pulley is held in position by a spring collar located between one end and the main driving gear which travels longitudinally with the spindle.



Bickford Plain Milling Machine

The feed motion is transmitted through a coarse pitch worm in mesh with a large gear on the pinion shaft. The end pressure of this worm is taken by a ball thrust bearing. The feed shaft is all gear driven. The feed changes are effected by opening the door in front of the machine and shifting a lever. The gear box gives ten feed changes for each of the three spindle speeds or a total of thirty changes in all.

The overhanging arm is of steel and 3¼ inches in diameter. The drop arm and braces are cast integral. The levers operating the power feed and stop are conveniently placed. The table has a deep oil channel extending around the platen and loose "splashes" (not shown) are provided for carrying the overflow of oil to a tank in the base. The lubricant is forced to the tool by a gear pump at the rear of the machine. The working surface of the table measures 7¼ by 29½ inches. The weight of the machine is 1750 pounds, and this same type is built in larger or smaller sizes. It is built by the Bickford Machine Co., Greenfield, Mass.

CHAMBERSBURG STEAM-HYDRAULIC PRESSES

The Chambersburg Engineering Co., Chambersburg, Pa., has developed a line of steam-hydraulic forging presses which are built in both the single-frame and four-column types. The single-frame presses range in size up to and including 400 tons pressure, and the four-column types up to and including 5000 tons capacity. These presses have a double-lever control, and multiple tonnages for the larger sizes. With the double-lever control, the entire operation of the press is governed by the two hand levers seen in Fig. 1 of the accompanying illustrations. As these levers perform the same functions as the two levers on a steam hammer, the operation of the press comes naturally to the workman. With one lever, the position of ram is adjusted for the length of stroke, and with the throttle lever, the power of the stroke is varied. In both cases the ram follows the direction in which the lever is moved.

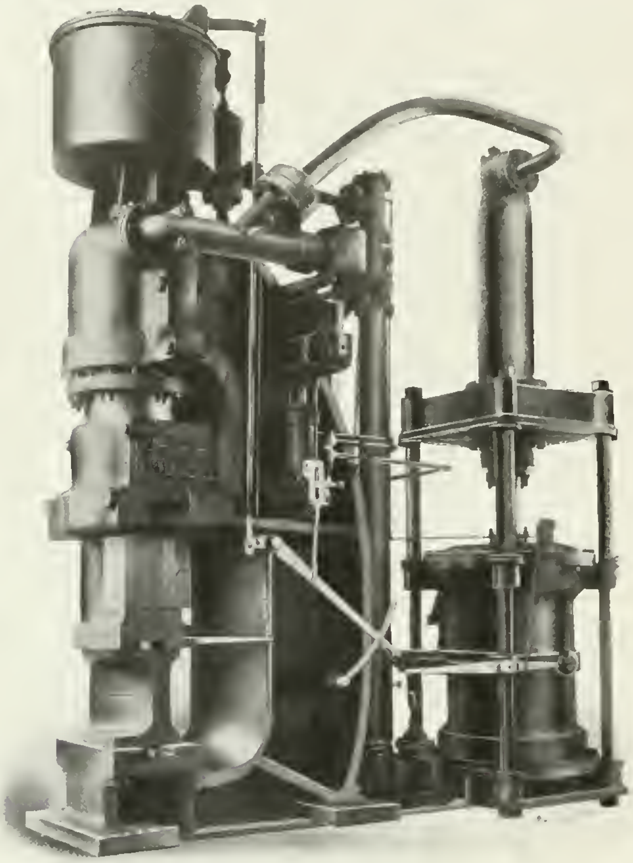


Fig. 1. Chambersburg Steam-hydraulic Press with Triple Intensifier

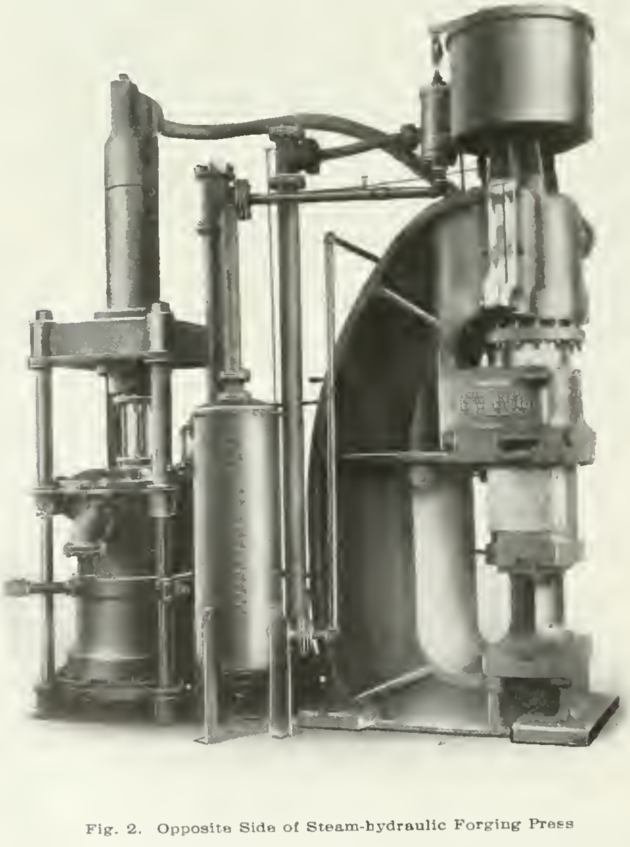


Fig. 2. Opposite Side of Steam-hydraulic Forging Press

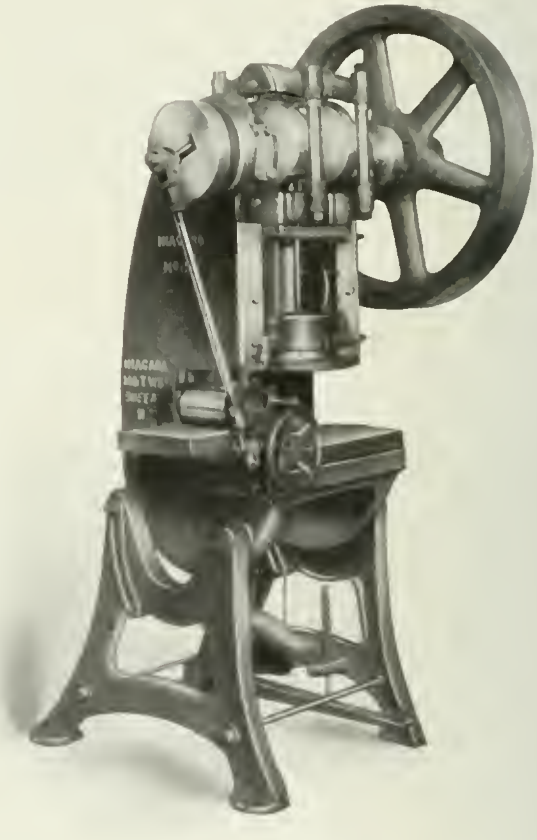
For the larger size presses, great economy in steam consumption is said to be effected by means of a triple intensifier which enables the operator to use selective pressures in proportion to the varying necessities of the work; in other words, the amount of steam used is regulated in accordance with the requirements of the work being forged. The usual practice has been to use a single-cylinder intensifier which consumes a constant volume of steam, whether the press is exerting a 500-ton pressure, or 2000 tons in a press having a maximum capacity of 2000 tons. In the Chambersburg design, a press having a maximum capacity of 2000 tons is arranged for three multiple pressures of 600 tons, 1200 tons or 2000 tons, with the steam consumption proportional to the tonnage being used.

The main frame of the 400-ton single-column press illustrated, is an open-hearth steel casting of I-beam section, the web being stiffened by heavy ribs. Projecting flanges at the base form a support for the press. The frame has heavy guides for the ram, fitted with a cap which is held rigidly by bolts to take care of strains in any direction when forging beveled work. The dies are skewed so that the work will clear the frame when either drawing or finishing, and the notches in the ram and die seat can be planed to suit any existing dies.

NIAGARA DOUBLE-ACTION CAM PRESS

The Niagara Machine & Tool Works, Buffalo, N. Y., has added to its line of presses the double-action cam press, shown herewith. This machine is intended for cutting and drawing shells, and possesses several new and interesting features.

Instead of making the adjustment on the blankholder slide (to accommodate dies of various heights) by means of screws connected to the cam roller yokes, a threaded sleeve is used on the lower end of the blankholder slide, which enables the adjustment to be readily and accurately made. This arrangement also makes it possible to locate the guides for the blankholder slide, directly in line with the center of the crankshaft. Adjustable gibs are provided, not only for the blankholder slide, but also for the inner slide, which is a decided advantage when using combination cutting and drawing dies.

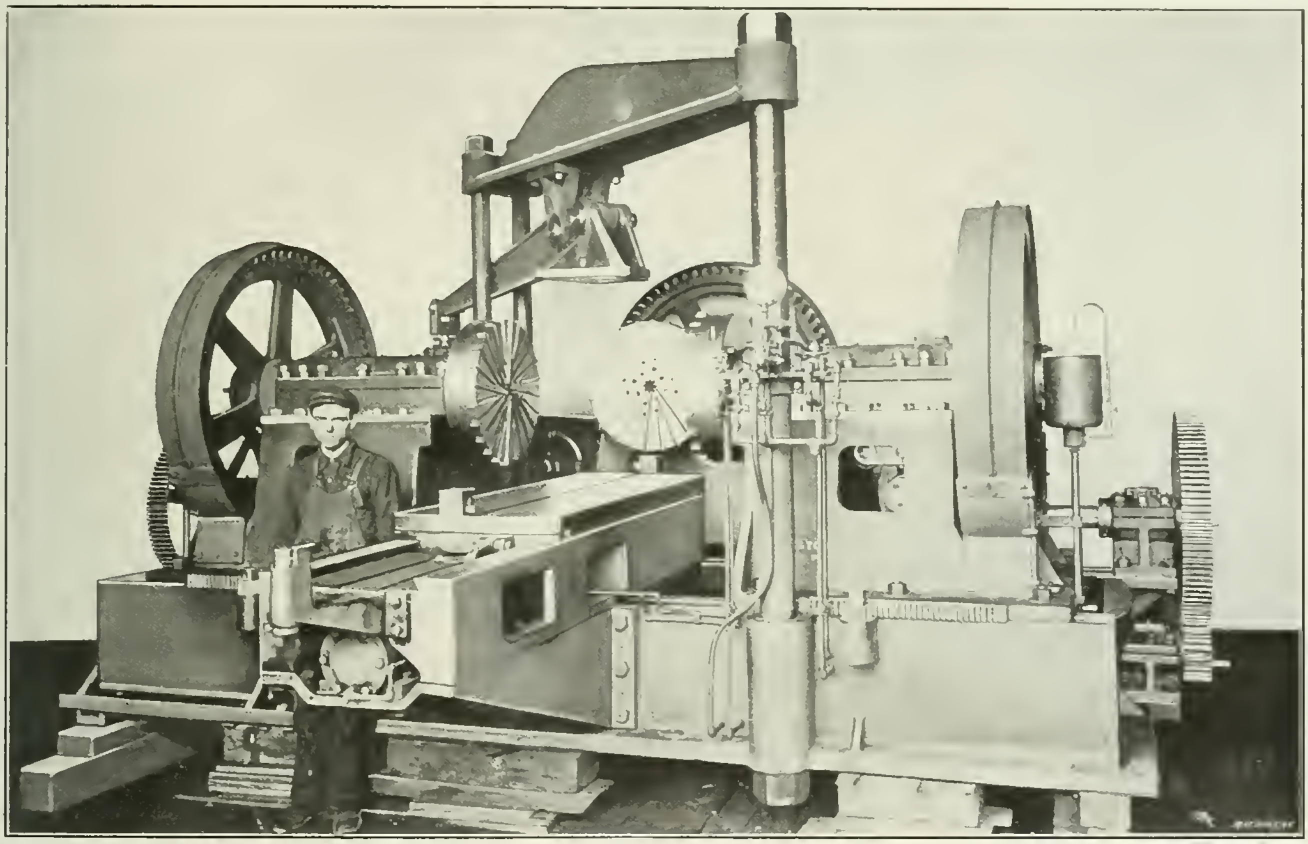


Niagara No. 85 Cam Press

The design of the press, in other respects, conforms with the most improved practice on machines of this type. The outer slide or blankholder is positive in its motion and it is raised and lowered by two cams keyed to the main shaft on each side of the crank. The cam roller yokes are rigidly connected with the blankholder, and provision is made for taking up wear. The lower cam rollers are set in oil boxes to insure good lubrication for both rollers and cams. The inner slide receives its motion from the crankshaft by means of a pitman, which has vertical adjustment. The press illustrated is equipped with a single roll feed attachment. Presses of this design are made in several sizes.

LARGE THREE-WAY FLANGE FACING MACHINE

The Pottstown Machine Co., Pottstown, Pa., has designed a very interesting machine for facing the flanges of large pipe fittings, valve bodies, and similar work. This machine is equipped with three 25-inch facing heads which operate simultaneously. The arrangement of the heads and method of driving them will be seen by referring to the accompanying illustration. The power is derived from a 35 horsepower motor at the rear, which drives through gearing having a ratio of 256 to 1. The spindles are carried by slides which are mounted in heads resting on the main bed. The spindles have a longitudinal movement of 1½ inch, which is sufficient to clear a rough casting and face the flanges to the finished dimensions. Each spindle is fed into the work by an air cylinder, and the feed is controlled by an oil cylinder. These cylinders are located inside the bed and connection is made with the spindle slides by levers which give a powerful feeding movement. The heads carrying the spindles can be adjusted along the bed to accommodate work of different widths. This adjustment is effected by racks and pinions located at the base, as shown in the illustration. Each head is rigidly secured to the bed by six 1½ inch bolts, and the back thrust is further provided for by jack-screws which rest against the ends of the bed and give a positive support.



Special Flange Facing Machine built by the Pottstown Machine Co.

The work is held in position by a massive steel yoke located above the machine and equipped with a lever and pneumatic cylinder, which is capable of exerting a pressure of fifty tons on the fitting. The movements of the work table, pneumatic clamp, and the facing heads, are controlled by three air valves, which are conveniently located on the yoke column at the right side of the table. An air gage is provided to show what pressure is being applied to the fitting, in order to prevent feeding the cutters against a casting before it is firmly clamped. The work table is long enough to permit using a double set of fitting holders or fixtures, so that the workman can load one fixture while the casting on the other end of the table is being faced.

The method of operating this machine is as follows: The fitting is placed in the fixture and the table is moved in by air to the working position. The three heads are then fed in to the required depth, and while this is taking place, the operator places another casting in the fixture attached to the outer end of the bed. When the inner casting is faced, the cutters are withdrawn and the table is moved outward to clear the heads, after which it is turned halfway around, thus bringing the rough casting in to the facing position. As all of these movements are pneumatically controlled, they are effected quickly by simply working the small air-valves shown. It should be mentioned that the distance which each head feeds inward is predetermined by a stop that arrests the movement of the feed lever and prevents further cutting.

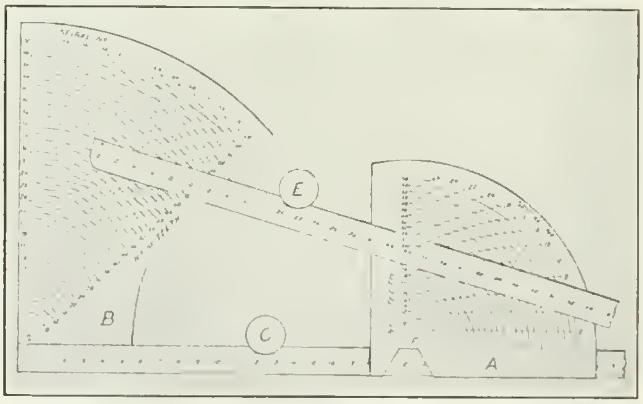
Each facing head has twenty-two high-speed steel cutters which are mounted radially and operate across the entire surface of the flange. The cutter-head spindles are 8 inches in diameter, and the driving gears have a diameter of 51 inches and a face width of 7½ inches. The maximum distance between the front cutter-heads is 45 inches, or 22½ inches from the center of a fitting. The two front heads will face to a minimum width of 9½ inches. The height from the top of the table to the center of the spindle is 16½ inches. The total floor space required by the machine is 17 feet, 4 inches, by 16 feet, 5 inches. The over-all height is 8 feet from the floor line, which is about 8 inches below the top of the main bed. The weight of this machine is 60,000 pounds.

LINEOMETER FOR DETERMINING CHAIN LENGTHS

The Diamond Chain & Mfg. Co., 240 W. Georgia St., Indianapolis, Ind., has developed an instrument by means of which the length of a sprocket or driving chain can be quickly determined without making a calculation. This instrument is known as a chain lineometer, and it enables the length to be ascertained by making three simple adjustments. The instrument in its simplest and cheapest form is made of paper (as shown in the accompanying illustration), and there is also a high-grade steel instrument, which operates on the same principle.

Referring to the illustration, there is a fixed scale *C* laid off in half-inch divisions, each representing a distance equal to the pitch of the chain. On the movable scale *E* each half-inch division represents a distance equal to two pitches—one for the upper half of the chain and one for the lower half. The circles on the sectors *A* and *B* are the pitch circles or 1-inch pitch sprockets, drawn half size. These circles are crossed by spirals having numbers which represent the number of chain links from the point where each spiral crosses a given circle to the corresponding point on the lower half of the circle.

As an example for illustrating the use of this instrument, suppose it is desired to find the chain length for sprockets having 72 and 36 teeth, respectively, a center-to-center distance of 15 inches and a pitch of ¾ inch. If the center distance is divided by the pitch, the result is 20, which is the center distance *in terms of the pitch*, and the sector *A* is set at this figure on scale *C*. The straightedge *E* is next set approximately tangent to the two pitch circles at *A* and *B*, corresponding to 36 and 72 teeth, respectively. The point where the spirals cross these pitch circles is then noted and the straightedge is shifted so that it covers all but one of these points. The zero point on the scale is set to coincide with the point not covered on the left-hand dial, and the point not covered on the right-hand dial should just touch the straightedge. In other words, place the straightedge in the position that the center line of the chain would occupy in passing from one sprocket to the other. The straightedge reading at the intersection of the spiral and pitch circle lines on the right-hand sector, equals twice the number of links in the span of "free" chain. For example under consideration, this is 38, and the number marked on the spiral passing through the zero point is 44, whereas, the number of the spiral passing through the thirty-eighth division is 14. The sum of these three numbers (96) is the chain length *in terms of the pitch* and 96 × ¾ inch = 72 inches, which is the length in inches.



Instrument made by Diamond Chain & Mfg. Co. for Determining Chain Lengths

As the length of a roller chain must, in general, be a multiple of twice the pitch, the reading on straightedge *E* must be an even number. If the spiral does not pass exactly through one of the even-numbered scale divisions, the next higher even number is used. If an offset connecting link is employed, this number must be odd, and if the chain is of the "block" type, the reading may be either even or odd, since the chain length can be any multiple of the pitch. With the steel instrument previously referred to, the adjustments are greatly facilitated. The right-hand sector is quickly clamped into position by a thumb-screw, and the zero point of the straightedge is brought to the proper pitch circle by a slide which is graduated on the left for roller chains and on the right for block and twin-roller chains. There is also a linked connection which allows the straightedge to swing about its zero point.

If it is desired to determine a center distance which will eliminate slack in the chain, shift the right-hand sector until one of the regular divisions of the straightedge is on a spiral; then take the center distance reading and multiply by the pitch. To find the length of a belt, a special set of sectors must be used.

CINCINNATI EIGHT-INCH PRECISION BENCH LATHE

The Cincinnati Precision Lathe Co., Cincinnati, Ohio, has brought out a new precision bench lathe which is a decided departure from conventional designs. This lathe is a friction-driven type and has a single constant-speed belt pulley. This arrangement does away with a cone pulley on the spindle, thereby permitting the use of exceptionally long bearings; in fact, the spindle has a bearing that is practically continuous (as will be seen by referring to Fig. 1) which gives a very rigid support and obviates chattering.

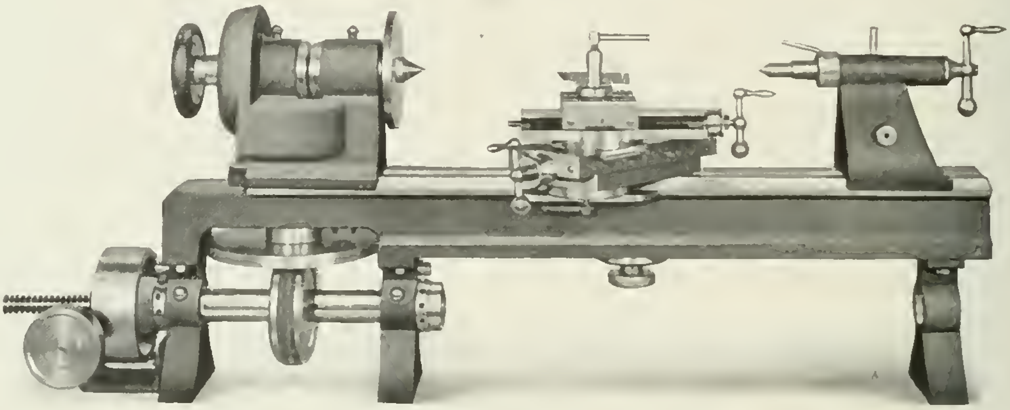


Fig. 1. Precision Bench Lathe built by the Cincinnati Precision Lathe Co.

The method of transmitting power from the main belt pulley to the spindle is shown more clearly in Figs. 2 and 3. The main driving pulley is keyed to a hollow, slotted driving shaft which contains a rack shaft, by means of which the position of the driving friction disk is varied, as will be explained later. A key passes through both of these shafts and engages the driving friction disk which transmits the movement to the horizontal driven disk above it. The latter is keyed to a vertical spindle which drives the lathe spindle through a pair of accurately cut miter gears, as shown in Fig. 2. There is a ball thrust collar bearing between the horizontal friction disk and the lathe bed, and the miter gears run in oil.

The mechanism for varying the speed adjustment is shown in the sectional view, Fig. 3. The rack shaft, previously referred to, meshes with a pinion attached to a handwheel on the outer edge of which is a speed indicator. By means of this handwheel, the friction driving wheel is shifted on the driven disk for obtaining any desired speed in either a forward or reverse direction. When the position of the disk is changed, the driving key slides in a slot cut in the hollow shaft. There is a depression in the center of the driven disk, so that the machine can be stopped independently of the

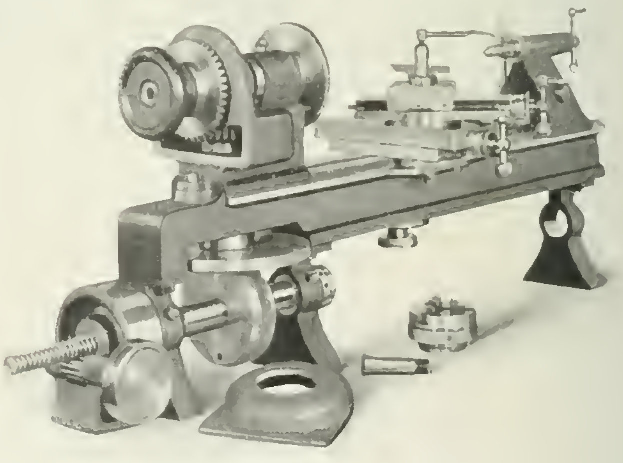


Fig. 2. Another View of the Precision Lathe—Spindle Gear Guard removed

driving belt. If desired, the friction disk can be chamfered at the outer edge to permit stopping the machine by placing the driver either at the central or outer positions. This friction transmission is said to give a strong drive, thus making it possible to take heavy cuts as well as light delicate cuts. The face or periphery of the driving friction disk contains layers of specially treated oak-tanned leather, subjected to a high pressure in order to increase its durability.

Any wear which may occur between the friction disks, can be taken up by means of eccentric bushings so arranged that the friction driving shaft may be raised or lowered parallel to the face of the driven disk. The power required for the heaviest cuts taken on a precision lathe, is so small in proportion to the efficiency of the drive that the friction mechanism cannot be overloaded.

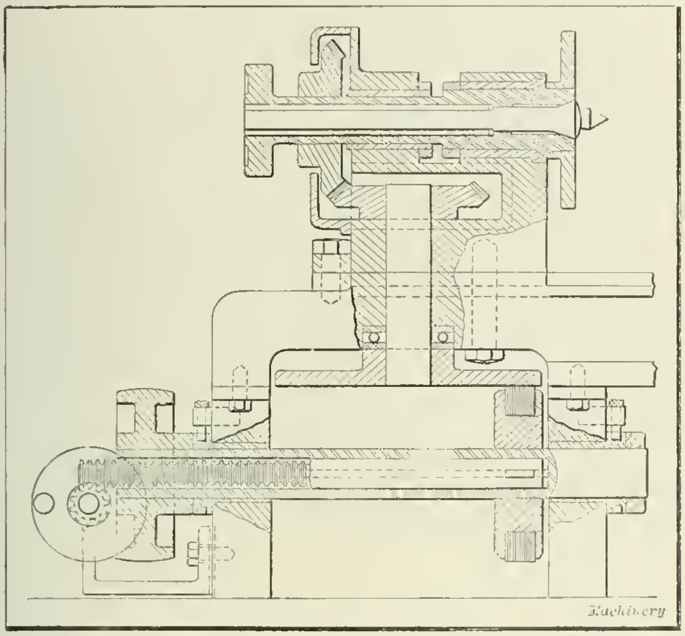
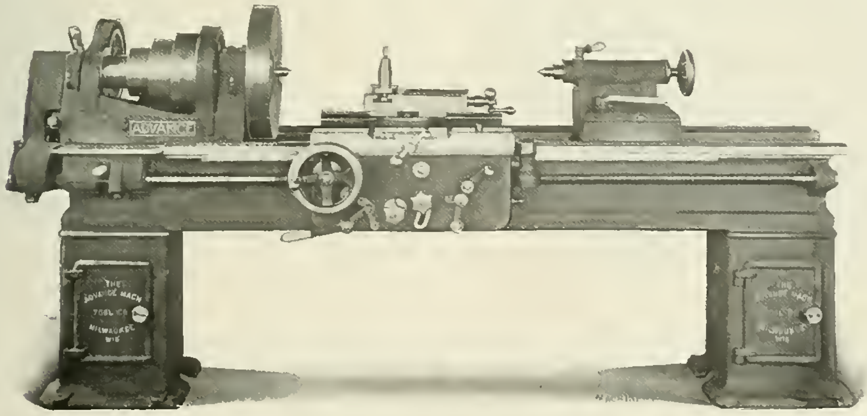


Fig. 3. Sectional View showing Arrangement of Driving and Speed Adjusting Mechanism

The location of the belt pulley eliminates overhead countershafts and permits driving from beneath the bench if desired. When the power is applied from beneath the bench, clutch friction pulleys are used, thus doing away with the tight and loose pulleys. This machine is constructed throughout of high-grade materials. The castings are of "close" iron and they are properly seasoned after being roughed out, before finishing. The spindle is hardened, ground and lapped and its bearings are of high-grade phosphor-bronze. The swivel slide rest is designed along modern lines and is built to withstand heavy service, if necessary. This lathe was designed by Mr. J. M. Tatman of Cincinnati.

ADVANCE NO. 2 ENGINE LATHE

The Advance Machine Tool Co., 591 Twenty-second St., Milwaukee, Wis., has brought out a heavy-duty engine lathe which embodies a number of improvements. The feed mechanism is located in the apron (see accompanying illustration), where it is always within convenient reach of the operator, regardless of the position of the carriage along the bed. This mechanism gives four feed changes varying from 0.015 inch to 0.060 inch. A wide range of feeds can also be obtained through change gears operated by a lever at the headstock end of the lathe.



Lathe built by Advance Machine Tool Co.

This machine has a swing over the V's of 18½ inches, and a swing over the carriage of 12 inches. The tailstock is of the offset type, thus permitting the compound rest to be set parallel to the centers when close to the tailstock. The headstock is extra heavy and has large bearings for the spindle. The spindle is made of chrome-nickel steel and has a 1 9/16-inch hole extending through it. The apron is the double-plate pattern and has no loose brackets of any kind. There is only one friction clutch for both the lateral and cross feeds, thus making it impossible to engage more than one feed at the same time. The lead-screw nut is provided with a stop so that the feeds cannot be operated while chasing threads, and *vice versa*. This lathe is of the heavy pattern, and is tested for alignment within a limit of from 0.001 to 0.0015 inch.

AMES UPRIGHT DIAL GAGE

The upright gage illustrated herewith is an addition to the line of dial gages manufactured by B. C. Ames Co., Waltham, Mass. It is of a low, compact design which is not easily upset and can be placed in the most convenient position for the operator. This gage is desirable for measuring paper, flexible cardboards, fabrics, and rubber, as well as metals of all kinds which have flat surfaces. It can be arranged with a small surface in place of the platen, for measuring sheet metals or any other material which does not have a flat even surface. The spindle of the gage has a travel of 3/10 inch, the same as the regular upright gage made by this company.

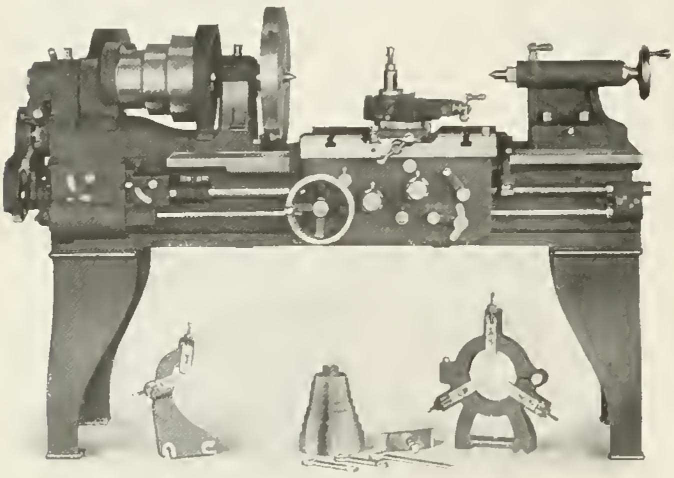
Dial Gage made by B. C. Ames Co.

ROCKFORD 16-INCH LATHE

The lathe illustrated herewith is a 16-inch double back-geared design built by the Rockford Lathe & Drill Co., Rockford, Ill. This machine is constructed throughout to meet the conditions of modern shop practice. The bed is of deep section and has wide cross braces. The headstock is massive and is equipped with large bearings lined with the best quality of babbitt metal. The spindle is of high-carbon steel and is accurately ground. It has a 1½-inch hole extending the full length, and draw-in collets up to 7/8 inch capacity may be used. The tailstock is of the offset type and has double clamping bolts to hold it securely to the bed. The carriage has a wide bridge and a bearing of 26¼ inches on the ways, with self-oiling felt wipers.

The thread cutting indicator is so arranged that it can be disengaged when not in use. The apron has a double bearing for all shafts. The gears are of wide face and coarse pitch and are cut from steel. The feeding movements are reversed in the apron, and an interlocking arrangement makes it impossible to engage the feeds and lead-screw simultaneously. The gear box gives three quick changes of feed for each change of gearing, by means of sliding steel gears and hardened steel clutches. The gear box simplifies the thread cutting and the compounding of gears is avoided.

The regular equipment includes the follow- and steady-rests, large and small faceplates, a full set of change gears, double-friction countershaft and wrenches. Extra attachments are also provided, including a draw-in attachment and collets, taper attachment, turret for the carriage, and a turret on the shears, with or without power feed. The lathe swings over the ways 18½ inches, and over the carriage, 11¾ inches. The maximum distance between the centers (with a 6-foot bed) is 28 inches. The ratios of the back gears are, respectively, 3.5 to 1 and 11.13 to 1. The thread cutting capacity varies from 2 to 96 threads per inch. The net weight of the lathe with a 6-foot bed, is approximately 2150 pounds.



Rockford 16-inch Double Back-geared Lathe

JONES & LAMSON DOUBLE-SPINDLE FLAT TURRET LATHE

The Jones & Lamson Machine Co., Springfield, Vt., is now building a flat turret lathe equipped with two spindles. This double-spindle machine is not intended to displace the well-known single-spindle type built by this company, but it has been developed for producing large quantities of duplicate parts. It is designed primarily for chuck work and can be used as a single-spindle machine if desirable. When two spindles are employed for machining two duplicate parts simultaneously, considerably more time is required for setting up the machine than is necessary for the regular single-spindle type, but the increased rate of production obtained with the two-spindle design, more than offsets this initial handicap. The single-spindle machine is considered the best type for ordinary machine building operations, regardless of whether the work is turned from the bar or is of the chucking variety. On the other hand, the double-spindle type is preferable when work is to be produced in such quantities that the time for setting up the machine becomes a secondary consideration.

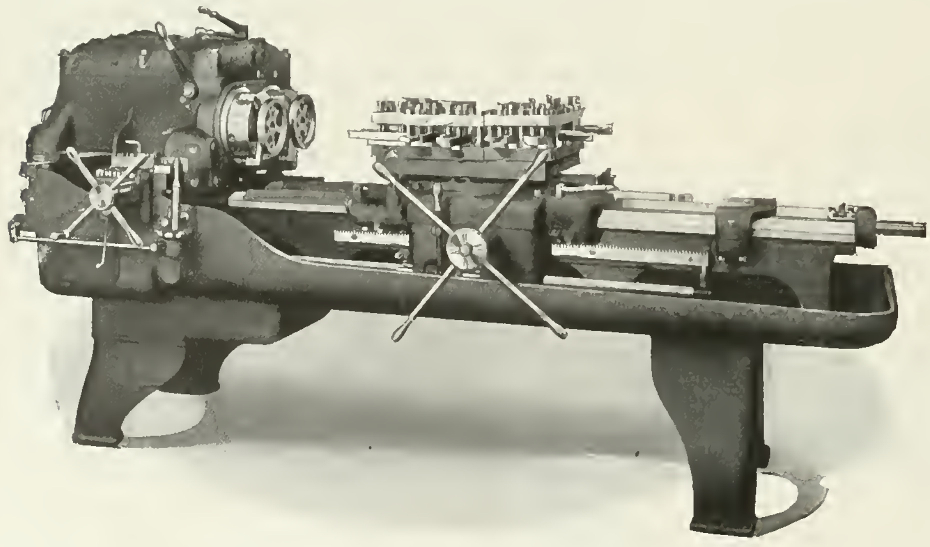


Fig. 1. Jones & Lamson Double-spindle Flat Turret Lathe

When the double-spindle machine is used as a single-spindle type, a chuck 17 inches in diameter is used, and when both spindles are in operation, two 9-inch chucks are employed. Fig. 1, of the accompanying illustrations, shows a general view of the machine arranged for using both spindles, whereas, Fig. 2 shows it equipped with the 17-inch chuck for single-spindle operation. Fig. 3 shows the head and a section of the turret at close range. The general construction of the head is illustrated in the line engraving Fig. 4 which indicates the method of adjusting the main spindle for wear and the means provided for receiving the end thrust.

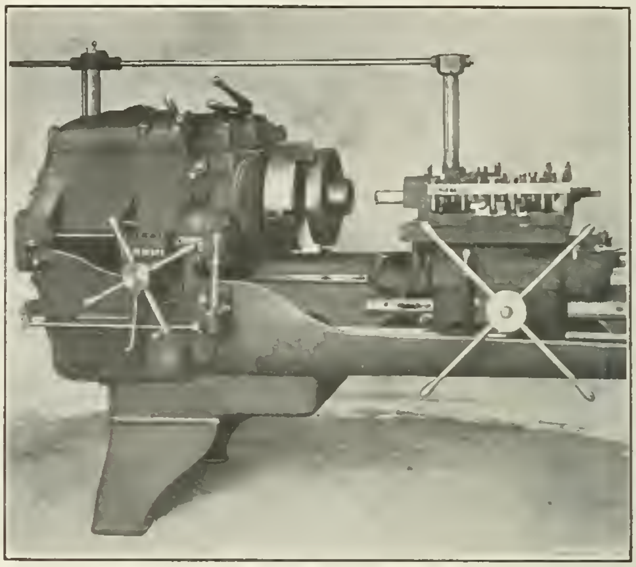


Fig. 2. Double-spindle Machine equipped with 17-inch Chuck for Single-spindle Operation

It will be noted that the head is supported by means of rolls *A* bearing upon the hardened steel rail *B*. To provide for vertical "take-up" upon this rail, there are eccentric rolls *C* which bear against the under side, as shown. The cross travel of the head is controlled by rolls *D* which bear against one side of rail *B*, while on the opposite side of the rail, eccentric rolls are similarly placed to provide a means of adjustment.

The two work spindles of the machine have bearings equipped with a form of bushing which enables play to be easily taken up. This arrangement consists of a taper sleeve *F* which bears against the bronze bushing *G*, and when it is necessary to take up wear, the taper sleeve is adjusted by means of the small pinion *H*. Both work spindles are operated by pinion *I* which meshes with the geared faces of the work spindles *J*. Upon this main spindle which supports pinion *I*, a small oil pump provides spray lubrication for the various parts.

The chucks are not attached to the main spindles by hubs of small diameter, in the usual manner, but in a more rigid way as illustrated in Fig. 5. The spindles of the machines, which, by the way, are steel forgings, are provided with heads of the same external diameter as the chucks. The outer end of the spindle *A* is threaded with a right-hand thread, and the inner end of the chuck or faceplace *B* (as the case may be), is threaded with a coarse left-hand thread of the same pitch. After inserting the driving pin *C* in sockets in the spindle and chuck or faceplate, respectively, a right- and left-hand threaded sleeve *D* is screwed on, thus bringing the outer face of the spindle and the inner face of the chuck or faceplate firmly together. To insure the chuck or faceplate being in the proper position, a seat is bored in the spindle which receives a projection on the inner side of the chuck or faceplate. This construction insures an accurate mounting, and prevents the chuck or faceplate from getting out of alignment.

When the machine is to be used as a single-spindle type, thereby employing a 17-inch chuck and permitting large work to be done, the head of the front spindle is covered with a shield as shown in Fig. 2. In this manner, large chucking work may be easily and efficiently machined. The method of supporting this large chuck on the spindle is exactly the same as has been previously described, although the chuck, of course, extends out beyond the means of support.

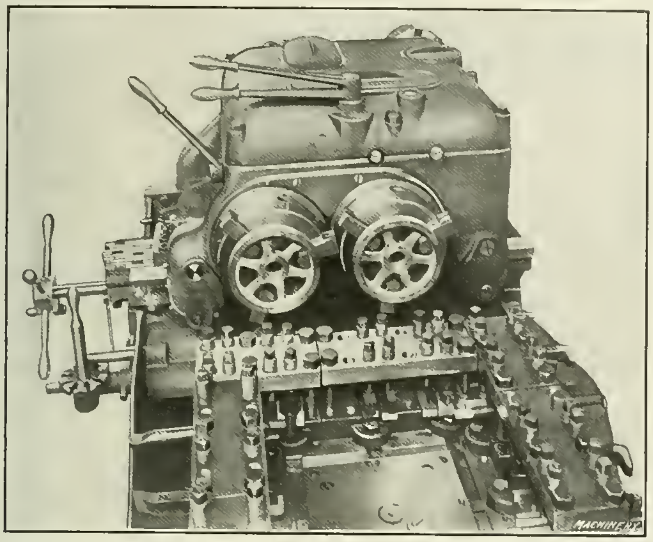


Fig. 3. Turret and Head of Double-spindle Turret Lathe

Fig. 6 shows the construction of the turret and tool-blocks. The general outline of the turret is square, and the tools are rigidly held, with a minimum amount of overhang, by means of the tool blocks and binding screws connected with the clamping plates. All of these parts are plainly shown in this illustration. Two duplicate sets of tools are clamped to each side of the turret, and these operate simultaneously on the two pieces held in the chucks or on the faceplates. Primarily the turret is used in but four positions, but when a 17-inch chuck or faceplate is employed, corner blocks may be held by the clamping plates in which tools are supported, giving, if necessary, four additional operations by indexing the turret to eight positions. Provision is made for holding dies at one side of the turret, and each of the corner tool-holding fixtures may be moved to or from its companion tool-holder a slight amount, by means of elongated slots in which the binding screws are placed. As a matter of convenience, the clamping plates are held down by $\frac{3}{4}$-inch cap-screws, while the set-screws which hold the tools are $\frac{7}{8}$ inch diameter. Thus it is possible to clamp through the set-screw holes if this should be necessary on account of a difficult "set-up." Hardened steel supports are provided to support the two inner ends of the turret while in operation. These supports obviate a great deal of chatter and permit the tools to work more satisfactorily. On the under side of the turret, hardened seats are secured which rest upon the carriage supports.

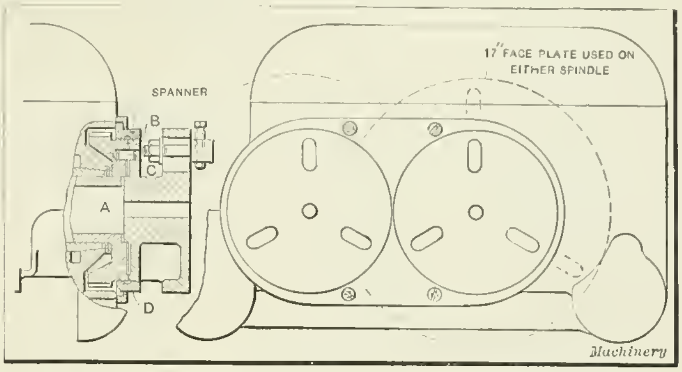


Fig. 5. Method of Supporting Chucks on Double-spindle Machine

A typical job to demonstrate the application of the double-spindle flat turret lathe is illustrated in Fig. 7. As may be seen, the work consists of sprocket wheels which are held in the two 9-inch chucks. At the first position of the turret, which is the one illustrated, the inside is rough-bored by tools *A*. At the second position of the turret, tools *B* rough-face the inner side of the flange; tools *C* face the outer side of the flange, while tools *D* turn the face of the flange. At the third position of the turret, tools *E* finish-turn the inside of the flange, tools *F* finish-turn the outside of the flange, while tools *G* finish the face of this flange. At the fourth position of the turret, tools *H* finish-bore the work; tools *I* complete the turning on the outside of the flange, while tools *J* accurately size the interior of the flange. It will readily be appreciated that the work done at the first position of the turret, can be accomplished in a much shorter space of time than that done at any of the other three positions.

With the double-spindle flat turret lathe, each operation is a double operation, and, moreover, it is not performed at the same speed; thus, if at one position of the turret, the tools are required to rough out the work, this may be done rapidly, for it has no bearing on the other operations that are subsequently performed. Furthermore, if the following operation has to be performed with great care, this may be done without reducing the speed of the less exacting operations.

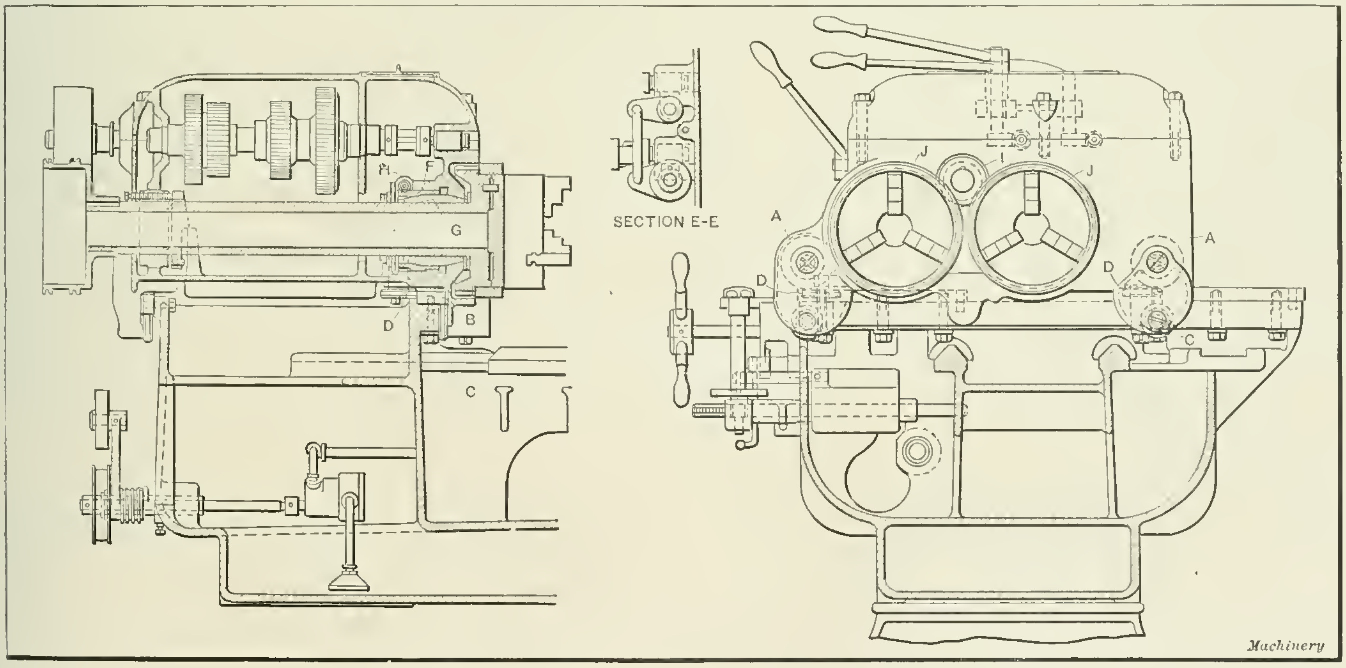


Fig. 4. Views showing the General Construction of the Headstock

A further demonstration of the advantages of a machine of this type involves the time factor. On some machines, of the automatic type, the time for producing any given piece is conceded to be the time of the longest operation performed; thus, if on a four-spindle automatic, the first operation requires 30 seconds, the second operation 30 seconds, the third operation 8 minutes, and the fourth operation 30 seconds, the time required to produce each piece with this machine will be 8 minutes. With the double-spindle turret lathe on similar work, the time required is the sum of the time of all of the operations divided by two. In this instance, therefore, the time for each piece would be 4¾ minutes, as contrasted with 8 minutes when performed on the multiple-spindle automatic. The double-spindle machine can be used advantageously in connection with the single-spindle flat turret lathe, the single-spindle machine being employed for general work, and the double-spindle machine for the manufacture of duplicate parts in quantity.

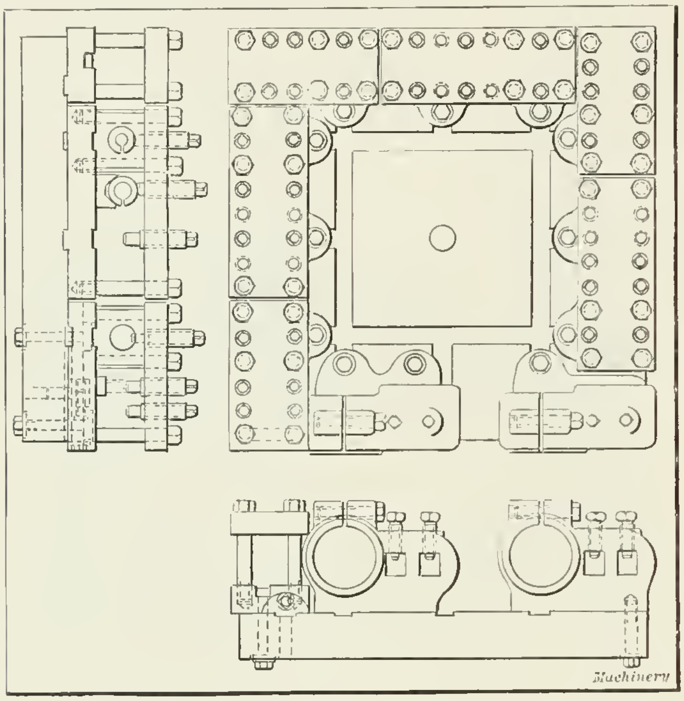


Fig. 6. Elevations and Plan View of Turret and Tool Blocks

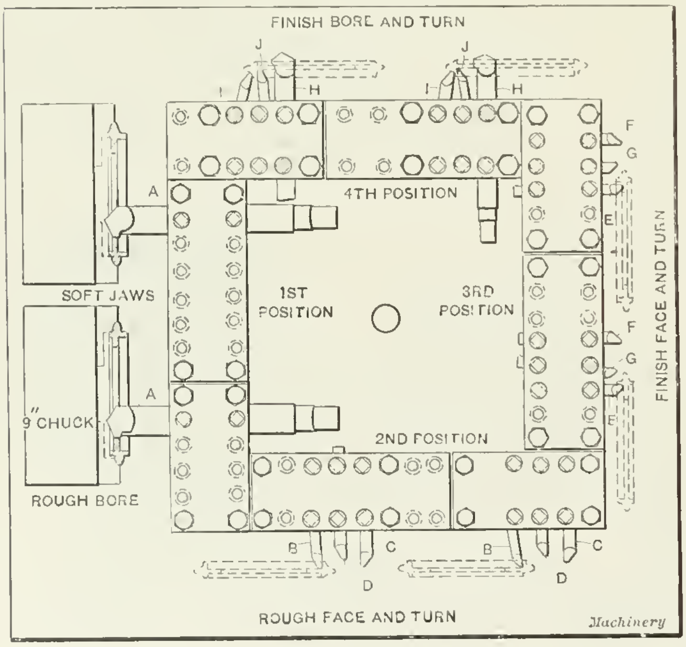


Fig. 7. Diagram showing Tool Equipment and Successive Steps in Machining Sprocket Blanks on Double-spindle Flat Turret Lathe

* * *

When a boss is made for bolt head or nut, it should be made at least one-quarter inch larger than the largest diameter of the bolt head or nut, so that the head or nut will have a full bearing, even if the hole be cored or drilled out of center.

NEW MACHINERY AND TOOLS NOTES

Filing Machine: Robinson Tool Works, Hartford, Conn. Bench filing machine having a square table which is adjustable for angular work. The stroke of the file may be varied from 0 to 2 inches. All the working parts are protected by a suitable cover.

Turret Head: Milliken Machine Works, West Newton, Mass. Ball turret head for converting ordinary lathe into a turret type, when machining work requiring a number of tools. The turret is held in the tailstock by means of a taper shank, and it is actuated by hand.

Tool Grinder: W. W. Blakely, 100 Leicester Court, Detroit, Mich. Attachment for grinding lathe tools, which is clamped to the ways of the bed and is driven by friction from the cone pulley. This grinder is intended to be used for sharpening tools while cuts are being taken, so that no time will be wasted.

Grinder Countershaft: Rivett Lathe & Mfg. Co., Brighton, Mass. Countershaft built for the grinders manufactured by this company. It is a complete unit and is made to fasten to the wall. The necessary speed changes are obtained by cone-pulleys, and the work-spindle driving-drum is controlled by a clutch so that the work may be stopped independently.

Bolt Cutter: H. B. Brown Co., East Hampton, Conn. Motor-driven bolt cutter built in two sizes, which have maximum capacities for diameters of ¾ inch and 1½ inch, respectively. The small machine is driven direct, and the larger size is equipped with gearing having a ratio of 5 to 1. These machines can be used for nut tapping as well as threading.

Coupling: Valley Iron Works, Williamsport, Pa. Interlocking jaw coupling having compressible sleeves and so designed that the power is transmitted by the jaws and not by the bolts which hold the two parts together. The principal features claimed for this coupling are: greatly increased strength, compensation for any inequalities in the shafts, proper alignment and the elimination of strain on the bolts.

Valve Grinder: McConnell-Browning Engineering Co., Richmond, Va. Hand-operated valve grinder for the grinding of gas or gasoline engine valves. The required reversing motion is obtained by a worm and sleeve, the latter being given a reciprocating movement by turning a crank. Means are provided for shifting the position of the valve on its seat while grinding, without removing the tool from contact.

Gear Hobber: Adams Co., 877 Market St., Dubuque, Iowa. No. 1 gear hobber capable of cutting spur gears, worm-wheels and spiral gears. This machine, in its regular form, will cut spirals of 8 degrees and under, and it can be modified to cut any angle desired, but cannot be adjusted to cut angles differing more than 8 degrees. This is claimed to be a very rigid and efficient machine and comparatively low in price.

Drill Socket: Scully-Jones & Co., 316 Railway Exchange Bldg., Chicago, Ill. Drill socket having a key on the inside and a keyway on the outside, extending almost the entire length of the socket. This gives a positive drive and eliminates the twisting of tangs either on the drill or the socket itself. A reinforcement at the base furnishes means for separating the sockets with a drift, and this type can be "nested" with any other make.

Bench Drill: Monarch Machinery Co., 249 N. 3d St., Philadelphia, Pa. Sensitive bench drilling machine with chuck having capacity for drills up to ¼ inch. The table is 8 inches in diameter and is mounted on a swinging arm. The table has a vertical movement of 7 inches, and the spindle a feeding movement of 4 inches. A two-step cone pulley provides two speeds, and an adjustable idler is used to vary the belt tension. The machine will drill to the center of a 10½-inch circle.

* * *

A WONDERFUL MACHINE

It is possible by the use of a few technical terms to make the description of a simple mechanism rather complicated. The following description of a new machine was supplied by a machinist in order to show how "big" words may complicate matters:

"Well," said James, "I went over and saw that new machine to-day, and it is astonishing the fine work it does. By means of a pedal attachment, a fulcrumed lever converts a vertical reciprocating motion into a circular movement. The principal part of the machine is a huge disk which revolves in a vertical plane. Power is applied through the axis of the disk, and while the speed of the driving arbor is moderate, the periphery of the apparatus is traveling at high velocity. Work is done on this periphery. Pieces of the hardest steel are by mere impact reduced to any shape the skillful operator desires."

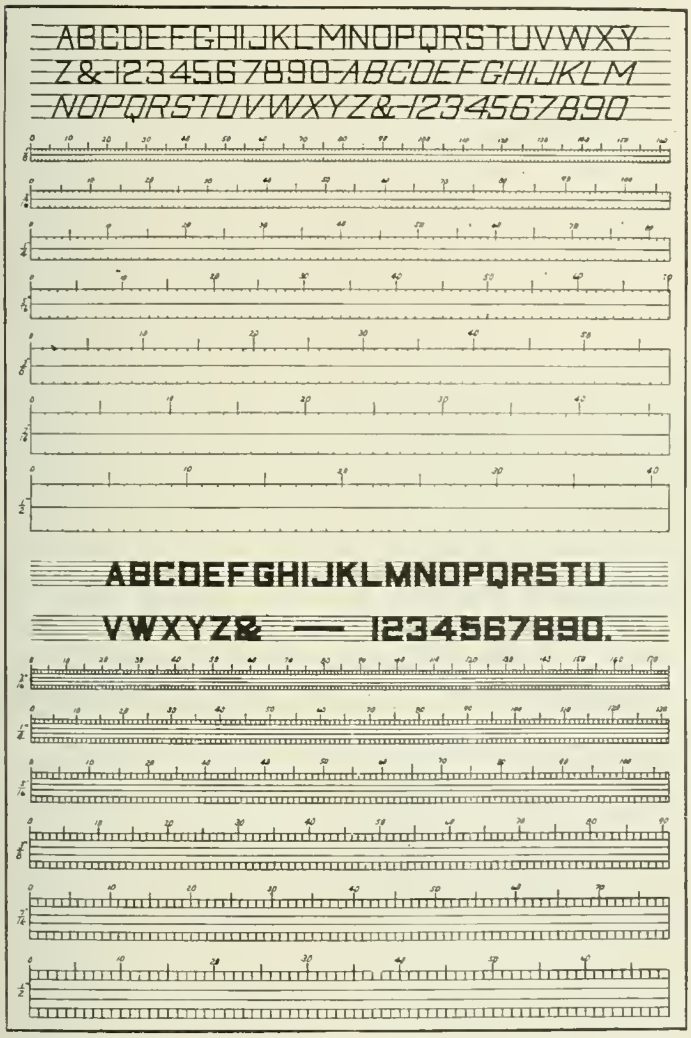
"What in thunder is that machine, anyway?" demanded Tom Briggs.

"Oh, it's a new grindstone," replied James, and a silence fell upon the group.

LETTERING TITLES

By E. J. G. PHILLIPS[*]

To produce a well executed title for tracings, having letters sufficiently large and bold to quickly attract attention, requires considerable time if done in the ordinary way. The method described in the following offers a way of producing very satisfactory titles in a relatively short time. The accompanying illustration is about a half-size representation of a master card, which if carefully prepared will serve as a convenient guide for laying out letters of various sizes, without the use of preliminary construction lines. It may be considered a tedious job to lay out this master card, but as this one layout will last for years, the time required is well spent. If the original is made on tracing cloth, a permanent vandyke negative may be made from it, and then black on white vandyke prints may be produced and mounted on cardboard in sufficient numbers to supply the entire drafting force.



Master Card for Laying out and Lettering Titles on Drawings

The upper half of the card is used for several styles of letters and figures from ⅛ to ½ inch in height; complete alphabets of two styles are shown, the first having vertical and the second slant letters. While the styles shown are very plain, more elaborate ones may be made from the same master card. For these letters the guide lines are laid out in the following proportions: the horizontal spaces are made equal to or one-third of the height and all letters are made two spaces wide, except M which requires three spaces, W, four spaces and I, one space. These proportions may not be exactly correct, but the writer believes that the alphabets given at the top of the illustration show reasonably good proportion.

The lower half of the card is used for block letters and figures from 3/16 to 1/2 inch high, as indicated at the left of each line. The usual proportions are used, *viz.* five spaces high and four spaces wide except M which requires five spaces, W, six spaces and I, one space. These guides may also be used for the Gothic letters as described in the March, 1910, number of MACHINERY. Every fifth vertical graduation is extended above the top line and every tenth graduation is numbered, convenient for locating a title in a certain space.

When the tracing is ready for the title, the master card is placed beneath the cloth, bringing the guides for the desired size of letters in their proper location, and then they are inked in. When slant letters are to be used, the triangle should be set so that when it matches one of the graduations in the top line, it will coincide with the next graduation to the left, in the bottom line.

When it is desired to locate a title in the center of a given space, the spaces required should be counted making the allowances previously given for each letter, and leaving one space between letters and four spaces between words. In this way the number of spaces required for the title can be quickly found, and by referring to the figures above each set of guide lines, the lettering can be begun at the proper place. On the other hand, if the space for the title is limited and it is desired to use the largest letters possible, first determine the number of spaces required; then by referring to the figures and measuring the length of the required number of spaces, the proper size of letters may be found.

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[*] Address: 233 Park Ave., Aurora, Ill.

* * *

THAT RED-HAIRED BOY

By A. P. PRESS

We needed another boy in the office, and the boss put it up to me one day. "Say, Jim," said he, "get me a good boy—one that is *good* for something. Get a red-headed boy if necessary—only get him!"

I transmitted the request to the office, just as he told me: "Wanted—One good office boy. *Must be red-headed.*"

The hiring clerk called me up and tried to call me down for it, but I told him that if he didn't like it, he could have it out with the boss, for it was none of my funeral anyhow. I waited a week, but the boy did not show up. I knew I had to get him somewhere, so I commenced watching the trolley cars as I came down mornings; and one day, clinging to the rear end of the running board, I saw what I thought we wanted. So I dropped off the car at the same time he did.

"Where are you working, son?"

"Down at the shear shop, sir."

"What do you make a week?"

"Four fifty, sir."

"Would you like a job at six dollars if you could get it?"

"I certainly would, sir." (Always with the "sir.")

"Well, go down to the hiring office and ask the boss there if he wants a boy. If he says 'No,' take your hat off and say, 'Kindly look at my head, sir,' and he will will hire you."

The kid went, and from what the hiring clerk told me afterwards, I think he did just as he was told. He came to work and made good with the "old man" right off, and stayed with us nearly a year. Every noon after lunch he used to slide off into the die-sinking department and work away on the end of a piece of steel—die-sinking. One day I asked him what he was doing. He answered, "I am going to be a die-sinker bye and bye, and I am working it up now."

A few weeks after that (this I learned long afterwards) he wrote a letter to a silver shop, asking them if they wanted a boy to learn die-sinking, and if so, he would like to hear from them. The boy waited a couple of weeks, then went down to the shop and asked if the boss die-sinker was there. When the boss came out, the boy asked:

"Is there any chance for an apprentice, sir?"

"Not a bit," said the foreman, as he turned to go back.

"But look, sir," he persisted. "I have done a little in that line," and he pulled a piece of aluminum about four inches long from his pocket. It was all covered over with impressions from the lines and stamps he had cut. Now, I never saw a die-sinker who would not leave a funeral procession to look at a scrap of metal. This one was no exception to the rest of them, so back he came, looked over the sample, and it ended with his promising the boy a job later on.

The next night the boy gave notice, having landed the job. It is not difficult to look a little way into the future and see where that boy will be five or ten years from now. Following the mark he has set for himself, he is going to get there—and he will not always be sinking dies either.

MACHINING A FAN MOTOR CASE IN A BARDONS & OLIVER TURRET LATHE

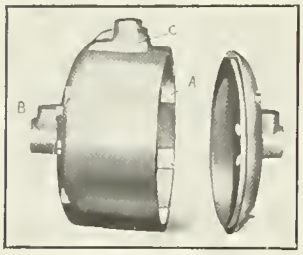


Fig. 1. Fan Motor Case to be machined

An excellent example of accurate turret lathe work is represented in Fig. 2, which shows the set-up used in machining the fan motor case shown in Fig. 1. This motor case is made from an iron casting with eight ribs cast on the inside circumference of the large hole, the remaining portions of the shell between the ribs not being more than ⅛ inch thick. The ribs *A* are to be machined, and a hole is to be drilled, bored and reamed in the shank *B*, which must be concentric with the large hole in the case to within a limit of 0.002 inch. When the shape and character of this casting are considered, 0.002 inch is a very close limit to attain, and can only be accomplished with a first-class tool equipment and considerable ingenuity on the part of the designer.

When being machined, the casting is gripped by the shank *B* in a spring collet, and is additionally driven by boss *C*, which fits in a slot in hood *A*, Fig. 2. Screwed into hood *A* are sixteen knurled thumb-screws *B* and *C*. These are used to support the casting during the roughing operations. The screws *B* in the circumference of the hood are opposite the projections or ribs on the casting, which are to be machined. The screws *C* in the rear of the cap are binder or tension screws for shank *B*, Fig. 1. The order in which the machining operations are carried on is very interesting, and it is due to this layout that such accuracy can be obtained.

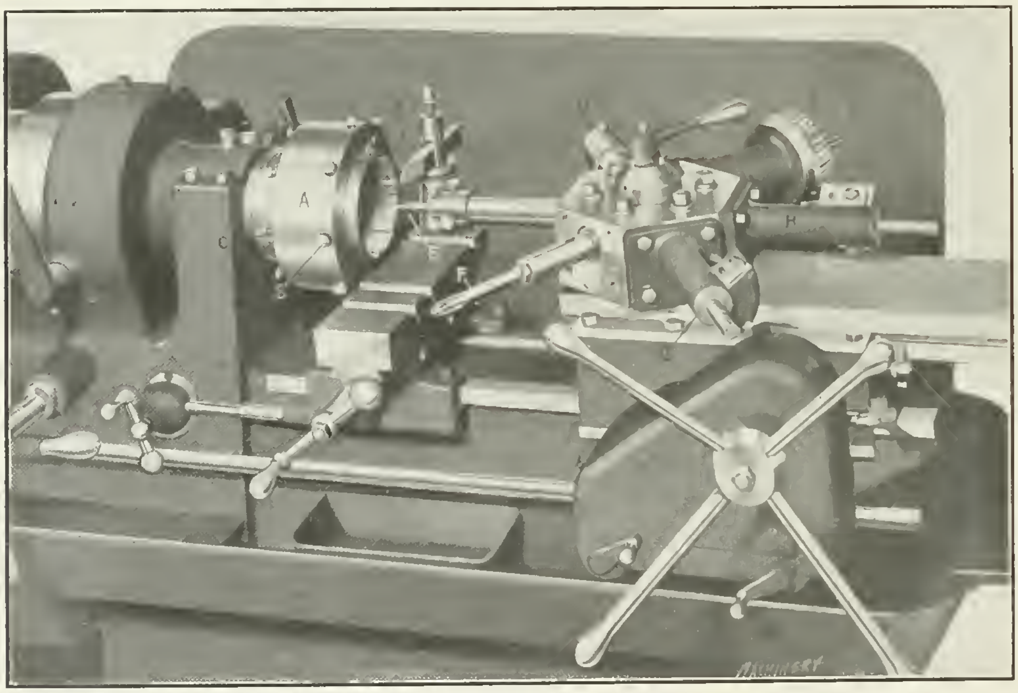


Fig 2. "Set-up" of Tools for Machining a Fan Motor Case in a Turret Lathe built by Bardons & Oliver, Cleveland

After the casting is placed in the chuck, the knurled screws *B* are tightened, centering the casting so that it will run practically true, and also holding it rigidly in the hood. The order of operations after the casting is placed in the chuck and the screws are tightened, is as follows. (Refer now to Fig. 2).

1. Drill small hole in shank *B*, Fig. 1, with drill held in holder *D* at a speed of 192 R. P. M. (open belt) and a feed of 0.0135 inch per revolution.
2. Bore small hole with boring tool *E* at a speed of 192 R. P. M. (open belt), feed 0.0135 inch per revolution.
3. Ream small hole with reamer *F* held in floating holder; speed 44 R. P. M. (with back-gears thrown in), feed by hand.
4. Rough-bore large hole with boring-tool *G* provided with two cutting tools; speed 44 R. P. M. (with back-gears thrown in), feed 0.020 inch per revolution.
5. Adjust knurled thumb-screws *B*, partly releasing their pressure on the casting.
6. Finish-bore large hole with boring-tool *H* provided with two cutting edges; speed 44 R. P. M. (with back-gears thrown in), feed by hand.
7. Again adjust knurled screws, leaving casting practically loose, and relieving all strains set up by the cutting tools.
8. Finish-ream large and small holes with reamers *I* and *J* (reamer *J* floating); speed 24 R. P. M. (with back-gears thrown in), feed by hand.

It is due largely to the manner in which this last operation is handled that the required accuracy is obtained. Here, it can be seen by referring to the order of operations, that the casting practically floats on the large reamer *I*, the small reamer *J* being guided by the hole which has been previously reamed and not removing any material, but simply acting as a "steady pin" for the large reamer. The cutting tools in the boring-tool holders *G* and *H* are spaced the same distance apart as the projections to be machined in the large hole, thus insuring rigidity and obviating chattering. The large hole is 5.505 inches in diameter and the small hole ¾ inch in diameter. The casting is faced off with the turning tool *K* held on the cross-slide, this operation being accomplished while the boring-tool *G* is at work. The time to complete one case is thirteen minutes, including clamping the work and machining.

* * *

ANNUAL MEETING OF THE N. M. T. A.

The fourteenth annual meeting of the National Metal Trades Association was held in New York City, April 11, at the Hotel Astor. The meeting was remarkable for the despatch with which the business was transacted, the public program, including the reading of several papers of length, being carried through in one day. The banquet given to the members and guests in the evening, at which speakers of international fame spoke on the tariff, universal peace and education, was a notable affair, giving a member of the president's cabinet an opportunity to voice sentiments regarding protection and free trade of extraordinary public interest. F. C. Caldwell of H. W. Caldwell & Son Co., Chicago, the president of the association, presided, assisted by Robert Wuest of Cleveland, the commissioner, who has well demonstrated his ability to conduct the affairs of this association of over seven hundred manufacturers of metal products.

The program included the valuable reports: "Systematic Compensation for Industrial Accidents," presented by Henry D. Sharpe, president of Brown & Sharpe Mfg. Co., and "Industrial Education," presented by F. A. Geier, president of the Cincinnati Milling Machine Co.; the papers "Prevention of Industrial Accidents," by William H. Doolittle, the association's safety inspector; "Employer's Liability and Workmen's Compensation What has been done to Date and is now doing in It," by Miles H. Dawson, attorney and consulting actuary, New York City; "How far must Business Yield to the Demands of Industrial Organizations?" by Hon. J. J. Feeley, of Boston; the reports of Commissioner Robert Wuest, and Assistant Commissioner H. E. Herrod, and other reports on the various activities of the association.

The report on industrial education comprised the Hartford, Cleveland, New Haven, St. Louis, Chicago, Springfield, New York and New Jersey and Cincinnati branches, all of which are doing effective work in educating boys. The cooperative course in engineering in Cincinnati has been in operation six years and three hundred are taking it. This year thirty-five will graduate and take positions as assistant engineers and foremen, and other executive positions. A new building has been added which will increase the capacity of the school to four hundred. The Cincinnati continuation school work has been extended to include the apprentices employed in the allied printing trades. Notwithstanding the depression in business, the attendance has been two hundred.

Mr. C. A. Prosser, the recently appointed secretary of the National Society for the Promotion of Industrial Education, spoke on the Page education bill, which carries an appropriation of $14,000,000. This bill to extend Federal aid to industrial education was primarily intended to help agriculture, and Mr. Prosser pleaded that the bill might be given a scope that would comprehend industrial education generally. He argued that the moral effect of Federal aid would be to make young men generally look upon the industries in a more favorable light and thus reduce the crowding in the so-called "genteel" occupations.

The report on industrial accidents by Mr. Doolittle is a painstaking paper describing a large variety of conditions in shops, mills and factories likely to cause accidents to workmen. Stereopticon views showed practical protective devices for machine tools, presses, saws, elevators, etc., which have been provided in the plants of members of the association.

The paper by Mr. Dawson, of which a full abstract appears in another part of this number, is a summary of the changes made in the relation of employers and employes in the United States and abroad by legislative enactment of employers' liability and workmen's compensation laws. The progress of this movement during the past two years is remarkable, and it foreshadows the time, comparatively close at hand, when every industry will be required to directly bear the burden of workmen's disabilities resulting from their occupations.

Judge Feeley's paper on the relations of capital and labor, defines a strike and what constitutes an unjustifiable strike under the laws of Massachusetts; also a lawful strike, methods of enforcing a strike, the sympathetic strike and the boycott.

The speakers at the banquet were Hon. Franklin MacVeagh, secretary of the treasury who spoke on the tariff; Hon. W. Morgan Shuster, formerly treasurer of Persia, whose theme was international peace; and Dr. Arthur A. Hammerschlag, of Pittsburg, a noted exponent of industrial education.

The officers elected for the ensuing year are:

President, Henry D. Sharpe, of Brown & Sharpe Mfg. Co., Providence, R. I.
First vice-president, W. A. Layman of Wagner Electric Mfg. Co., St. Louis, Mo.
Second Vice-President, L. H. Kittredge of the Peerless Motor Car Co., Cleveland, Ohio.
Treasurer, Howard P. Eelles of the Bucyrus Co., Cleveland, Ohio.

* * *

SINKING OF THE TITANIC

The sinking of the White Star Steamship *Titanic* on her first voyage is the most appalling of the long roll of disasters on the sea. Though built with all the safeguards that human ingenuity could devise, collision with an iceberg off Cape Race, Newfoundland, just before midnight, April 14, so crushed the hull that in less than three hours she had sunk in one of the profound depths of the Atlantic, carrying down 1600 of the passengers and crew and millions in treasure. The boasted security of the modern steamship seems a hollow mockery in the face of this catastrophe—so great that it stuns the intelligence and sickens the imagination. A great vessel of 46,000 tons registered, the largest ever built, was lost by an accident that everyone familiar with the perils of the sea knew to be possible, but which few supposed could be so disastrous as this.

Out of this appalling disaster the wireless telegraph emerges triumphant. Without this wonderful means of communication few, if any, would have survived to tell the awful tale. Although but a few hours in the boats before they were picked up by the *Carpathia* of the Cunard line, several of the 700 died of shock and the intense cold. Had life boats been available for all and had there been time to embark in an orderly way, the loss of life even then would have been severe. Many more lifeboats are needed but will be futile unless both crew and passengers are drilled to act systematically in emergencies, each going to his appointed place on signal. But important as are lifeboats and lifeboat drill they are secondary. The business of steamship companies is transporting passengers from one port to another—not dumping them into small boats to perish in the open sea. Let us devote more thought to making vessels stronger and safer, to the construction of bulkheads that will stand the greatest water pressure that can be imposed on them, to the design of bulkhead doors that will promptly close in emergencies, to the personnel of the crews and finally to navigation laws that will stop this reckless trifling with death in taking the risks of the shorter route and running at full speed when icebergs are moving down from the North.

* * *

AN ACCESSION TO MACHINERY'S STAFF

We are glad to announce that Mr. William Ledyard Cathcart has become a member of MACHINERY's editorial staff in the capacity of consulting engineer. Mr. Cathcart will devote particular attention to problems in mechanics and machine design, and to the preparation of a series of reference books on machine shop practice and machine details, which he is especially qualified to edit.

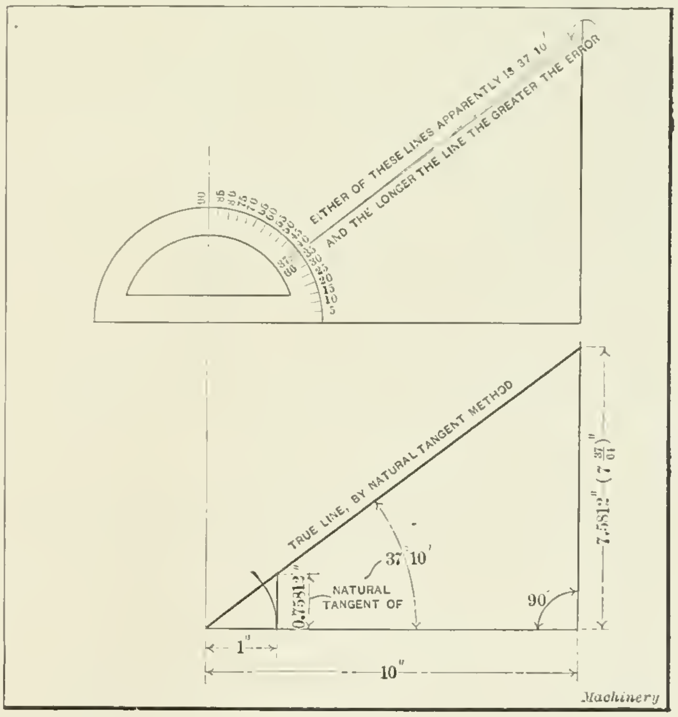
Mr. Cathcart is a graduate of the University of Pennsylvania and the United States Naval Academy, and following his graduation served sixteen years as an officer of the engineering corps of the United States Navy. During the Spanish-American War he volunteered for service, was appointed chief engineer in the Navy and ordered to special duty at Washington on the staff of the late Admiral Melville, then engineer-in-chief. Mr. Cathcart spent two years as professor of marine engineering; four years as adjunct professor of mechanical engineering, Columbia University; seven years as treasurer of a textile manufacturing company; five years with the Babcock & Wilcox Co., New York, translating, collating and analyzing scientific data from French and German sources. Prof. Cathcart is the author of "Machine Design," "Fastenings" and co-author with Prof. J. Irvin Chaffee of "The Elements of Graphic Statics."

* * *

LAYING OUT ANGLES ACCURATELY

By HARRY B. WRIGLEY*

In laying out an angle by an ordinary circular protractor, it is evident that a slight error at the circumference of the protractor will be multiplied many times in plotting a long line. The angle can be laid out accurately by the "natural tangent" method. To illustrate, assume that it is necessary to lay out an angle of 37 degrees, 10 minutes. The natural tangent is 0.75812, and as this represents the altitude in inches of a right angle triangle having a base 1 inch long, the alti-


EITHER OF THESE LINES APPARENTLY IS 37° 10'
AND THE LONGER THE LINE THE GREATER THE ERROR
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
TRUE LINE, BY NATURAL TANGENT METHOD
37° 10'
NATURAL TANGENT OF
0.75812"
90°
7.5812" (7 37/64")
1"
10"
Machinery

Two Methods of Laying Out Anglee—Note the Advantage of the "Natural Tangent" Method tude having a base 10 inches long will be ten times the natural tangent or 7.5812 inches (7 37/64 inches). It is evident that it is only necessary to find the natural tangent of the angle and multiply it by 10 which is equivalent to moving the decimal point one place to the right, in order to obtain the altitude when the base is 10 inches. A 10-inch base is taken as a matter of convenience, as it simply means moving the decimal point as described. The two methods of laying out angles—by means of the protractor and natural tangent—are shown in the accompanying illustration, where it can be seen that the angle can be laid out much more accurately by the latter method.

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* Address: Care of Y. M. C. A., Allentown, Pa.

[A similar method for laying out angles accurately, but which employed the use of the sine, was illustrated and described in MACHINERY, June, 1911. It is evident that any of the functions of a right angle triangle—sine, cosine, tangent, or cotangent—can be used for laying out angles. Some prefer the sine, as the sine of half the angle is equal to half the chord.—EDITOR.]

* * *

PERSONALS

J. C. Ward, director and general manager of Edgar Allen & Co., Ltd., Chicago, departed April 21 for a business trip in Japan. Mr. Ward expects to be gone for several months.

F. B. Jacobs, who for the past year has been traveling for the Carborundum Co., Niagara Falls, N. Y., gathering data on shop practice, has entered the company's store at Philadelphia as a salesman.

E. Hawkinson, foreman in the toolmaking department of the Canadian General Electric Co's. plant at Peterboro, Ont., for the last three years, has resigned his position to take the position of tool designer for the Russell Motor Car Co., of Toronto.

William W. Bishop, for six years manager of the machinery department of the Cincinnati Iron & Steel Co., Cincinnati, Ohio, has resigned his position to become associated with the sales department of the Shaw Electric Crane Co., with headquarters in Chicago.

George Langen, works manager of the Cincinnati Planer Co., who intended to start in March for an extended European trip, was stricken with appendicitis two days before his sailing date. Mr. Langen is recovering, but his trip has been indefinitely postponed.

Ralph E. Flanders, of the Fellows Gear Shaper Co., Springfield, Vt., formerly associate editor of MACHINERY, addressed the American Society of Swedish Engineers, Brooklyn, N. Y., April 20, on the subject: "Scientific Management from a Social and Economic Standpoint."

Selbert M. Connor, heretofore an engineering draftsman with one of the large railroads terminating in Chicago, has started in business for himself, having opened an office at 414 Sherman St. Mr. Connor will undertake drawing, mapping and the execution of commissions for patterns, model work or any work of a mechanical nature.

A. N. Goddard (W. P. I. '99), for thirteen years with the Morgan Construction Co., Worcester, Mass., as assistant superintendent, recently resigned his position to become superintendent with the Union Twist Drill Co., Athol, Mass. When leaving the Morgan Construction Co., the employes presented him with a solid gold watch and guard suitably engraved.

E. F. Lake, formerly steel editor of the *American Machinist*, who for the past year has been conducting a consulting metallurgical business in Bayonne, N. J., has been placed in charge of the laboratory of the Perfection Spring Co., Cleveland, Ohio. Mr. Lake has contributed a number of valuable articles on alloy steels, extrusion of metals and die-casting machines to MACHINERY.

R. S. Bryant has been appointed consulting engineer of the Standard Welding Co., Cleveland, Ohio. Mr. Bryant was formerly with the Bryant Rim Co., of Columbus, Ohio, and his long experience in the design and manufacture of automobile rims peculiarly fits him to carry out the company's policy of constantly improving its products and service, as well as keeping its automobile rim designs in every way up to the latest requirements of the trade.

George Sherwood Hodgins, a well-known writer on railway topics, at one time editor of the *Railway Digest* and later of *Railway and Locomotive Engineering*, has been engaged by the commissioners of the Trans-Continental Railway of Canada to make a special report concerning the shop equipment of the various roundhouses, terminal shops, etc., now built or being constructed on that line. Mr. Hodgins will be engaged for several months on this work.

Frederick A. Hall, engineer, 5-9 Beekman St., New York, announces that Mr. Mancius S. Hutton is associated with him in the management of the office and conduct of the business. Mr. Hutton, who is the son of Prof. F. R. Hutton, honorary secretary and past president of the American Society of Mechanical Engineers, will have general charge of correspondence regarding the business, and will give special attention to the departments of boilers, engines and power equipment in which Mr. Hall acts as the direct representative of manufacturers.

Dr. Rudolf Diesel of Munich, Germany, director of the Busch-Sulzer Bros.-Diesel Engine Co., St. Louis, Mo., came to New York April 6 on the steamer *Amerika*. He will make a tour of the United States, lecturing before engineering societies and other bodies on the possibilities of the internal combustion engine. He is the inventor of the Diesel engine which is displacing steam engines in Europe for industrial purposes, and is being applied as the motive power of marine vessels with success. Dr. Diesel predicts that the internal combustion locomotive will eventually displace the steam locomotive because of its superior economy and simplicity. He was made an honorary member of the American Society of Mechanical Engineers, April 30, at the meeting of the gas power section. The conferring of honorary membership was followed by an illustrated lecture by Dr. Diesel on the development of the Diesel engine.

OBITUARIES

Frank B. Manville, an inventor of automatic machinery for making wire goods, and one of the organizers of the E. J. Manville Machine Co., Waterbury, Conn., died at his home in Waterville, Conn., March 29, aged sixty-two years. Mr. Manville invented machinery for making hooks and eyes, threading bicycle spokes by the rolling process, and forming rims for bicycle wheels. He also invented a brass shoe lace hook. He had worked in the Winchester, Colt, Whitney and Ames armories, and at the Elgin watch factory. Although one of the organizers of the E. J. Manville Machine Co., he was no longer connected with that concern. A widow and three brothers survive him.

Stanley K. Fox, machine demonstrator for the Gleason Works, Rochester, N. Y., was lost in the wreck of the *Titanic*, April 15. He helped the women and children into the life boats until the last one was filled and then calmly awaited his fate. Mr. Fox was thirty-eight years old, and was twenty-eight when he made his start with the Gleason Works without mechanical training. He soon became an expert machine operator, excelling all others in setting up work rapidly. Soon he was sent out to demonstrate machines and made many friends by his enthusiasm and kindly nature. He made his first European trip four years ago and was abroad last year from June to October and went again on the last trip in January. A memorial service was held in St. Andrew's Episcopal Church, Rochester, April 20, in which Rev. Dr. Thomas paid a high tribute to Mr. Fox's sterling qualities.

* * *

COMING EVENTS

May 9-18. First Annual Aeronautical Exhibition held in the Grand Central Palace, New York City, under the auspices of the Aero Club of America.

May 13-15.—Triple joint convention at Norfolk, Va., of the American Supply and Machinery Manufacturers' Association, National Supply and Machinery Dealers' Association, and Southern Supply and Machinery Dealers' Association. The program includes papers on "Workmen's Compensation"; "Motion Study"; "The National Banking and Currency Problem"; and "The American Merchant Marine." F. D. Mitchell, secretary treasurer, 309 Broadway, New York.

May 13-25. Newark industrial exposition under the auspices of the Board of Trade of Newark, N. J., in the First Regiment Armory. It is claimed that one hundred thousand different articles are manufactured in the three thousand shops of the Newark industrial district, the diversity being proportionately greater than that of any other manufacturing district in the country. William G. Rose, manager, Newark, N. J.

May 14-17.—Sixth annual convention of the Master Boiler Makers' Association at the Fort Pitt Hotel, Pittsburg, Pa. J. R. Flannery, of the Flannery Bolt Co., Frick Building, Pittsburg, Pa., secretary and treasurer of the general committee of arrangements.

May 16-17.—Semi-annual convention of the National Machine Tool Builders' Association at Atlantic City, N. J., Hotel Chalfonte headquarters. E. P. Bullard, Jr., president, Bridgeport, Conn.; James H. Herron, secretary, Cleveland, Ohio.

May 20-22. Railway Storekeepers Association's conventinn in Buffalo, N. Y. Hotel Statler, headquarters. Wm. E. Kelley, secretary-treasurer, 825 Wabash Ave., Chicago, Ill.

May 27-31.—International Safety Congress to be held at Milan, Italy. Dr. W. H. Tolman, director of the American Museum of Safety, 29 W. 39th St., New York City, is a delegate to the congress from the United States.

May 28-31.—Spring meeting of the American Society of Mechanical Engineers in Cleveland, Ohio. Hotel Hollenden, headquarters. Calvin W. Rice, secretary, 29 W. 39th St., New York.

June 12-14.—Annual convention of the American Railway Master Mechanics' Association at Atlantic City, N. J.

June 17-19.—Annual convention of the Master Car Builders' Association at Atlantic City, N. J.

June 17-22.—First annual gas engine show under the auspices of the National Gas Engine Association in the Auditorium, Cleveland, Ohio. Albert Stritmatter, secretary, Cincinnati, Ohio.

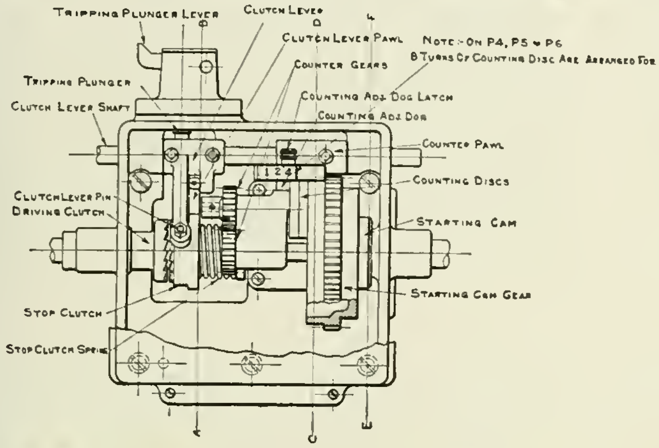
July 9.—Annual convention of the American Railway Tool Foremen's Association in Chicago. H. L. Miller, secretary of the supply association, 835 Monadnock Bldg., Chicago, Ill.

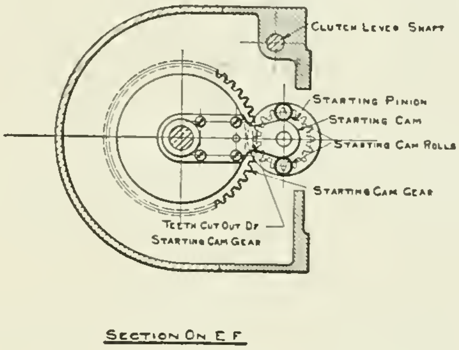
August 20.—Annual convention of the International Railroad Master Blacksmith's Association at Hotel Sherman, Chicago, Ill. J. E. Carrigan, Rutland Railway, Rutland, Vt., chairman of the executive committee.

September 2-7.—Sixth congress of the International Association for Testing Materials at the Engineering Societies Building, 29 W. 39th St., New York. H. F. J. Porter, secretary, 1 Madison Ave., New York.

September 24-26.—Annual convention of the American Foundrymen's Association and allied bodies, in Buffalo, N. Y.; hotel Statler, headquarters. Richard Moldenke, Watchung, N. J., secretary.

Study these Diagrams of the Mechanism that Indexes Gears so Accurately and Quickly



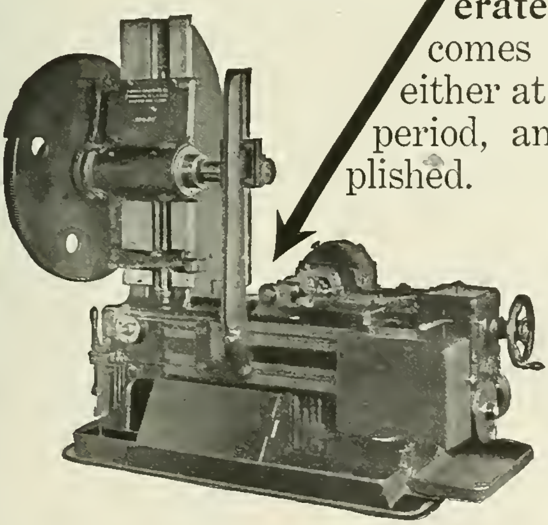


The indexing mechanism on a gear cutting machine is a feature of great importance.

It should not operate with a shock, for that will cause the spacing of the gear teeth to be inaccurate. Neither should it operate too slowly, for that will impair the production of the machine.

The indexing mechanism on B. & S. Automatic Gear Cutting Machines overcomes both of these difficulties because of certain exclusive features in its design.

At each indexing, the mechanism **starts slowly, is accelerated and then retarded** just before it comes to a stop. Hence there is no shock either at the beginning or end of the indexing period, and the operation is quickly accomplished.



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Write for special circulars of these machines.

BROWN & SHARPE MFG. CO.

PROVIDENCE, R. I., U. S. A.

October 7-11.—Annual convention of the American Electric Railway Association and allied associations in Chicago, Ill. The exhibit will be at Dexter Pavilion, 43d and Halstead Sts. H. C. Donecker, secretary-treasurer, 29 W. 39th St., New York.

SOCIETIES, SCHOOLS AND COLLEGES

Columbia University, New York, has issued an announcement for the Summer session for 1912, beginning July 8 and continuing until April 16.

American Society of Engineer Draftsmen, 116 Nassau St., New York City. Year book containing the constitution and by-laws governing the society; also list of members.

Beloit College, Beloit, Wis. Sixty-fifth annual catalogue of the college, containing information relating to the faculty and students, the courses, admission requirements, scholarships, etc.

Virginia Polytechnic Institute, Blacksburg, Va. Bulletin, April, 1912, covering 172, 6 by 9-inch pages, giving courses of instruction, and general information useful to prospective students, as well as a list of students for the year 1911-1912.

Louisiana State University, Baton Rouge, La. Bulletin giving information relative to the summer school of the university. The term of this summer school begins June 3 and ends August 2. The courses of instruction, admission requirements, fees, etc., are dealt with in this bulletin.

Modern Systems Correspondence School, 6 Beacon St., Boston, Mass. Booklet entitled, "As Others See Us," being an extract from an article in *Castings* on specialized correspondence schools. This school, of which Mr. Oscar E. Perrigo is director, specializes its courses to meet the needs of individuals.

Society of Automobile Engineers removed its New York office from No. 1451 Broadway to the U. S. Rubber Bldg., Broadway and 58th St., May 1. The growth in membership and activities of the society made necessary the removal to larger quarters. The new location will be appreciated by out-of-town members, being close to the Columbus Circle subway station and on the route of the Broadway surface car lines.

Northwestern University, Evanston and Chicago, Ill. Annual catalogue 1911-1912, covering 515, 6 by 9-inch pages, containing complete information of the various departments of the University, including the College of Liberal Arts, the College of Engineering, and the School of Commerce, and information relating to fraternities, university societies, alumni association, register of students, and general information relating to expenses, fees, etc.

American Association for Labor Legislation, Metropolitan Tower, New York City, is entitled to much credit for the enactment of the phosphorus match bill signed by President Taft, April 9. Investigation of "phossy jaw," the occupational disease of match factory workers, led to the introduction of the bill in June, 1910, immediately after the publication of the report on phosphorus poisoning by John B. Andrews, secretary of the association. Public sentiment demanded the prohibition of the death-dealing match. Through this legislation one of the most terrible of occupational diseases will be abolished.

NEW BOOKS AND PAMPHLETS

Electric Power on the Farm. By Adolph Shane. 62 pages, 6 by 9 inches. 31 illustrations. Bulletin No. 25 of the Iowa State College of Agriculture and Mechanic Arts, Ames, Iowa.

Second Annual Report on the Statistics of Express Companies in the United States, for the year ending June 30, 1910. 38 pages, 8 by 10 inches. Published by the Interstate Commerce Commission, Washington, D. C.

Kerrawalla's Textile and Engineering Directory and Year Book. 10 by 13 inches, 111 pages. Published by C. D. Kerrawalla, Kalachowki Road, Parel, Bombay, India.

The Textile and Engineering Directory and Year Book for 1912 is the seventh issue. Among the useful information contained are complete lists of cotton ginning and pressing factories, jute presses, cotton jute, woolen and silk mills, iron works, gold, copper, iron, lead, manganese, ruby, salt and coal mines, flour, sugar, oil, rice, saw, bone and paper mills, quarries, coil works, roperies, mica works in India, cotton mills in China and Japan together with a number of useful tables for mill and factory owners, managers engineers, carding, spinning and weaving masters, hardware and mill store merchants, etc. The directory is freely circulated among the users of textile and engineering machinery in India and is, therefore, of special interest to manufacturing concerns who wish to reach this trade.

Transportation Rates. By A. M. Fisher. 16 pages, 5 by 7½ inches. Published by the author, New York. Price 50 cents.

This comment upon transportation rates, it is stated, has been written with particular reference to the section of the Interstate Commerce Act which is properly known as the "long and short haul" clause. The booklet is written from an extremely one-sided point of view, in which the opinions of the old-time "stand-pat" railway managers' ideas only are considered. As an example of the spirit of the booklet the following statement may be quoted: "It need not be anticipated that there will be a general revival of business with the present Interstate Commerce Act in effect and enforced." Digressing somewhat from the avowed purpose of the book, the author mentions that "it is hardly to be expected that profitable methods can be devised for the operation of the subways and other urban transportation service." It is difficult to understand on what basis this statement is made, in view of the fact that financiers seem to be extremely anxious to obtain monopolies in transportation services in cities, subways included. Another example of the peculiar mental processes by means of which the conclusions in this booklet are arrived at is the statement that the result of a parcels post would be "a very decided influence toward increasing the cost of living." The author finally advocates the introduction of scientific transportation rates. Just what he means by "scientific" is not entirely clear, but may perhaps be surmised from the few quotations given above.

NEW CATALOGUES AND CIRCULARS

Crocker-Wheeler Co., Ampere, N. J. Bulletin No. 147 on Crocker-Wheeler electric fans.

Detroit Fuse & Mfg. Co., Detroit, Mich. Revised bulletin No. 23 on the "Detroit" three-phase motor starter.

Studebaker Automobile Co., South Bend, Ind. Bulletin No. 1023 on electric commercial motor vehicles for all purposes.

Damascus Bronze Co., Pittsburg, Pa. Pamphlet on "Damascus" bronze products with special reference to bearings.

Detroit Fuse & Mfg. Co., Detroit, Mich. Catalogue of the "Detroit" ironclad fused switches and the "Arkless" indicating fuses.

Hannifin Mfg. Co., Chicago, Ill. Catalogue of air-operated chucks, countershafts, gate valve seating chucks, special tools and machinery.

Rockford Iron Works, Rockford, Ill. Circular and specifications of the Rockford inclinable open-back foot press, size A; also No. 4 flywheel press.

General Fire Extinguisher Co., Providence, R. I. Bulletin on the "Grinnell" automatic sprinklers for the protection of shops, mills and factories from fire.

J. H. Williams & Co., 61 Richards St., Brooklyn, N. Y. Catalogue of lathe dogs, C-clamps, machinists' clamps, planer strap clamps, drop-forged wrenches, drop forgings, etc.

F. O. Weydell, 224 S. Jefferson St., Chicago, Ill. Circular of the "Hi-Low" drawing table which can be quickly changed in height from 36 to 44 inches to suit the convenience of the draftsman.

American Tap & Die Co., Greenfield, Mass. Catalogue No. 4 of "Adamantine" screw plates; "Eagle" brand taps, dies, stocks and tap wrenches; and pipe tools, comprising stocks, dies, taps and reamers.

Autocall Co., 100-110 Franklin Ave., Shelby, Ohio. Card illustrating the "Autocall" and its application in the manufacturing establishments for locating foremen, superintendents and others without loss of time.

Francis Reed Co., Worcester, Mass. Circular of the No. 20 Stanley sensitive drill having six spindle speeds, detachable countershaft, ball thrust bearing for spindle, ample power for one-half-inch drill and which sells for $50.

Brown Hoisting Machinery Co., Cleveland, Ohio. Pamphlet illustrating and describing "Brownhoist" suspended bins for coal, ore, ashes, etc., and catalogue of the "Brownhoist" tramrail systems, trolleys and electric hoists.

Electric Controller & Mfg. Co., Cleveland, Ohio. Bulletins, Nos. 1009 on push buttons; 1016 on automatic motor starters for non-reversing direct-current motors; 1025 on lifting magnets; and 1027 on current limit panels for direct-current motors.

Universal Stamping Co., Buffalo, N. Y. Bulletin illustrating safety devices made to prevent the flying of chips from shaper tools, lathe tools and other cutting tools, emery wheel guards, safety belt hanger, snap-on reflectors, lamp shades, lamp stands, etc.

Chicago Pneumatic Tool Co., Chicago, Ill. Bulletins, E-19, E-20, E-21 and E-22 on universal electric drills, operating on direct or alternating current; electric drills for heavy work; Duntley track drill; and air-cooled direct current drills, respectively.

Pawling & Harnischfeger Co., Milwaukee, Wis. Booklet entitled, "Cutting the Cost of Lumber Production," illustrating handling and transporting apparatus built by the company, comprising monorail systems, traveling electric cranes and hoists and electric transfer cars for handling lumber in bulk.

Watson-Stillman Co., 192 Fulton St., New York, has just issued catalogue No. 85 "Hydro-Pneumatic Wheel Presses," which describes and lists the company's line of full hydro-pneumatic wheel presses. Seventy-six types and sizes of hydraulic tools exclusively of Watson-Stillman designs are also listed.

Scully Jones & Co., 316 Railway Exchange, Chicago, Ill. Circular of the "Wear-ever" sockets for drills. The sockets are made of special steel, heat-treated, and reinforced at the bottom by a solid ring of metal of increased diameter having a drift groove which saves time in separating nested sockets.

Bausch & Lomb Optical Co., Rochester, N. Y. Circular of the "Balopticon" for the projection of large opaque objects on a screen. This instrument is designed for educational purposes and enables a lecturer to project drawings, photographs, working models, mechanisms, etc., directly on the screen without previous preparation.

Eureka Co., North East, Pa. Price-list of copper hammers for machine shop use, furnished in sizes from ¼ pound to 16 pounds, with or without handles. Copper hammers are more durable than babbitt hammers and have the characteristic of not seriously marring steel or cast iron when employed for driving or hammering work.

Industrial Instrument Co., Foxboro, Mass. Bulletin No. 60 on indicating gages for all purposes comprising pressure and vacuum gages, compound, ammonia, pyrometer, test, hydraulic, electric alarm, altitude, sulphite, illuminated dial, standard duplex and triplex, and recording gages, thermographs, marine and locomotive clocks, etc.

Watson-Stillman Co., 192 Fulton St., New York. Bulletin J describing a filling liquid, called "jackohol," developed for hydraulic tools such as jacks, presses, punches, benders, etc. This liquid does not freeze, thicken, gum or change chemical composition. It is invariably protective to the metal surfaces and packings with which it comes in contact.

W. P. Davis Machine Co., Rochester, N. Y. Treatise on keyseating and keyways compiled for American machine shop practice. This interesting and valuable little booklet contains a fund of useful information on a very practical subject affecting everyone having to do with the design and construction of machinery. The booklet also illustrates the Davis keyseater made in two sizes.

Pratt & Whitney Co., Hartford, Conn. Wall hanger of machinists' handy tables comprising U. S. standard screw threads, standard dimensions of wrought iron, welded tubes, table of cutting speeds and feed per minute, metric standard screw threads, pitch or angle diameters of hand taps, U. S. and Whitworth standard and A. S. M. E. standard screw threads for machine screws.

Furnace Gas Consumer Co., Matteawan, N. Y. Pamphlet entitled "Smokeless Chimneys," describing a furnace gas consumer for the prevention of smoke, consisting of a bank of fire clay tubes installed back of the bridge-wall underneath the boiler which becomes incandescent and thus promotes complete combustion of the gases before they are cooled by contact with the water-backed surfaces.

Keuffel & Esser Co., Adams and Third Sts., Hoboken, N. J. Descriptive circular of an improved farm transit with and without compass for the use of builders, architects, instructors, farmers, etc. This instrument, which without compass sells for $30, has a 10-inch telescope, one-inch aperture. The same instrument with compass sells for $38. The circular also illustrates farm levels selling for $16 and $25.

General Electric Co., Schenectady, N. Y. Booklet No. 4926 on the application of electricity to marine service. The publication is printed in colors and describes the various pieces manufactured and supplied by the company for marine use. The data given are of general interest to motor boat owners and among these data will be found reproductions of the flags of the principal yacht clubs throughout the country.

J. M. Carpenter Tap & Die Co., Pawtucket, R. I. Catalogue No. 19 on tools for cutting screw threads comprising taps, dies, screw plates, die-stocks, tap wrenches, etc. The catalogue also contains useful tables on U. S. Standard threads, V threads, International, and French standard threads, Whitworth standard threads, British Association standard, Acme standard and A. S. M. E. standard for machine screws, etc

Rahn-Larmon Co., Cincinnati, Ohio. Catalogue of Rahn-Larmon engine, turret and gap lathes built in the following series and sizes: Series A, 16-, 18- and 20-inch engine lathes; series A, 16-, 18- and 20-inch gap lathes; series B, 18-, 20- and 22-inch engine lathes; series D, 22-, 24- and 26-inch engine lathes; series G, 24- and 48-inch extension bed gap lathes; and series F, 26-, 28-, 30- and 32-inch engine lathes.

Hale-McAdams Wheel Co., 224 High Avenue, Cleveland, Ohio. Circular of the Cleveland friction clutch which is made in nine sizes,

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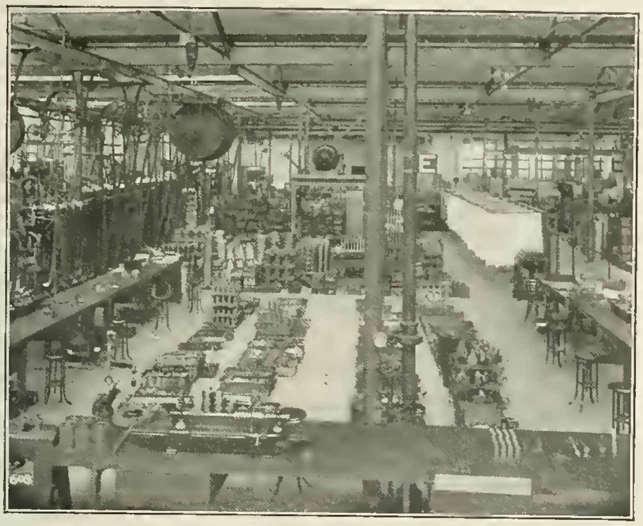
is inspected after every operation. Some of them pass through this department as many as twenty times before they are finished. Hardened gears, clutches, and similar parts are also tested with the scleroscope and must meet definite standards of hardness set for each piece.



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ranging from 8 inches diameter to 24 inches diameter and having capacities of 8 to 63 horsepower per hundred revolutions per minute. The clutch is self-oiling, has few parts, is easily adjusted, and has other advantages of interest to all those concerned with the installation of clutches.

Industrial Instrument Co., Foxboro, Mass. Bulletin No. 61 on portable or hand tachometers, single-spindle multi-speed spring type made by Dr. Th. Horn of Leipzig, Germany. These instruments show at a glance the rate of rotation or peripheral speed and by means of the selective speed-changing mechanism a single instrument may have several scales. One of the forms of this instrument is a cut meter for showing the cutting speed of lathe and planer work.

New Process Twist Drill Co., Taunton, Mass. Catalogue of carbon high-speed and "Reliance" high-speed twist drills. The regular carbon steel and high-speed drills are hot-forged and twisted instead of being milled from the solid as is the common practice. The "Reliance" high-speed twist drills are made from profile stock inserted in a carbon steel shank by a special process. The claim is made that the hot forging process gives the drill greater strength because the grain follows the spiral fluting.

Hess-Bright Mfg. Co., 2111 Fairmount Ave., Philadelphia. Pa. Data Sheets, Nos. 5-A, 52-1, 65-A, 68-A, 70-A, 75, 76 and 78 on mounting collar type ball thrust bearing to take thrust in one direction only; DWF adapter bearings; centrifugal basket mountings; application of floating bushes to grinding spindles; DWF adapter and method of assembling with bearings on a straight shaft; standard form of mounting for two-bearing four-cylinder crankshaft; built-up crankshaft and two-cylinder V type motor; and mountings for rolls.

Adams Co., 877 Market St., Dubuque, Iowa. Circular No. 812 illustrating and describing the No. 4 Farwell universal gear hobber which was illustrated and described in the March number of Machinery. This gear hobber cuts spur gears, worm-wheels, spiral and worm gears, herringbone gears, ratchet wheels, sprocket wheels, etc. It has a capacity for gear diameters up to 24 inches, and with arbor support removed, up to 28 inches. The vertical feed of the head is 12 inches and the coarsest diametral pitch cut in steel is 3½ pitch, and in cast iron or bronze, 3 pitch.

Crescent Machine Co., 56 Main St., Leetonia, Ohio. Catalogue for 1912 of "Crescent" wood-working machinery comprising band saws, "Crescent" angle band saws which may be tilted for bevel sawing, guards for band saws, setting and filing clamps, saw tables, saw guards, shaper fence, single and double spindle shapers, jointers, variety woodworker, planers and matchers, surfacers, swing cut-off saws, disk grinders, universal borers, post borers, etc. A valuable feature of the catalogue is the data on the horsepower required for machines, which enables a customer to estimate the probable power requirements of machines to be installed.

W. S. Rockwell Co., 50 Church St., New York. Specimen views from catalogue No. 14 showing installations of Rockwell oil and gas furnaces, among which are installations of single chamber and double chamber annealing furnaces, double-end underfired annealing furnaces for brass, copper, German silver, sterling silver, etc.; single-end underfired annealing furnaces for the same fuel and purposes are shown, also annealing and hardening furnaces, carbonizing furnaces, rotary annealing and hardening furnaces, rod heating furnaces, forge furnaces, brass melting furnaces, plate heating furnaces, and soft metal furnaces, all using oil or gas fuel.

General Electric Co., Schenectady, N. Y. Bulletins Nos. 4915 on direct current motors; 4921 on electric heating and cooking; 4922 on electricity in metal mines; 4923 on modern electrical equipment for economical production of iron and steel; 4928 on searchlight projections for commercial use; 4929 on electrically operated brick plants; 4933 on small polyphase motors; 4934 on battery charging rheostats; 4935 on GE-201-A railway motor; 4940 on commutating pole motors; 4941 on water flow meters; 4942 on Thompson direct current test meter; 4943 on direct current motor starting panels for heavy service; and 4944 on isolated and small plant alternating current switchboard panels.

Westinghouse Electric & Mfg. Co., East Pittsburg, Pa. Leaflets, Nos. 2362 on type CA alternating-current motors; 2409 on self-starting synchronous motors, ranging in capacity from 90 to 1500 horsepower and from 220 to 6600 volts; 2441 on the application of small motors; 2443 on motors for crane and hoist service; 2446 on type QK electrically-operated brakes for direct-current cranes and hoist motors; 2447 on type SP electrically-operated brakes designed especially for mill and crane service; 2449 on hand-operated controllers for light crane and hoist service; 2383 on alternating-current steel mill motors, type MA; and circulars Nos. 1088 on three-wire direct-current generators; 1522 on multiple unit trains and HL control; and 4049 on type F carbon circuit-breakers.

TRADE NOTES

Doehler Die-Casting Co., Court and Ninth Sts., Brooklyn, N. Y., has established a Detroit office in the Ford Bldg., Room 1313, in charge of the company's vice-president, Mr. H. B. Griffin.

E. L. Essley Machinery Co., Chicago, Ill., has made Mr. James L. Gough sales manager and Mr. James J. Shanahan representative for Indiana and Michigan, replacing Mr. J. A. Richardson, resigned.

Canton Machinery Exchange, 624 N. Market St., Canton, Ohio, was recently organized to deal in machine tool specialties, and the catalogues and literature of manufacturers of machine tools and accessories are requested.

Edgar Allen & Co., Ltd., Chicago, Ill., formerly of 434 W. Randolph St., has moved to larger and more commodious quarters at 718-722 W. Lake St., where a full stock of all grades of Allen's tool steels will be carried.

Allis-Chalmers Co., Milwaukee, Wis., which recently went into the hands of receivers, has been reorganized with a capital stock of $42,500,000. The stock consists of $26,000,000 common and $16,500,000 seven per cent accumulative preferred stock.

Lucas Machine Tool Co., Cleveland, Ohio, was awarded a gold medal and diploma at the Brussels Exposition in 1910 for the Lucas precision horizontal boring, drilling and milling machine which was exhibited by the company's representative, Mr. Alfred H. Schütte.

Page-Storms Drop Forge Co., Chicopee, Mass., has installed a thoroughly equipped chemical laboratory, modern in every respect. It is under the direction of an experienced chemist who was connected with the Halcomb Steel Co., Syracuse, N. Y., for about four years.

Andrew C. Campbell, Waterbury, Conn., will erect a factory on State St. for the manufacture of a patented self-spreading cotter-pin. The cotter-pin is so fashioned that when inserted in a hole and driven with a hammer, one part slips past the other, thus spreading their ends, and preventing the pin from falling out.

Suffern & Son certified public accountants, have established a branch at 1121 Newhouse Bldg., Salt Lake City, Utah, under the direction of Mr. Charles A. Secor, as resident partner. This office will have a staff of competent accountants and will also command the services and abilities of the entire organization.

Joseph T. Ryerson & Son, Chicago, Ill., have been appointed as sole agents for Chicago territory to represent the full line of multi-spindle drill presses manufactured by the Fox Machine Co., Grand Rapids, Mich., and a machine has been installed on the floor of the Chicago machine tool warehouse for demonstrating purposes.

Hoskins Mfg. Co., 459 Lawton Ave., Detroit, Mich., maker of Hoskins electric furnaces, pyrometers and heating appliances, and "International" electric heaters, has opened an office in the Oliver Bldg., Pittsburg. This office will enable the company to more adequately care for its rapidly growing business in the Pittsburg district.

Rickard & Sloan, 20 Vesey St., New York, is a newly organized advertising firm, composed of William L. Rickard and Clifford A. Sloan. The firm will give particular attention to the planning and management of advertising campaigns for firms engaged in the manufacture of mechanical and electrical apparatus and accessories.

Buffalo Foundry & Machine Co., 63 Winchester Ave., Buffalo, N. Y., was damaged by fire early in the morning of April 11 to the extent of about $10,000. Because of its steel and glass construction the building is practically fireproof, excepting the roof, where the greatest damage was done. The damage stopped business in the plant for only a few days.

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COMPOSITION, HEAT TREATMENT AND PROPERTIES OF CARBON AND NICKEL STEELS—I

Kind of Steel and General Designation		Carbon, Per Cent	Manganese, Per Cent	Phosphorus,* Per Cent	Sulphur*, Per Cent	Nickel, Per Cent	Heat Treatment†	Elastic Limit, Pounds per Square Inch		Reduction in Area, Per Cent		Elongation in 2 Inches, Per Cent	
								Annealed	Heat Treated	Annealed	Heat Treated	Annealed	Heat Treated
Carbon Steels	0.10 Carbon	0.05–0.15 (0.10)	0.30–0.60 (0.45)	0.04	0.04	....	Quench at 1500° F.	28,000–36,000	....	60	......	30–40	......
	0.20 Carbon	0.15–0.25 (0.20)	0.50–0.80 (0.65)	0.04	0.04	....	A or B	30,000–40,000	40,000–75,000	45–60	15–60	25–35	15–35
	0.30 Carbon	0.25–0.35 (0.30)	0.50–0.80 (0.65)	0.04	0.04	....	C or D	35,000–45,000	40,000–80,000	40–55	30–60	20–30	10–30
	0.40 Carbon	0.35–0.45 (0.40)	0.50–0.80 (0.65)	0.04	0.04	....	E	40,000–50,000	45,000–100,000	40–50	25–55	20–25	5–25
	0.50 Carbon	0.45–0.55 (0.50)	0.50–0.80 (0.65)	0.04	0.04	....	E	45,000–60,000	50,000–110,000	30–40	15–50	15–20	0–20
	0.80 Carbon	0.75–0.90 (0.80)	0.25–0.50 (0.35)	0.04	0.04	....	F	....	90,000–160,000	......	....	......	......
	0.95 Carbon	0.90–1.05 (0.95)	0.25–0.50 (0.35)	0.04	0.04	....	F	....	90,000–160,000	......	....	......	......
Nickel Steels	0.15 Carbon Nickel	0.10–0.20 (0.15)	0.50–0.80 (0.65)	0.04	0.04	3.25–3.75 (3.50)	G H or K	35,000–45,000	(H or K) 40,000–80.000	45–65	40–65	25–35	15–35
	0.20 Carbon Nickel	0.15–0.25 (0.20)	0.50–0.80 (0.65)	0.04	0.04	3.25–3.75 (3.50)	G H or K	40,000–50,000	(H or K) 50,000–125,000	40–65	40–65	20–30	10–25
	0.25 Carbon Nickel	0.20–0.30 (0.25)	0.50–0.80 (0.65)	0.04	0.04	3.25–3.75 (3.50)	G H or K	40,000–50,000	(H or K) 60,000–130,000	40–60	30–60	20–30	10–25
	0.30 Carbon Nickel	0.25–0.35 (0.30)	0.50–0.80 (0.65)	0.04	0.04	3.25–3.75 (3.50)	H or K	45,000–55,000	65,000–150,000	35–55	25–55	15–25	10–25
	0.35 Carbon Nickel	0.30–0.40 (0.35)	0.50–0.80 (0.65)	0.04	0.04	3.25–3.75 (3.50)	H or K	45,000–55,000	65,000–160,000	35–55	25–55	15–25	10–25
	0.40 Carbon Nickel	0.35–0.45 (0.40)	0.50–0.80 (0.65)	0.04	0.04	3.25–3.75 (3.50)	H or K	55,000–70,000	70,000–200,000	30–50	15–55	15–25	5–20
	0.45 Carbon Nickel	0.40–0.50 (0.45)	0.50–0.80 (0.65)	0.04	0.04	3.25–3.75 (3.50)	H or K	55,000–70,000	70,000–200,000	30–50	15–55	15–25	5–20
	0.50 Carbon Nickel	0.45–0.55 (0.50)	0.50–0.80 (0.65)	0.04	0.04	3.25–3.75 (3.50)	H or K	55,000–70.000	70.000–200,000	30–50	15–55	15–25	5–20

* Phosphorus and sulphur not to exceed values given.
Values within parentheses are preferred percentages.
Data given is based on, and condensed from, the report of the Iron and Steel Division of the Society of Automobile Engineers, January, 1912.

† See Table IV for detailed description of heat treatment.

COMPOSITION, HEAT TREATMENT AND PROPERTIES OF CARBON AND NICKEL STEELS—II

Kind of Steel and General Designation		Carbon, Per Cent	Manganese, Per Cent	Phosphorus,* Per Cent	Sulphur*, Per Cent	Nickel, Per Cent	Chromium, Per Cent	Heat Treatment†	Elastic Limit, Pounds per Square Inch		Reduction in Area, Per Cent		Elongation in 2 Inches Per Cent	
									Annealed	Heat Treated	Annealed	Heat Tr'ted	Annealed	Heat Treated
Low Nickel-Chromium Steels	0.15 Carbon Low Ni-Cr	0.10–0.20 (0.15)	0.50–0.80 (0.65)	0.04	0.04	1.00–1.50	0.30–0.75	G H or K	30.000–40,000	(H or K) 40,000–100,000	40–55	40–65	25–35	15–25
	0.20 Carbon Low Ni-Cr	0.15–0.25 (0.20)	0.50–0.80 (0.65)	0.04	0.04	1.00–1.50	0.30–0.75	G H or K	30,000–40,000	(H or K) 40 000–100,000	40–55	40–65	25–35	15–25
	0.25 Carbon Low Ni-Cr	0.20–0.30 (0.25)	0.50–0.80 (0.65)	0.04	0.04	1.00–1.50	0.30–0.75	H or K	40,000–55,000	50,000–125,000	35–50	25–55	20–30	10–25
	0.30 Carbon Low Ni-Cr	0.25–0.35 (0.30)	0.50–0.80 (0.65)	0.04	0.04	1.00–1.50	0.30–0.75	H or K	40,000–55,000	50,000–125,000	35–50	25–55	20–30	10–25
	0.35 Carbon Low Ni-Cr	0.30–0.40 (0.35)	0.50–0.80 (0.65)	0.04	0.04	1.00–1.50	0.30–0.75	H or K	45,000–60,000	55,000–150,000	30–45	25–50	15–25	5–20
	0.40 Carbon Low Ni-Cr	0.35–0.45 (0.40)	0.50–0.80 (0.65)	0.04	0.04	1.00–1.50	0.30–0.75	H or K	45,060–60.000	55,000–150.000	30–45	25–50	15–25	5–20
	0.45 Carbon Low Ni-Cr	0.40–0.50 (0.45)	0.50–0.80 (0.65)	0.04	0.04	1.00–1.50	0.30–0.75	K	55,000–70,000	60,000–175,000	30–50	20–45	15–25	5–15
	0.50 Carbon Low Ni-Cr	0.45–0.55 (0.50)	0.50–0.80 (0.65)	0.04	0.04	1.00–1.50	0.30–0.75	K	55,000–70.000	60,000–175,000	30–50	20–45	15–25	5–15
Medium Nickel-Chromium Steels	0.15 Carbon Med. Ni-Cr	0.10–0.20 (0.15)	0.30–0.60 (0.45)	0.04	0.04	1.50–2.00 (1.75)	0.75–1.25 (0.75)	G H or K	35,000–45.000	(H or K) 45,000–110,000	45–55	35–65	20–30	10–25
	0.20 Carbon Med. Ni-Cr	0.15–0.25 (0.20)	0.30–0.60 (0.45)	0.04	0.04	1.50–2.00 (1.75)	0.75–1.25 (1.00)	G H or K	35,000–45.000	(H or K) 45,000–110,000	45–55	35–65	20–30	10–25
	0.25 Carbon Med. Ni-Cr	0.20–0.30 (0.25)	0.30–0.60 (0.45)	0.04	0.04	1.50–2.00 (1.75)	0.75–1.25 (1.00)	H or K	40,000–50,000	55,000–130,000	40–55	30–60	20–30	10–25
	0.30 Carbon Med. Ni-Cr	0.25–0.35 (0.30)	0.30–0.60 (0.45)	0.04	0.04	1.50–2.00 (1.75)	0.75–1.25 (1.00)	H or K	45,000–50,000	55,000–150,000	35–50	30–55	15–25	10–25
	0.35 Carbon Med. Ni-Cr	0.30–0.40 (0.35)	0.30–0.60 (0.45)	0.04	0.04	1.50–2.00 (1.75)	0.75–1.25 (1.00)	H or K	45,000–55.000	60,000–160,000	35–50	30–55	15–25	5–20
	0.40 Carbon Med. Ni Cr	0.35–0.45 (0.40)	0.30–0.60 (0.45)	0.04	0.04	1.50–2.00 (1.75)	0.75–1.25 (1.00)	H or K	50,000–60,000	60.000–175,000	35–45	25–50	15–25	5–20
	0.45 Carbon Med. Ni-Cr	0.40–0.50 (0.45)	0.30–0.60 (0.45)	0.04	0.04	1.50–2.00 (1.75)	0.75–1.25 (1.00)	K	55,000–65,000	100,000–200,000	35–45	20–35	15–25	0–15

* Phosphorus and sulphur not to exceed values given.
Values within parentheses are preferred percentages.
Data given is based on, and condensed from, the report of the Iron and Steel Division of the Society of Automobile Engineers, January, 1912.

† See Table IV for detailed description of heat treatment.

COMPOSITION, HEAT TREATMENT AND PRORERTIES OF CARBON AND NICKEL STEELS—III

	Kind of Steel and General Designation	Carbon, Per Cent	Manganese, Per Cent	Ph'sphorus,* Per Cent	Sulphur,* Per Cent	Nickel, Per Cent	Chromium, Per Cent	Vanadium†, Per Cent	Heat Treatment‡	Elastic Limit, Pounds per Square Inch		Reduction in Area, Per Cent		Elongation in 2 Inches, Per Cent	
										Annealed	Heat Treated	Annealed	Heat Tr'ted	Annealed	Heat Treated
High Nickel-Chromium Steels	0.15 Carbon High Ni-Cr	0.10-0.20 (0.15)	0.30-0.60 (0.45)	0.04	0.04	3.25-3.75 (3.50)	1.25-1.75 (1.50)	......	L	40,000-50,000	....	45-60	.....	20-25	.....
	0.20 Carbon High Ni-Cr	0.15-0.25 (0.20)	0.30-0.60 (0.45)	0.04	0.04	3.25-3.75 (3.50)	1.25-1.75 (1.50)	......	L M or P	40,000-50,000	(M or P) 50,000-125,000	45-60	30-65	20-25	5-20
	0.25 Carbon High Ni-Cr	0.20-0.30 (0.25)	0.30-0.60 (0.45)	0.04	0.04	3.25-3.75 (3.50)	1.25-1.75 (1.50)	......	M or P	40,000-50,000	60,000-140,000	45-60	30-65	20-25	5-20
	0.30 Carbon High Ni-Cr	0.25-0.35 (0.30)	0.30-0.60 (0.45)	0.04	0.04	3.25-3.75 (3.50)	1.25-1.75 (1.50)	......	M or P	45,000-55,000	60,000-175,000	40-55	30-60	15-25	5-20
	0.35 Carbon High Ni-Cr	0.30-0.40 (0.35)	0.30-0.60 (0.45)	0.04	0.04	3.25-3.75 (3.50)	1.25-1.75 (1.50)	......	M or P	45,000-55,000	60,000-175,000	40-55	30-60	15-25	5-20
	0.40 Carbon High Ni-Cr	0.35-0.45 (0.40)	0.30-0.60 (0.45)	0.04	0.04	3.25-3.75 (3.50)	1.25-1.75 (1.50)	......	P	50,000-60,000	65,000-200,000	40-50	20-50	15-25	0-15
	0.45 Carbon High Ni-Cr	0.40-0.50 (0.45)	0.30-0.60 (0.45)	0.04	0.04	3.25-3.75 (3.50)	1.25-1.75 (1.50)	......	Q	50,000-60,000	150,000-250,000	40-50	15-25	15-25	0-15
Chromium-Vanadium Steels	0.15 Carbon Cr-Va	0.10-0.20 (0.15)	0.50-0.80 (0.65)	0.04	0.04	....	0.70-1.10 (0.90)	0.12 (0.18)	S or T	35,000-45,000	(T) 50,000-90,000	50-70	40-70	25-30	10-25
	0.20 Carbon Cr-Va	0.15-0.25 (0.20)	0.50-0.80 (0.65)	0.04	0.04	....	0.70-1.10 (0.90)	0.12 (0.18)	T	40,000-50,000	55,000-100,000	50-65	45-65	20-30	10-25
	0.25 Carbon Cr-Va	0.20-0.30 (0.25)	0.50-0.80 (0.65)	0.04	0.04	....	0.70-1.10 (0.90)	0.12 (0.18)	T	40,000-50,000	55,000-100,000	50-65	45-65	20-30	10-25
	0.30 Carbon Cr-Va	0.25-0.35 (0.30)	0.50-0.80 (0.65)	0.04	0.04	....	0.70-1.10 (0.90)	0.12 (0.18)	T	45,000-55,000	60,000-150,000	50-60	25-55	20-25	5-15
	0.35 Carbon Cr-Va	0.30-0.40 (0.35)	0.50-0.80 (0.65)	0.04	0.04	....	0.70-1.10 (0.90)	0.12 (0.18)	T	45,000-55,000	60,000-150,000	50-60	25-55	20-25	5-15
	0.40 Carbon Cr-Va	0.35-0.45 (0.40)	0.50-0.80 (0.65)	0.04	0.04	....	0.70-1.10 (0.90)	0.12 (0.18)	T	50,060-60,000	65,000-175,000	45-55	15-50	15-25	2-15
	0.45 Carbon Cr Va	0.40-0.50 (0.45)	0.50-0.80 (0.65)	0.04	0.04	....	0.70-1.10 (0.90)	0.12 (0.18)	U	55,000-65,000	150,000-200,000	40-55	10-25	15-25	2-10
	0.50 Carbon Cr-Va	0.45-0.55 (0.50)	0.50-0.80 (0.65)	0.04	0.04	....	0.70-1.10 (0.90)	0.12 (0.18)	U	60,000-70,000	150,000-200,000	35-50	15-35	15-20	2-16

* Phosphorus and sulphur not to exceed values given.
† Vanadinm content not to be less than 0.12 per cent.
‡ See Table IV for detailed description of heat treatment.
Values within parentheses ar preferred percentages.
Data given is based on, and condensed from, the report of the Iron and Steel Division of the Society of Automobile Engineers, January, 1912.

No. 155, Data Sheet, MACHINERY, June, 1912

COMPOSITION, HEAT TREATMENT AND PROPERTIES OF CARBON AND NICKEL STEELS—IV

The heat treatments given below refer to the treatments specified for various kinds of steel in the three accompanying tables.

Heat Treatment A.

After forging or machining:
1. Carbonize at a temperature between 1600° F. and 1750° F. (1650°-1700° F. desired).
2. Cool slowly or quench.
3. Reheat to 1450°-1500° F. and quench.

Heat Treatment B.

After forging or machining:
1. Carbonize at a temperature between 1600° F. and 1750° F. (1650°-1700° F. desired).
2. Cool slowly in the carbonizing mixture.
3. Reheat to 1500°-1550° F.
4. Quench.
5. Reheat to 1400°-1450° F.
6. Quench.
7. Draw in hot oil at a temperature which may vary from 300° to 450° F., depending upon the degree of hardness desired.

Heat Treatment C.

After forging or machining:
1. Heat to 1475°-1525° F.
2. Quench.
3. Reheat to 600°-1200° F. and cool slowly.

Heat Treatment D.

After forging or machining:
1. Heat to 1500°-1550° F.
2. Quench.
3. Reheat to 1400°-1450° F.
4. Quench.
5. Reheat to 600°-1200° F. and cool slowly.

Heat Treatment E.

After forging or machining:
1. Heat to 1500°-1550° F.
2. Cool slowly.
3. Reheat to 1400°-1450° F.
4. Quench.
5. Reheat to 600°-1200° F. and cool slowly.

Heat Treatment F.

After shaping or coiling:
1. Heat to 1425°-1475° F.
2. Quench in oil.
3. Reheat to 400°-800° F., in accordance with degree of temper desired, and cool slowly.

Heat Treatment G.

After forging or machining:
1. Carbonize at a temperature between 1600° F. and 1750° F. (1650°-1700° F. desired).
2. Cool slowly in carbonizing material.
3. Reheat to 1450°-1525° F.
4. Quench.
5. Reheat to 1300°-1400° F.
6. Quench.
7. Reheat to a temperature from 250°-500° F. (in accordance with the necessities of the case) aud cool slowly.

Heat Treatment H.

After forging or machining:
1. Heat to 1500°-1550° F.
2. Quench.
3. Reheat to 600°-1200° F. and cool slowly.

Heat Treatment K.

After forging or machining:
1. Heat to 1500°-1550° F.
2. Quench.
3. Reheat to 1300°-1400° F.
4. Queuch.
5. Reheat to 600°-1200° F. and cool slowly.

Heat Treatment L.

After forging or machining:
1. Carbonize at a temperature between 1600° F. and 1750° F. (1650°-1700° F. desired).
2. Cool slowly in the carbonizing mixture.
3. Reheat to 1400°-1500° F.
4. Quench.
5. Reheat to 1300°-1400° F.
6. Quench.
7. Reheat to 250°-500° F. and cool slowly.

Heat Treatment M.

After forging or machining:
1. Heat to 1450°-1500° F.
2. Quench.
3. Reheat to a temperature between 500° F. and 1250° F. and cool slowly.

Heat Treatment P.

After forging or machining:
1. Heat to 1450°-1500° F.
2. Quench.
3. Reheat to 1375°-1425° F.
4. Quench.
5. Reheat to a temperature between 500° F. and 1250° F. and cool slowly.

Heat Treatment Q.

After forging:
1. Heat to 1475°-1525° F. (Hold at this temperature one-half hour, to insure thorough heating.)
2. Cool slowly.
3. Reheat to 1450°-1500° F.
4. Quench.
5. Reheat to 250°-550° F. and cool slowly.

Heat Treatment S.

After forging or machining:
1. Carbonize at a temperature between 1600° F. and 1750° F. (1650°-1700° F. desired).
2. Cool slowly in the carbonizing mixture.
3. Reheat to 1600°-1700° F.
4. Queuch.
5. Reheat to 1475°-1550° F.
6. Quench.
7. Reheat to 250°-550° F. and cool slowly.

Heat Treatment T.

After forging or machining:
1. Heat to 1600°-1700° F.
2. Quench.
3. Reheat to some temperature between 500° F. and 1300° F. and cool slowly.

Heat Treatment U.

After forging:
1. Heat to 1525°-1600° F. (Hold for about one-half hour.)
2. Cool slowly.
3. Reheat to 1650°-1700° F.
4. Quench.
5. Reheat to 350°-550° F. and cool slowly.

No. 155, Data Sheet, MACHINERY, June, 1912

MACHINERY

June, 1912

FORCE-MAKING FOR EMBOSSING DIES

By CHESTER L. LUCAS*

THE term "force" is used in connection with die sinking, but the words "force" and "hub" are often confused by those who are not familiar with this work. A hub is a hardened steel punch used to form an impression in a die. Usually the die is heated to facilitate this operation. Only a small percentage of dies require the use of a hub, but there are some designs that are more easily cut "on the hub." A die having flat panels with projecting lines, as illustrated in Fig. 9, would be very difficult to make without a hub, and so would one in which a number of letters or parts of the design had flat faces cut to the same depth, as shown in Fig. 10. After the dies are made, the work of the hub is done, unless duplicate dies are to be made at some future time.

A "force," or "forcer," is, as its name implies, a block of metal which *forces* sheet stock into every crevice in the impression of a die. A force is probably used with nine out of every ten embossing dies. The exceptions are dies in which the design is extremely shallow and the metal relatively thick, and dies for emblems, buttons or similar work in which the design is so intricate that a force would be of no advantage. "Strikings" to illustrate these cases are shown at *A*, *F*, *G*, *M*, *N*, *O*, and *R*, Fig. 1. In such cases the metal is simply driven into the impression by a flat steel block held in the hammer of the press. This block is often called a flat force, and is usually made by heating a piece of round bar steel, about two inches long, laying it on a plain hard die block in the press, and striking several blows upon it with the hammer of the press, in which has been mounted a "pick-up." One of these pick-ups is shown in Fig. 8. The flat force is hardened and tempered to a light straw color.

Fig. 2 illustrates four embossing dies for which forces would be required, and Fig. 3 shows a group of forces, those at *A* and *D* being made of copper and the rest of steel. Those at *B* and *C* show the reverse sides with the ridges formed by the pick-up. In Fig. 4 are shown, in place, the die *A*, the force *B*, and the pick-up *C*, keyed in the hammer of the press, which is illustrated at *D*.

Forces are made from different materials, depending upon the character of the work, the design of the die, and the thickness of the metal being stamped. In determining the material from which a force shall be made it is quite important that the number of impressions be taken into consideration. Thus, if only fifty or one hundred impressions are to be made, it would be inexpedient to make a steel force.

Tin or Lead Forces

Tin or lead forces are used for embossing dies where the designs are large and no small detail is required, and the material to be stamped is soft, like brittania metal or silver. Tin is, by far, the better of these two metals, but often lead is employed in its place. The stampings shown at *C* and *P*, Fig. 1, are easily made by means of tin forces. The metal is soft and thin and the detail is not too complicated. The method of making a tin or lead force is to surround the design on the die with a wall of putty. The molten tin or lead is then poured into this enclosure and allowed to set. This operation can often be performed without removing the die from the press. As soon as the metal has cooled, the putty is removed from the die and the hammer brought down upon the tin or lead casting. The blow thus struck imbeds the top side of the force into the pick-up of the hammer and sharpens the face of the force, leaving it ready for use.

A typical job upon which this class of force is employed is shown set up in the press in Fig. 5. The work being stamped is a silver hand-mirror mounting. The lead force for this job may be seen imbedded in the pick-up of the press, which has

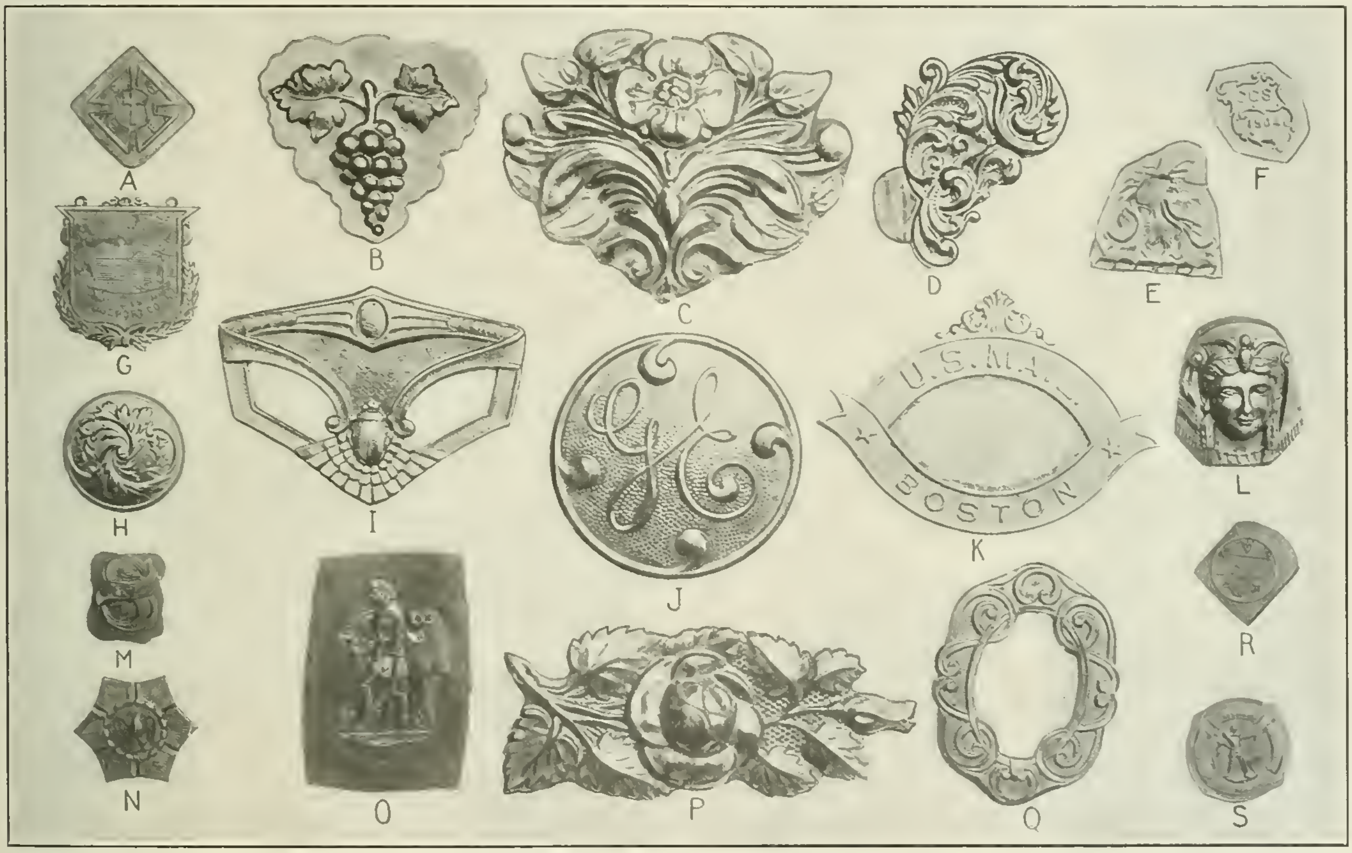

Fig. 1. Stampings from Embossing Dies involving Use of Forces of Various Kinds

a series of parallel slots extending both ways across its face, enabling it to hold the large lead force firmly. In the stampings shown in front of the die, holes have been punched at the center of the impression. This is done to allow the metal to "pull" evenly in forming the design, thereby lessening the danger of cracking or causing thin spots in the work. Beside these stampings is shown a lead force that has just been removed from one of the other presses. Lead or tin forces are very short-lived, but as they are extremely easy to make, they are profitable to employ if the character of the work permits it.

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* Associate Editor of MACHINERY.

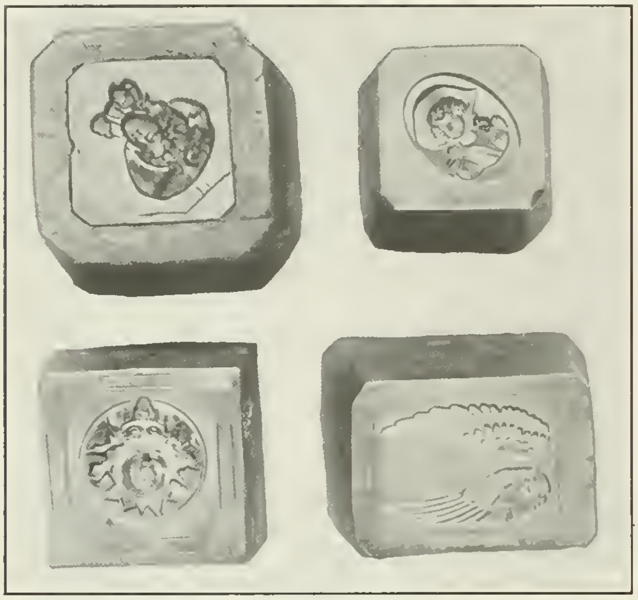
Fig. 2. Embossing Dies requiring Forces

Cast Brass Forces

On long runs of soft metal stamping, when it would be too slow to stop and renew the lead force many times, cast brass forces are made. A plaster of Paris pattern is first made, and after being cut away in certain places and built up at the ends to anticipate the loss from shrinkage of the brass, a casting is made. After filing up this casting, it is fitted to the pick-up and struck into the die to bring up the design. It is relieved where necessary, and is then ready for use. Fig. 6 shows a pattern for a brass force.

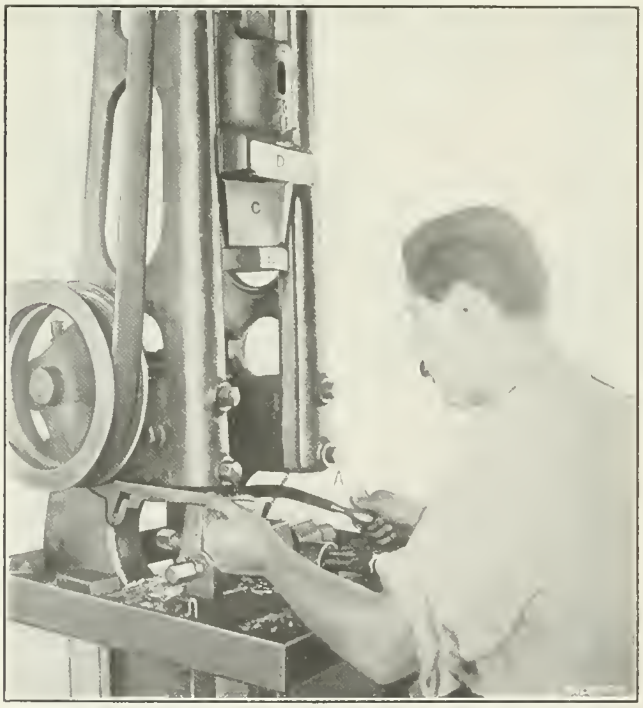

Fig. 4. Showing the Use of Embossing Die, Force and Pick-up

Copper Forces

For work in which the requirements are somewhat more severe than in the work just described, copper forces are generally used. They are especially useful in striking up small gold emblems which are too deep to be successfully made with a flat block for the top die. One of these designs is shown at *S*, Fig. 1. Copper forces are seldom used for work over one and one-half or two inches in diameter. They are made by taking a blank piece of sheet copper from 1/16 to 1/8 inch thick, placing it on the die, and striking it into the impression. This operation is performed without heating the metal. In order to get the force "full," it is often necessary to anneal it and restrike it several times. It is then finally placed in the die with a small piece of beeswax on top of it, and is "picked up" on the flat top die. The metal blanks are then struck up in the usual manner.

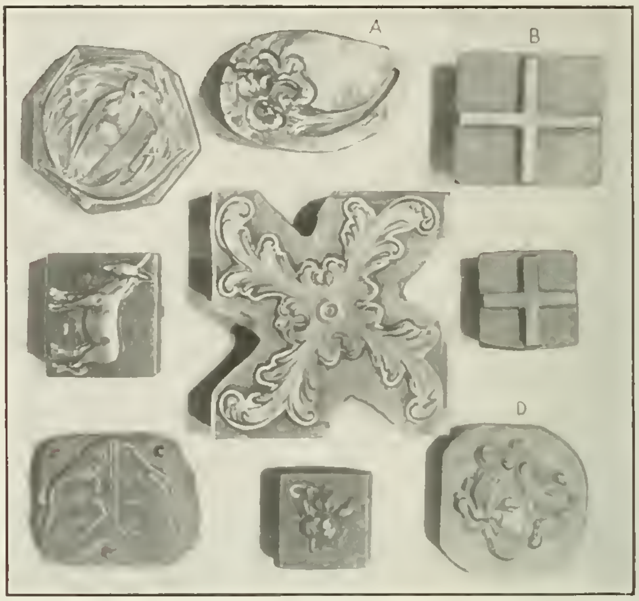

Fig. 3. Copper and Steel Forces

Difficult cases require that the blanks be run through a first operation consisting of striking them into the impression of the die; this being done, they are struck a second blow, which is often so severe that the copper force is loosened from the hammer at each blow. It is, however, an easy matter to lay the partly formed blanks in the die, place the copper force on top, seated in the impression in the partly formed blank, and proceed with the striking. Thus it is immaterial whether the force sticks to the top die or not.

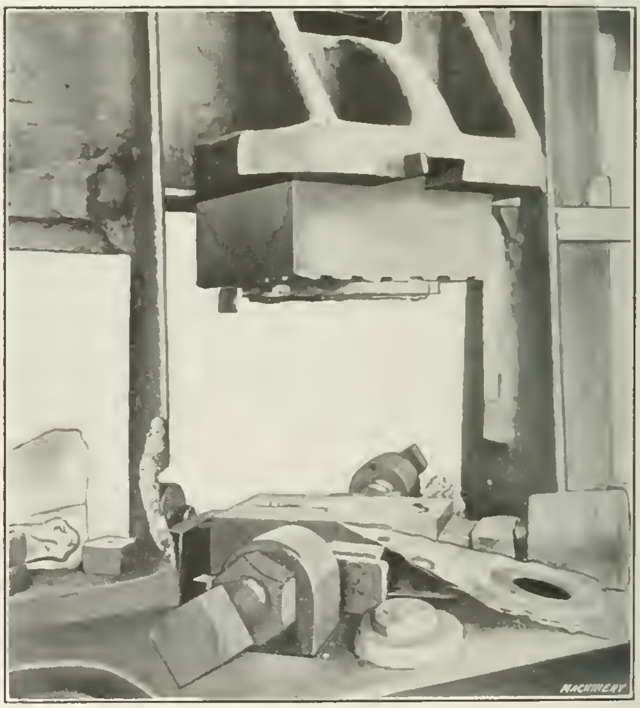

Fig. 5. Lead Force in Use

Copper forces are also used for striking up deep articles in which the requirements are too severe for tin or lead forces, because of the metal being excessively hard or thick. The samples shown at *H* and *L*, Fig. 1, should be made by using copper forces. A force for this class of work is made by heating a piece of bar copper to a red heat, placing it on the die which has been previously set up in position in the press with a pick-up in the hammer, and striking it repeatedly into the die impression until every detail of the design is plainly visible on the force. During this striking operation it is necessary to clean out the die after each blow, either by an air blast or with a wire brush. The whole operation must be carried through as rapidly as possible in order to get the force "up" at the first heat, because a second heat produces an inferior force, on account of the softening of the metal on reheating. The copper force is left in the pick-up, and while cooling, is struck into the die at intervals to make up for the shrinkage. If the design is fairly symmetrical in all directions, the result of the shrinkage will be negligible, but if the design is long and narrow, trouble generally arises, a point which will be touched upon more fully in the following.

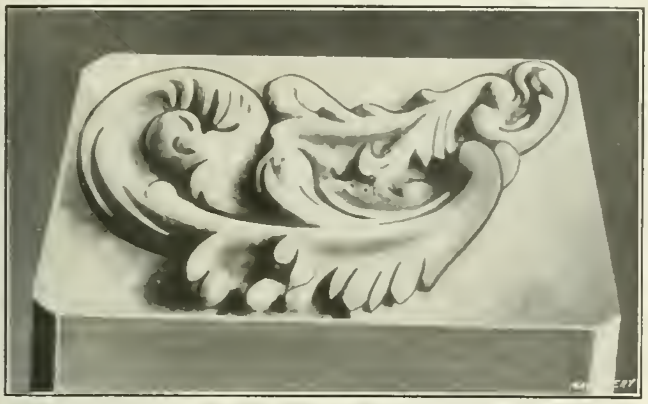

Fig. 6. Plaster of Paris Pattern for a Brass Force

Soft Steel Forces

Soft steel forces are employed in many shops in preference to hardened tool-steel forces because there is less danger of the die being injured by careless operators. If a hardened force, for instance, is struck into the die without any work being placed in it, the die will be injured. In general, soft steel forces are employed in cases where a lead, tin or copper force would not stand up to the requirements, and yet a tool-steel force is not required. A typical piece of work of this character is shown at *K*, Fig. 1.

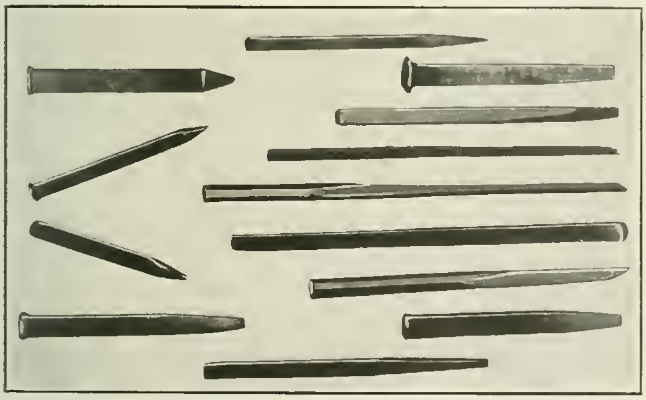

Fig. 7. Chisels and Punches used in Fitting and Relieving Forces

Another case in which it is advantageous to use soft steel forces is where the trouble caused by shrinkage would be great, and it is, therefore, considered best to work up the force cold. This is especially true of forces for name-plate dies where the letters are weak and narrow. A force cannot be made cold, however, without a great deal of trouble, unless the design is fairly shallow and of even depth.

When working up a machine-steel force cold, the outline of the blank should first be machined to approximately match the impression of the die. The face of the force should then be covered with a thin coating of solder. This is best accomplished by flowing solder over the face of the force, afterwards wiping off the surplus with a piece of clean waste. In this condition the force is laid upon the die in the press, care being taken to have its face match that of the impression in the die, after which a fairly hard blow is struck upon the top side of the force. This will leave an impression upon the force-face; the steel may be chipped off from the parts of the force where it is not needed, as shown in Fig. 17, and the force refitted in the die and struck again. This process is repeated until every detail of the force comes up sharp. Sometimes it is advantageous to use punches to drive the metal down and out of the way rather than to try and chip it away with chisels. Some of these punches are shown in Fig. 7, and the method of doing the work is illustrated in Fig. 18.

The advantage of working up a force cold, as mentioned, is that the problem of shrinkage does not enter into the work. The shrinkage of a force is illustrated by Figs. 11, 12 and 13. Fig. 11 shows the face of a die with the impression of a long narrow scroll cut in it. In working up a force for this design, it should be done cold, if possible, and the force will then fit as shown in Fig. 12. If, however, it is thought best to try to make the force hot, the result will generally be as shown in Fig. 13, in which the force, while a good fit for the die when hot, shrank in cooling. The shrinkage of the force may be evened up by distributing the poor fit in both directions and by favoring the worst places during the relieving. By doing a little driving over of the metal and with the aid of a few impressions struck cold, the force may be made passable. It takes, of course, a great deal more skill to make a force cold than it does to fit it hot, but for designs resembling that in Fig. 11, the force should be made cold if possible.

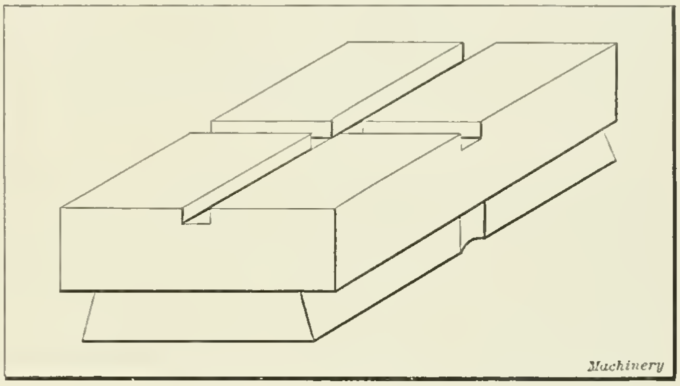

Fig. 8. One Form of Pick-up

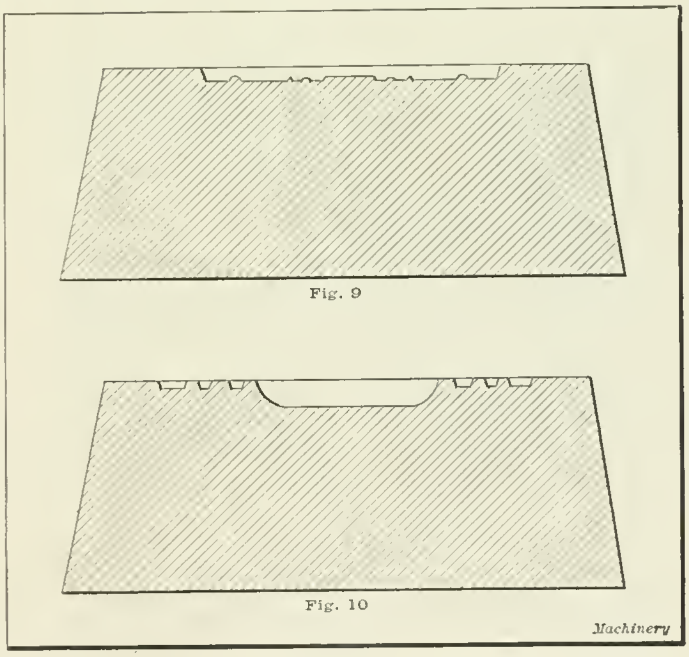

Fig. 9

Fig. 10

Figs. 9 and 10. Types of Dies that can best be made by Use of Hubs

Hardened Steel Forces

Without doubt, the majority of forces used for the ordinary run of brass and copper work are made of tool steel and hardened. This is necessary either on account of the toughness of the metal being worked, the thickness of the stock, or the large number of impressions to be produced.

For making a force of this character, Jessop's steel is considered the best. Other brands of steel on the market are, however, used to good advantage, and no doubt the use of Jessop's steel may be traced to the fact that it has been a good, well-known steel for so many years back. In selecting the stock for a force of this kind, the shape of the blank piece of steel should depend upon the design of the die. While a good many force-makers simply cut off a piece of square or round steel from the bar, heat it, and strike it into the die, there are many cases when the force could be more quickly made by using a blank that had been carefully prepared by machining. Such an instance is illustrated in Figs. 14 and 15. In these two illustrations the impressions in the dies are alike. In Fig. 14, a flat block of steel is shown being struck into the die. The idea of this illustration is to bring out the fact that it is very difficult to get the center of the force "full" when using a blank of this shape, because the steel at the sides retards the central part of the blank from flowing into the impression in the die. To overcome this tendency, the force-blank should be turned in a lathe so as to round the ends about as shown in Fig. 15. When a force-blank of this shape is struck into the die, the first part of the impression to be filled is the center. The last part of the impression to be filled, and the easiest, is the outside edge of the design.

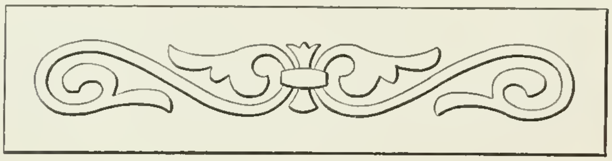
Fig. 11

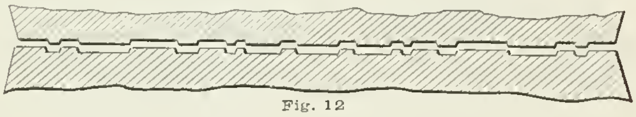
Fig. 12

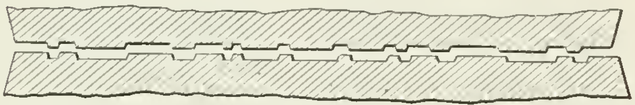
Fig. 13

Fig. 11. Design of a Die whose Force can best be made Cold. Fig. 12. Illustrating the Way a Force must fit the Die. Fig. 13. Showing the Effect of Shrinkage

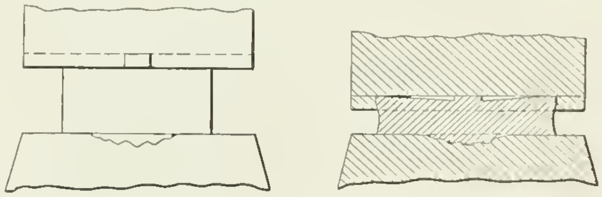
Fig. 14

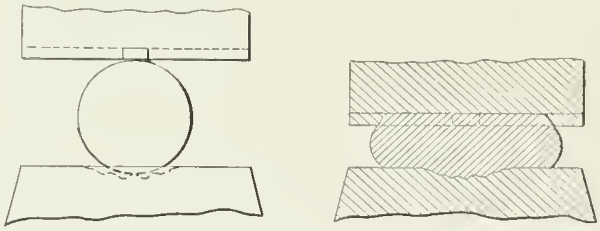
Fig. 15

Fig. 14. Making a Force from a Flat Piece of Steel. Fig. 15. Making a Force from a Round Piece of Steel

In striking up a force, there are several essential points to be borne in mind. Among these the most important is to have the ways of the drop press adjusted so that there will be a minimum amount of shake to the hammer; the die should be solidly held in place by the poppet screws, care being taken to see that it rests on an even base on the bed of the press. The edges of the grooves in the pick-up should also be in good condition. After heating the blank to a bright red heat, it should at once be carried to the die and laid in the proper position and struck immediately. In striking, the heaviest blows should be struck at the beginning, picking the force up at the first blow if possible, as the hot steel should not be kept in contact with the face of the die any longer than possible. During the operation of striking up the force, the scale formed should be brushed off the die as rapidly as possible after each blow with a wire brush, or, better still, with an air blast. It is often necessary to use a second or even a third heat. If the design is fairly regular in outline and the impression does not have too much detail, the force may be struck into the die at short intervals while cooling in its position on the pick-up, which will, in a measure, reduce the evils of shrinkage.

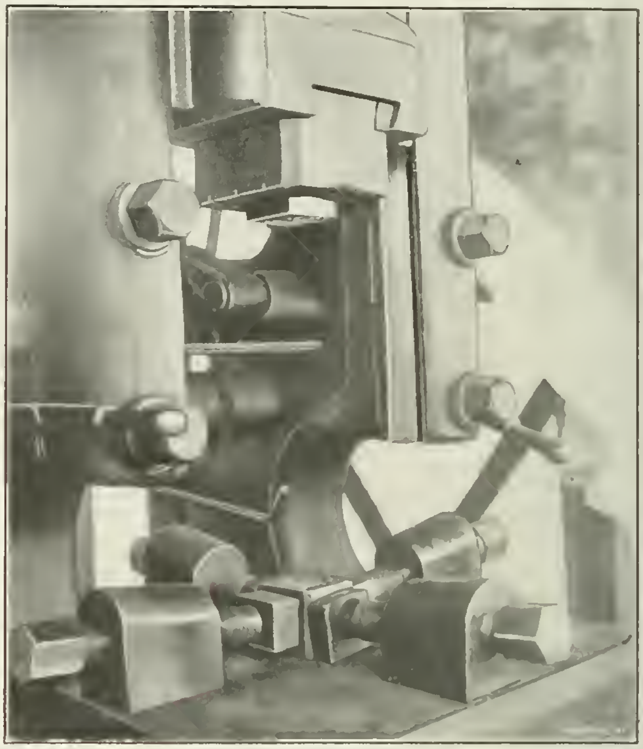
Fig. 16. Striking the Force in Cold

In order to make it possible to grip the force while working on the face, the first operation after striking consists in squaring up the edges in the shaper. It is usually necessary to anneal the force before it can be machined. At this time the machine work necessary for the relieving (which will be referred to later) can also be done. In addition, the ribs on the back of the force should be peened out to fit the slots in the pick-up, for, in cooling, these ribs have shrunk until they are a loose fit in the slots. In some shops forces are held in the pick-up from the back by means of screws engaging tapped holes in the force, but this is not good practice.

Fig. 17. Fitting and Relieving the Force—Chipping

Fitting and Relieving the Force

The fitting of a force consists in overcoming the "misfit" caused by shrinkage. This is accomplished by "driving" over all necessary parts, "stretching" the design toward the ends, and chipping off at the inside of the design. When nearly fitted, the force may be struck into the die cold a few times to properly shape the affected parts. Between these blows, it will usually be found that additional cutting or punching is necessary to facilitate the remainder of the work of fitting.

In order to produce good stampings from the force, certain parts of its face must be relieved. The amount of this relief depends upon the design, and especially upon the thickness of the metal being stamped. The first step in the relieving of the force consists in cutting away the metal from the background of the face of the force around the design to a depth slightly in excess of the thickness of the metal. This operation may be, and usually is, partly accomplished by machining in the shaper or lathe, going as close to the edge of the design as possible without running into it. In removing this metal, it is, of course, necessary to take the same depth from the interior of the design of a piece like that shown at *Q*, Fig. 1, as from the outside, so that the force will not strike hard at the center. On large rings, etc., the interior of the design can best be relieved in the lathe.

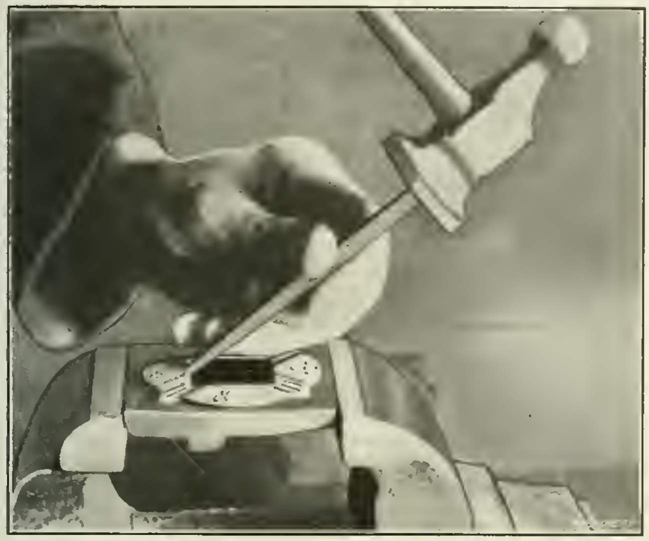
Fig. 18. Fitting and Relieving the Force—Driving up

The next step consists in chipping away the remainder of the metal up to the edge of the design as illustrated in Fig. 17. This being done, the metal must be removed from any straight portions of the design of the force. This will be more clearly understood by referring to Fig. 19—especially the section shown at *B*. If, on a design of this character, the force is not relieved on the sides, which in this case are very nearly straight, the effect of the blow upon the metal will thin the stock at the points *F*, *G*, *H*, and *I*, in the manner shown. To overcome such troubles, the force must be relieved at these and similar portions so as to produce a stamping of even thickness as shown at *C*. In this view it will be seen that the two ribs on the force are very much thinner than the corresponding impressions in the die, due to the fact that they have been relieved. At *A* is shown a force set into the impression of the die after having been properly relieved. It may be thought strange that the face of the force is not also relieved, but it must be remembered that it is the face of the design that receives the full effect of the blow, and all stock possible should be left on this part of the force. In order to leave the face of the force as high as possible, the stock is often punched or driven up from the sides, thereby forcing the face of the force higher than it formerly was. Occasionally there is a force which requires no relieving. Such an instance is shown at *D*, in which the design could be struck up without relieving the force at all, unless it be very slightly around the background outside of the design. At *E* is shown another instance where the sides must be relieved to permit the force to push the metal into the bottom of the design and act with the full blow upon the impression at this part of the die.

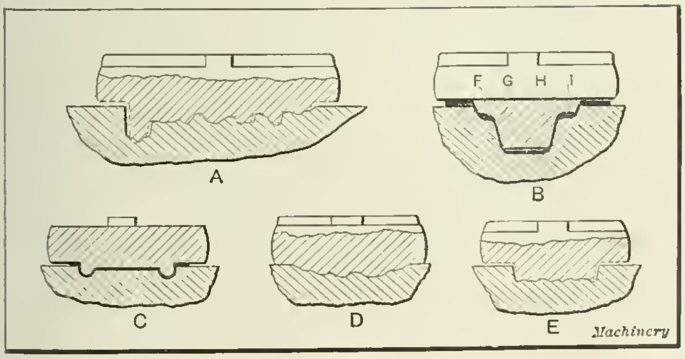

Fig. 19. Illustrating Points about Relieving Forces

The most difficult parts of a force to bring up are "matted" backgrounds, like those shown on parts *I* and *J*, Fig. 1. The detail is here too fine to be brought up by punches. The best way to take care of such places is to clean all scale from the surface and strike the force into the die, cold, several times. In stamping thin metal, the matted portions will not "come up" unless the force is perfectly fitted at these points. Moreover, it is seldom advisable to lower a matted background in relieving, for all possible pressure is needed to bring up the matting to the best advantage.

Hardening the Force

After the force had been fitted and relieved and a few stampings struck up to make sure that the work has been done right, the force may be hardened. The temper of the force should be drawn to a dark straw color. If there is little detail to the design it will be best to draw the temper to a purple color, especially if the metal being worked is hard, thereby lessening the risk of breaking the force while in use.

All of the presses shown were made by the Standard Machinery Co., Providence, R. I., and were photographed through the courtesy of Philip Vester & Brother, and George Parks Co., both of Providence, R. I.

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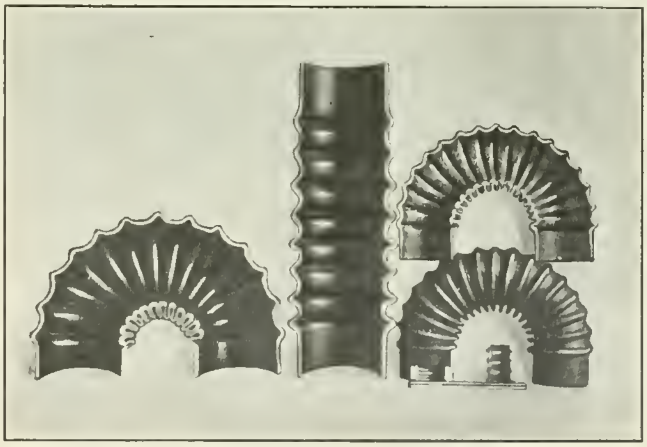
ELASTIC CORRUGATED TUBES

The accompanying illustration from *Engineering* shows a form of corrugated tube which has been designed for expansion joints, heating- and smoke-tubes, superheaters, condensers, etc., where the tubes are subjected to wide ranges of temperature. These tubes, instead of having a spiral corrugation, frequently seen in tubes made in the past, have corrugations parallel to one another. This method of construction is adapted to tubes made in a great range of sizes. Owing to the construction the tubes can be bent to a very small radius. They are manufactured with an inside diameter of from 1⅜ to 18 inches. The process of manufacture is claimed to be such that after pressing out the corrugations, the pipe retains its exact original internal diameter, and there is an absolute uniform thickness of the metal in all the parts.


Some Examples of Elastic Corrugated Tubes

The chief advantages claimed for these pipes are: That they are of great utility in all cases where the expansion or vibration of pipes has to be taken into consideration; that they are valuable as boiler tubes because of the increased heating surface and because they relieve the strain due to expansion and contraction; that they are well adapted for superheaters owing to the whirling motion given to the steam; that they are exceedingly well fitted for expansion joints; that they take up much less space than bends of ordinary piping, because the bends can be made much shorter; and that the stress on the flanges and connections is greatly reduced.

MACHINE FOR FORMING FLEXIBLE TUBING

By RICHARD TOEPLITZ*

Flexible tubing is extensively used in the automobile industry in connection with horns and speedometers, etc. The usual method of making this tubing is to form a length of ribbon stock and turn it over a revolving mandrel, at the same time making it airproof by running an asbestos cord between the single turns. This method has several disadvantages, the most prominent of which are the difficulty of freeing the finished tubing from the mandrel and the starting of a new piece of stock.

Briefly stated, the machine to be described in the following consists of a stationary mandrel supported by the frame of the machine, and a faceplate, which carries the forming rolls and the ribbon stock for the tubing, and which revolves on the mandrel. The formed tubing is pushed from the end of the mandrel as soon as formed, and is received by a special pair of rolls whose purpose it is to prevent the tubing from twisting. Referring to the illustrations, Fig. 1 shows the details of the tube forming machine; Fig. 2 shows the forming rolls together with a section of the formed stock; Fig. 3 shows a length of flexible tubing; and Fig. 4, the rolls which receive the tubing as it leaves the forming machine.

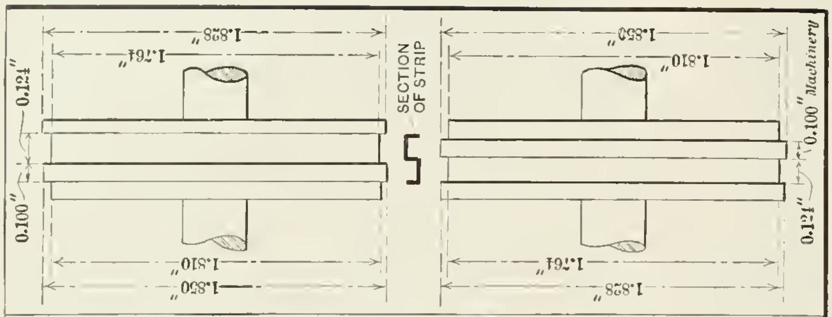


Fig. 2. Forming Rolls

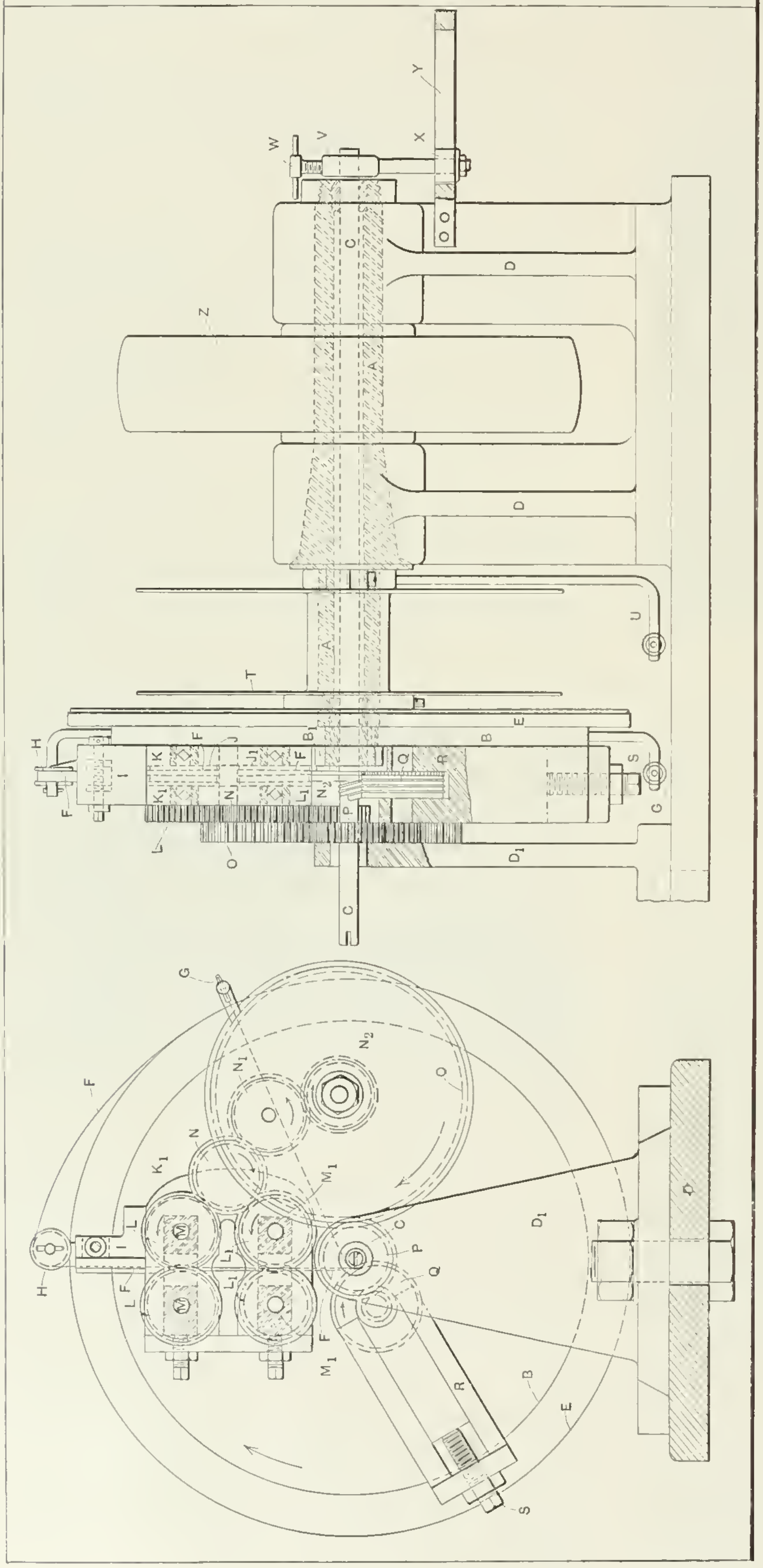


Fig. 1. Details of the Tube Forming Machine

The construction of the forming machine, Fig. 1, is as follows: On the main-shaft *A* of the machine is mounted the faceplate *B*. The main-shaft is hollow throughout its entire length to receive the mandrel *C*, which is supported by bushings at both ends. Shaft *A* runs in suitable bearings located in the main casting or frame *D* of the machine. On the reverse side of faceplate *B* is located a case *E*, which contains the ribbon stock from which the tubing is formed. This ribbon stock comes in the form of rolls and provision is made for readily replacing these rolls as they are used up. The ribbon stock *F* leaves case *E*, and running over roller *H* passes through bracket *I* to the forming rolls *J* and J_1. These forming rolls are an important factor in the operation of tube making, and are shown in detail in Fig. 2. Referring to this latter illustration, in which the rolls are shown approximately full size, it will be seen that the rolls are in reality dies, running together so that the projections on the one roll push the stock into depressions on the corresponding roll. The brass for which this set of rolls was made was 0.012 inch thick and 19/64 inch wide. The rolls are made of tool steel and hardened.

Returning to Fig. 1, the shafts *M* and M_1, upon which the forming rolls run, are mounted in suitable boxes which, in turn, are fitted in slides in the side plates *K* and K_1. By means of adjusting screws and check nuts, the rolls are kept in proper relation to each other, varying, of course, with the thickness of metal being formed. Keyed to the outer ends of shafts *M* and M_1 are gears *L* and L_1. These gears are cut with 29 teeth of 16 pitch, and both pairs are driven by means of gears *N*, N_1 and N_2, which also have 29 teeth. Gear N_2 is permanently attached to gear *O*, which has 105 teeth of 16 pitch. Gear *O* is mounted, together with the other mechanism previously described, upon faceplate *B*, and is driven by contact with the stationary gear *P* held upon the frame of the machine.

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* Address: 416 East 83rd St., New York City.

The face of the grooved roller *Q*, which corresponds exactly with the shape of the strip, is mounted in fixture *R* which is located on faceplate *B*, and is adjusted with relation to the center mandrel *C* by means of set-screw *S*. The function of this roller is to roll the stock into its circular form after it has left the forming rolls. Reel *T* is mounted on shaft *A* behind case *E* which carries the ribbon stock. A supply of asbestos cord is contained on this reel, the free end of which passes over guide roller *U* to guide roller *G*, from which it runs to the mandrel as may be seen in the front elevation view of Fig. 1. This cord is wound between the single turns of the metal and its function is to make the joints of the tubing air- and liquid-tight.

As before stated, mandrel *C* runs completely through the main shaft *A*. At the rear end of the machine a holder *V* is clamped to it by clamping screw *W*. At the lower end of this holder is mounted roll *X* which is free to turn. This roll engages a slot in bracket *Y* that is bolted to the machine at this point. The object of this holder is to prevent the mandrel from turning while the tubing is being formed, but it does not interfere with the longitudinal travel of the arbor within the limits of the slot in bracket *Y*.

Operation of the Machine

The machine is operated by starting a coil of brass ribbon over pulley *H* down through the forming rolls *J* and J_1. At the same time, the end of the asbestos cord is run over rolls *U* and *G* down to the mandrel *C*. Mandrel *C* is moved to its extreme "in" position, and the end of the formed ribbon is passed through the slot in the end of the mandrel. The end of the asbestos cord is also caught in this slot. The machine is turned about two revolutions by hand and care taken that the brass ribbon and asbestos cord are properly coiled; then the grooved roller *Q*, the right-hand side of which feeds into the formed strip of stock, is pressed against the tube and locked by the tension screw. The extreme right-hand ridge on this roll is very finely corrugated to assist in driving the brass strip, and, moreover, this roll is keyed to the same shaft as a gear which meshes with the stationary gear *P*. The action of this roller moves the tubing and mandrel forward until the holder *V* on the rear end of the mandrel touches the end of the slot in *Y*; then the machine is stopped and the end of the strip is removed from the slot in the mandrel; the mandrel is then pulled back, it being held from turning by means of holder *V*. The machine can now be run continuously, as long as the coil of stock in case *E* lasts. As the faceplate and shaft turn about the mandrel *C*, it is obvious that the entire chain of gearing, forming rolls and grooved roll *Q* revolve with the shaft about the stationary gear *P*.

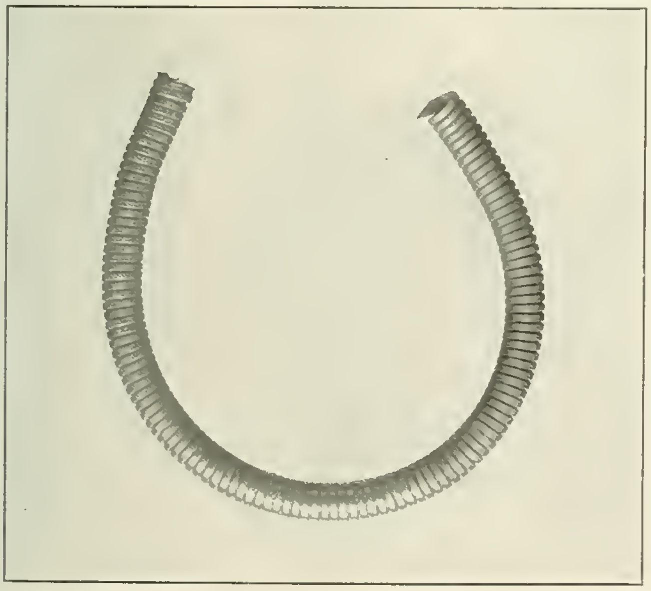

Fig. 3. Flexible Tubing

It is very important that the stock should be drawn through the forming rolls just fast enough to be taken up completely as it turns about the mandrel *C*; thus it will be very apparent that if stock which is thicker or thinner than 0.012 inch be used, or if the diameter of the tubing being formed is larger or smaller than in this instance, the gearing must be changed by substituting larger or smaller gears.

It has been found advantageous to guide the tube around the pulley *A*, Fig. 4, and to hold the tubing in place by roller *B* so that it cannot twist as it leaves the machine. This pulley *A*, being mounted on a shaft *C* upon the outer end of which is a handwheel *D*, enables the operator to coil up the tube as it is being formed.

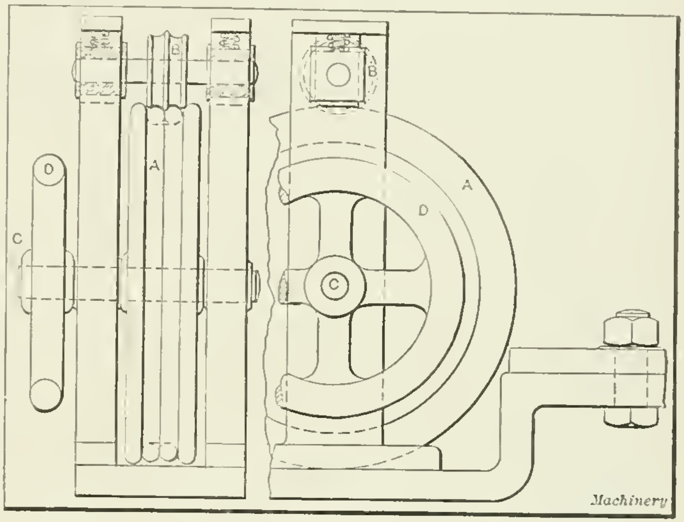

Fig. 4. Roller for receiving the Tubing after it leaves the Machine

After the supply of ribbon in case *E* has been exhausted, it may be replenished by moving back stand D_1, Fig. 1, and withdrawing the grooved roller *Q*. But B_1, on the end of main-shaft *A*, is then removed and plate *B* lifted off, thus making it possible to slip in a new coil of brass ribbon. The asbestos will last for several coils of brass. Should tubing of smaller or greater diameter be required, it is only necessary to remove the tube bushings at the ends of mandrel *C*, put the proper size mandrel and corresponding bushings in place, and change the gearing so that the speed at which the brass strip travels is equal to one turn around the mandrel for each revolution of the machine.

This machine, which is in successful operation, has required no repairs and is turning out an average of 225 pounds of tubing per day. A roll of ribbon weighing in the vicinity of 12 pounds will produce a continuous length of tubing about 70 feet long. The machine is run at a rate of 225 R. P. M. and at this speed will produce 30 inches of tubing per minute.

* * *

HEAT TREATMENT FOR VANADIUM TOOL STEEL

The George Hamilton Co., Providence, R. I., maker of figured rolls for rings, galleries, hubs, dies and tools, recommends the following treatment for vanadium tool steel in *American Vanadium Facts*. The brand "Hawk H" hardens very well in oil, water, brine, or sulphuric acid, but oil is preferred for the best results. In oil hardening, heat to between 1450 and 1550 degrees F. (dull cherry red) and then quench in oil. In hardening for toughness, draw to about 425 degrees F. (very faint yellow). In water hardening, heat to about 1400 degrees F. to get the best results.

* * *

TIME LOST WAITING FOR TRAINS

The traveler in the West who would go from town to town on local railway trains should count on wasting about one hour waiting for each train—but not always. If he could be sure that the trains would always be late he could allow for it and conserve his time, but, of course, if he does so the train he wants to take is likely to be on time. The annual loss of time of the traveling public through defective train service is enormous, and it is a serious indictment of railway management that such conditions generally prevail.

FORMING IRREGULAR-SHAPED SHELLS IN THE AUTOMATIC SCREW MACHINE

By S. NEVIN BACON

A tool-designer would be foolish to tool-up an automatic screw machine to produce parts which would naturally be made in a punch press, just because the operations would be interesting. When the pieces to be manufactured, however, require several machining operations in different departments, a screw machine, equipped with special tools, can sometimes be used to economize time by completing the work in one operation. At *A* in Fig. 1 is shown a shell made from a ⅞-inch brass rod, in which two holes of different diameters are drilled. The end of the piece in which the larger hole is drilled had to be formed to an oval shape, as shown at *B*, after the work had left the screw-machine department. The forming of the oval was at first accomplished in the press department, but was later produced with a hand-operated fixture. The piece is now completed in a No. 2 Brown & Sharpe automatic screw machine.

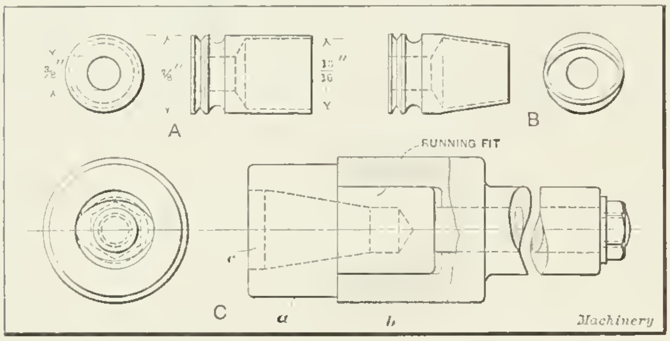

Fig. 1. The Oval-shaped Shell and the Tool used in Forming it

The operation of forming the oval is simple, being performed by the tool shown at *C* in Fig. 1, which is held in the turret. This tool, which is made in two parts, consists of a revolving former *a*, free to rotate as shown. Having the part *a* so that it revolves freely, avoids the necessity of stopping the machine spindle while shaping the oval. The hole at c is spherical and is gradually worked to an oval shape, so that in operation it is only necessary to press the tool forward over the stock to form the oval. The cam lobe for doing this operation is shown in Fig. 4 from 39 to 47 on the lead cam circle. The order of operations for making this piece is as follows:

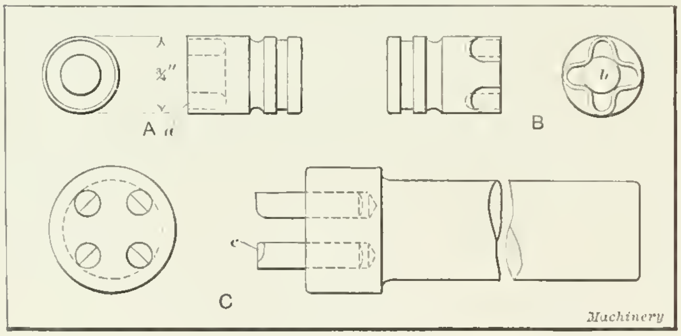

Fig. 2. An Irregular-shaped Shell and the Forming Tool used

Order of Operations	Revolutions	Hundredths
Feed stock to stop	13.5	3
Revolve turret	13.5	3
Drill large hole, 0.750 inch rise at 0.0092 inch feed	81.0	18
Revolve turret	13.5	3
Drill small hole, 0.500 inch rise at 0.0061 inch feed with turret drilling attachment, total speed 1200 R.P.M.	40.5	9
Revolve turret	13.5	3
Shape oval, 0.750 inch rise at 0.021 inch feed	36.0	8
Form, 0.070 inch rise at 0.001 inch feed	(72.0)	(16)
Cut off, 0.470 inch rise at 0.002 inch feed and revolve turret three times	229.5	51
Clearance	9.0	2
Total	450.0	100

The spindle is rotated contiuuously at 600 revolutions per minute, and it requires 45 seconds to make one piece, giving a gross product of 800 pieces in 10 hours.

Another interesting example of this class of work is shown in Fig. 3, where *A* is the piece partly completed, and *B* the finished piece which is made from a ¾-inch brass rod. To produce an elongated shape on the end of this piece in a No. 2 Brown & Sharpe automatic screw machine required much experimenting before it was successfully accomplished. The first operation is to rough-form the shell from the turret with the tool shown at *C* in Fig. 3. Then the turret is revolved and the tool *E* is placed in the hole in the work. This tool *E* dwells in the piece, acting as a punch or support, while the tool *D*, held on the front cross-slide, acting as a die or former, passes over the work rough-forming the oval surfaces *c*. All that is necessary now is to complete the curves *d*, which is accomplished with the turret tool shown at *F*. The machine spindle is stopped by means of the ordinary brake while these tools are in operation. The order of operations for making the piece shown at *A* in Fig. 3 is as follows:

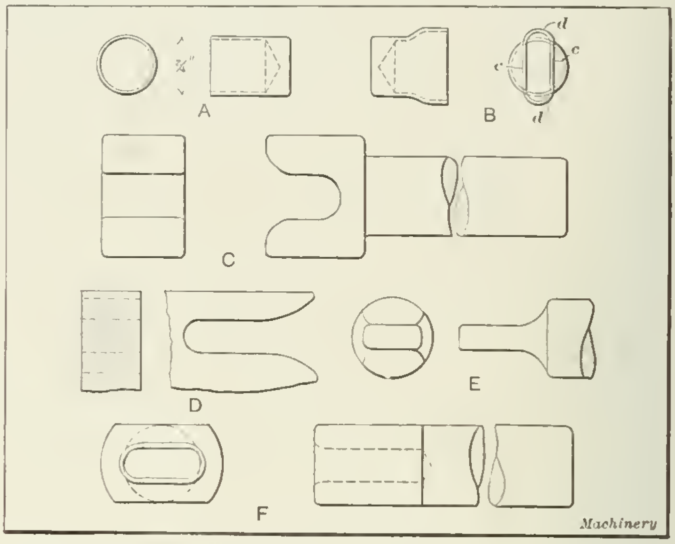

Fig. 3. Another Oval-shaped Shell and the Tools used in Forming it

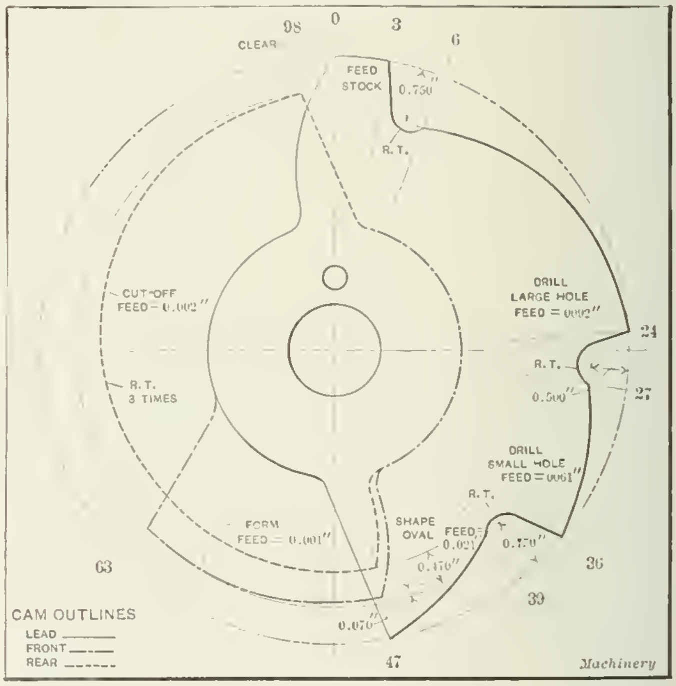

Fig. 4. Cams used in Producing the Oval-shaped Shell shown in Fig. 1

Order of Operations	Revolutions	Hundredths
Feed stock to stop	14	3
Revolve turret	15	3
Center, 0.300 inch rise at 0.0051 inch feed	58	12
Revolve turret	14	3
Drill, 0.720 inch rise at 0.0087 inch feed	82	17
Revolve and stop spindle with brake	14	3
Rough shape from turret	14	3
Revolve turret	14	3
Shape from front cross-slide	19	4
Revolve turret (clearance)	15	3
Finish shape	19	4
Revolve turret and start spindle	15	3
Cut off, 0.410 inch rise at 0.0022 inch feed	187	39
Total	480	100

The spindle is rotated at 720 revolutions per minute, and it requires 40 seconds to make one piece, giving a gross product of 900 pieces in 10 hours.

Another good example of special screw-machine work is shown at *A* and *B* in Fig. 2. The recess *a* is cupped out by means of a one-tooth hollow mill, which is provided with clearance, both inside and out. The forming of the end of this shell to the shape shown at *B* is accomplished by means of the tool shown at *C*, having a shank to fit in the turret. Four pins *c* are driven into the body of this turret tool and are rounded off as shown. Two of these tools are used, one as a rougher and the other as a finisher. The pins *c* in the roughing tool are set further apart than they are in the finishing tool. When ready to form the work, the machine spindle is stopped by means of the ordinary brake, and the thin metal shell is forced down against the body or teat *b* by means of the pins in the tool shown at *C*.

* * *

OLD DAYS IN AN EASTERN MACHINE SHOP

By R. H. G.

About thirty-five years ago the Pratt & Whitney Co. of Hartford, Conn., made all kinds of special machines to order, and it was only necessary for the customer to send a sample of the article that he wished made in large quantities to the firm; an automatic machine would then be designed and built for the work. At that time there were working in the drafting-room of the plant some of the best mechanics and inventors in this country. The machines designed always had novel features, and in this way the company obtained its prominent position. Mr. Frank Pratt, the president, was himself one of the best draftsmen and designers in his day, and had on his staff such men as J. Reynolds, John J. Grant, Charles Church, and others.

One day Mr. Pratt came into the drafting-room and asked if a certain special machine had been laid out; when nobody replied, he said: "Give me a drawing-table and I'll show you young fellows how to draw a machine in quick time." He was soon at work, and it did not take him long to outline the machine. He had, however, not done any work of this kind for several years, and the calculations of the various movements proved tedious to him. He was also anxious to finish the work, and started to ink in the drawing before it was quite completed. Then he was called away on business for a few days, and when he started drawing again, upon his return, he noticed several mistakes, so that it became necessary for him to do a good deal of erasing. When the erasing commenced, Mr. Reynolds spoke up and said: "Mr. Pratt, there's a new way out for making drawings quick and easy." Mr. Pratt, who always was interested in everything new, said: "What is it?" Mr. Reynolds replied, "You take a large sheet of drawing paper, and after carefully fastening it to your table, you cover the entire paper with lines and circles, and then you erase those which you do not wish to use."

It is not necessary to state that Mr. Reynolds did not stay to see the effect of his explanation of the new scheme for making drawings.

* * *

SAFETY GATES FOR SHOP DOORS OPENING ON RAILROAD TRACKS

The very frequent practice of running railroad tracks close to factory walls and having doors from the factory open directly upon the railroad track, has been the cause of many fatal accidents. A simple method of guarding against accidents of this kind has been adopted by a large western concern. Small gates are provided which ordinarily extend across the railroad track, but which are so arranged that when cars are to pass along the track, they can be swung aside so as to close the entrance to the shop. The gates are cared for by the switching crew, who close them across the doors of the shop when a train approaches. This means of safety is very effective, because it cannot easily be neglected. Should the switchman not attend to his duties, however, the neglect would be apparent, as the gates extending across the tracks in front of the approaching train would be broken by it, and, hence, an indisputable evidence of the neglect to close the gates in front of the doors opening upon the tracks would be at hand.

SELECTION OF MACHINE TOOLS

By J. G. W.

The selection of the proper tool for any particular work is becoming more and more of a problem. A few years ago the machine tools of the different classes and of the various standard sizes did not differ materially, even though made by different manufacturers, but at present the buyer is confronted with the problem as to whether some special equipment offered by a maker is the most desirable for his work, or whether it may be entirely too special for his requirements. If one has been interviewed by a number of the salesmen representing the manufacturers of highly specialized equipments, he is apt to be influenced in favor of something which later proves not to be applicable to the class of work in hand.

The tendency is to be convinced that you are behind the times, and that it is necessary to buy something highly special. A few years ago it happened that a certain shop had occasion to purchase a number of new tools. After the superintendent had been interviewed by the various representatives of the manufacturers building a particular class of equipment he was interested in, he finally conceived the idea of submitting specifications for the work which was to be done on the particular tools, leaving the selection of the best possible equipment for the work to the judgment of the various concerns bidding. This seemed to insure the best equipment obtainable being furnished, but as a matter of fact, when the tools were delivered, it was found that they were not applicable to the conditions which existed in this shop. The speeds and feeds to be used for certain cuts in different kinds of material had been left to the judgment of the builder, but it was found that the speeds in some instances were 25 to 40 per cent lower than those actually used on the old tools. Some of the equipment had special attachments requiring two or three different tools, where according to the former practice the same work had been done with one special tool or attachment. As a result, some of this equipment had to be entirely changed to conform to the existing conditions.

After this experience, the next lot of tools was purchased according to a different method. The particular man that was doing the work which would be done on the new tools was asked to give suggestions as to speeds, feeds, and special attachments. The result was that on the larger equipment, particularly, all of the high-class attachments were left off, such as micrometer scales, quick returns, etc. When the equipment was received, there were no complaints from the employes, because it was as near their own ideas as possible, and it permitted them to make the very best time on the tools.

This experience may not hold in other factories, but it certainly worked out to advantage in the case referred to, and proved conclusively in that case that the men who actually do the work, particularly if piece work or the premium plan is in vogue, constitute a fair criterion to go by in selecting tools.

Of course, many will consider it rather unsafe to rely on the judgment of the men in the shop, as they are often prejudiced against anything new. The writer readily admits that, as regards consulting the workmen in the selection of tools, there can be a great deal said against this method. If the workmen are not on a premium or piece-work basis, it would certainly not be advisable. When, however, the men are directly benefited by the increased output, they will favor such features as will make an increase possible. The experience related, of course, is merely stated as a matter of fact, and the conclusions drawn might not apply to other shops. The point made, however, is that the judgment of the operator may, in many cases, prevent mistakes in the selection of equipment, and eliminate appliances which are not needed for the particular class of work in hand.

* * *

When designing worm gearing, care should be taken in the construction of the gear box, so that the end thrust of the worm is well taken care of. The construction must be rigid enough to prevent binding of the worm shaft in its bearings. Ball bearings should be used in all places where end thrust is produced, so that the frictional load is reduced to a minimum.

LOCATING JIG BUTTONS

By H. P. FAIRFIELD[*]

The use of jig buttons for accurately locating centers in the body or frame of drill jigs is not a new method, but perhaps some of the readers of MACHINERY have never seen it applied. It is for these that the accompanying halftones are presented. The reasons for using jig buttons and the general subject of jig and fixture making are excellently treated in MACHINERY'S Reference Books Nos. 3, 41, 42, and 43, and these are freely used by the classes in jig and fixture construction at the Worcester Polytechnic Institute. It is probable that by no other method used in the average shop, can centers for jig bushings be so accurately located as by means of these jig buttons.[†] The buttons can be placed so accurately to the true location that the ordinary shop measuring and testing instruments can detect no errors; and expert jig-makers can bore the holes and can place the drill bushings so nicely that the inspection department can find no errors. In the shops of one firm with which the writer is familiar certain jigs are invariably rejected by the inspector if any error can be found. In most jig construction, however, certain tolerances are allowed.

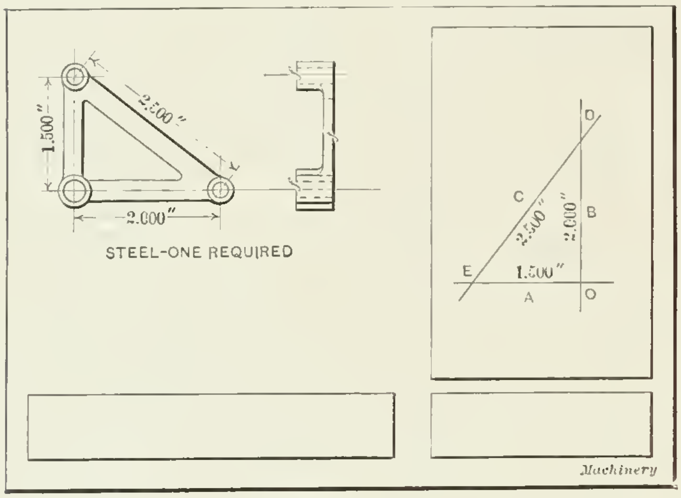

Fig. 1. Piece to be drilled, and Jig Plate to be laid out

The method of setting jig buttons described in the following, is typical of the common practice of toolmakers. To illustrate the operation it was thought best to choose as simple an example as possible. and, therefore, the buttons are located upon the cover plate of a simple drill jig used to drill the holes in the piece shown in the line-engraving Fig. 1. The lay-out of the length of the sides to insure a right angle at *O* is very simple, as the sides *A*, *B*, and *C* must be to each other as 3, 4, and 5; or, in other words, if the relations of the sides to each other are as 3, 4, and 5, angle *O* will be a right angle; because the square of the base plus the square of the perpendicular in a right-angled triangle is equal to the square of the hypotenuse. The halftones show, step by step, how to locate the buttons at the exact points desired. In the problem selected not only must the buttons be at the points shown, but those at *O* and *D* must be in a line exactly parallel to the side of the plate on which they are to be set.

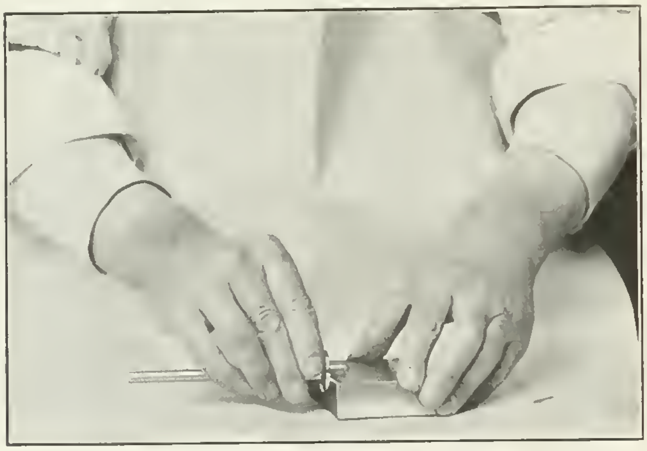

Fig. 2. First Step in Laying-out the Jig Plate

While different toolmakers may proceed in different ways, the order of progression here followed represents good average practice. Assume that the cover plate is planed to shape. The portion upon which the buttons are to be located can be prepared for a lay-out by wetting with a solution of copper sulphate (blue vitriol). As this evaporates, a thin deposit of copper is left upon the surface of the plate; the finest line scratched through this upon the surface of the plate is very distinct, and the points of intersection of the lines can also be easily noted. Now, set the scratch-gage to the distance that the line *OD*, Fig. 1, is to be from the edge of the plate, and gage or scribe a fine line parallel to the working edge of the plate with the tool held as shown in Fig. 2. This line is the line *OD* of the triangle. Next, place the beam of a square firmly against the base side of the plate and slide the blade along the plate until it coincides with the center *O*. Using a fine pointed scriber, scribe a line at right angles to *OD*, as shown in Fig. 3. This is the line *OE* of our right-angled triangle. At the intersection of *OD* and *OE*, at point *O*, locate a light center-punch mark as shown in Fig. 4. If a magnifier

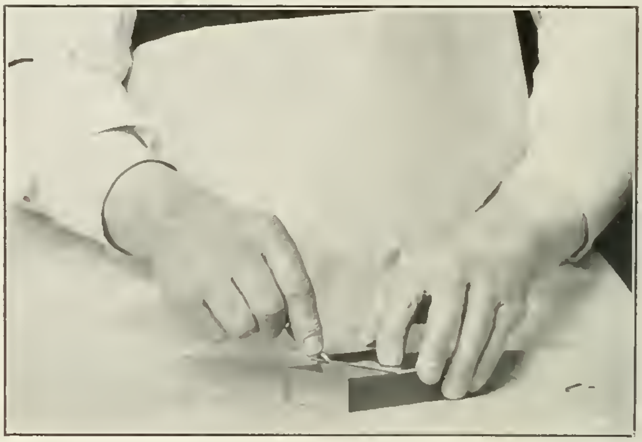

Fig. 3. Second Step in Laying-out Jig Plate

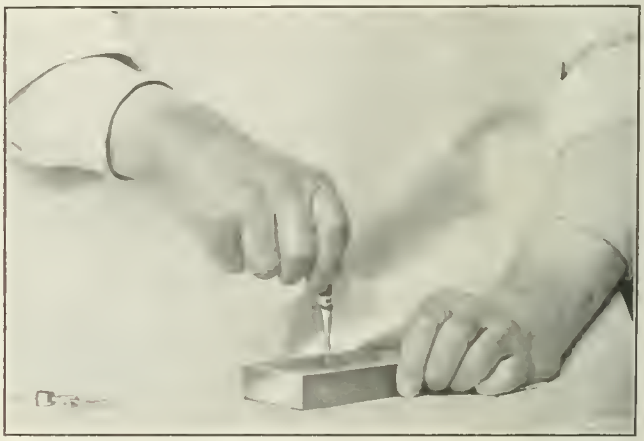

Fig. 4. Prick-punching the Intersections of the Lines

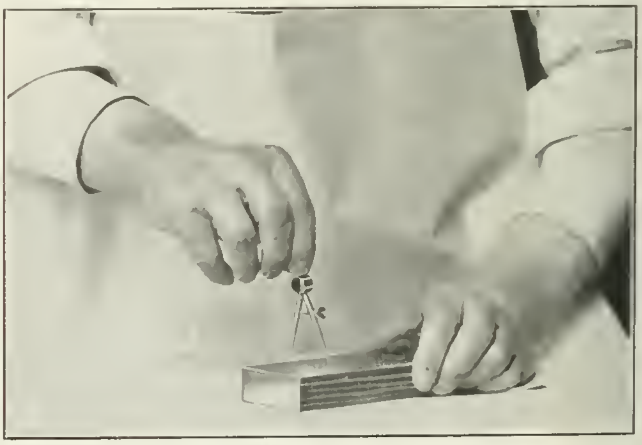

Fig. 5. Laying-out Location of Center by the Aid of Dividers

such as jewelers employ is used, this light prick-punch mark can be located very accurately, but as the buttons are subsequently located by independent means any high degree of accuracy in the preliminary location is not necessary. The writer uses the automatic center-punch shown in Fig. 4 for all lay-outs.

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[*] Address: Worcester Polytechnic Institute. Worcester, Mass.

[†] See MACHINERY, April, 1912: "A New System for Locating Holes to be Bored on the Milling Machine."

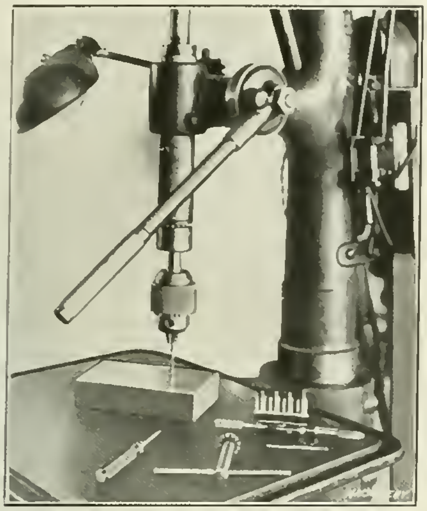
Fig. 6. Drilling for the Button Screw

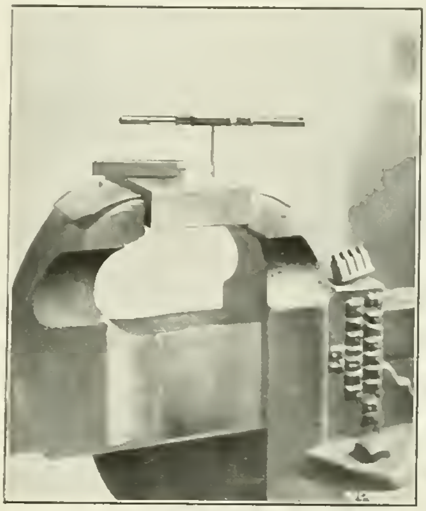
Fig. 7. Tapping for the Button Screw

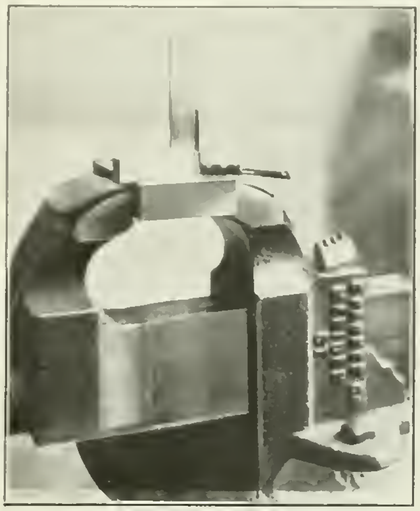
Fig. 8. "Squaring-up" the Tap

Next, set a pair of toolmakers' dividers to the length of line *OE*, and with *O* as a center scribe a short arc across *OE*, as shown in Fig. 5. If the points of the dividers are kept sharp, this line, like the preceding ones, will show sharply against the copper coating. With the center-punch lightly prick a center at the point of intersection of line *OE* and the short arc just scribed, as shown in Fig. 4. If an adjustable automatic center-punch is used, the center points can be as lightly pricked as the toolmaker wishes. The location of point *D* on the line *OD* is prick-punched in a manner similar to that of the location of *E*. Deepen and enlarge the prick-punched centers sufficiently to enter the point of the tap drill, and drill for the button screws as shown in Fig. 6. Tap the drilled hole for the button screws (see Fig. 7), carefully testing to insure perfect "squareness" with the surface upon which the buttons are to be clamped, as shown in Fig. 8. If this is not carefully done, the buttons cannot be so easily and accurately adjusted.

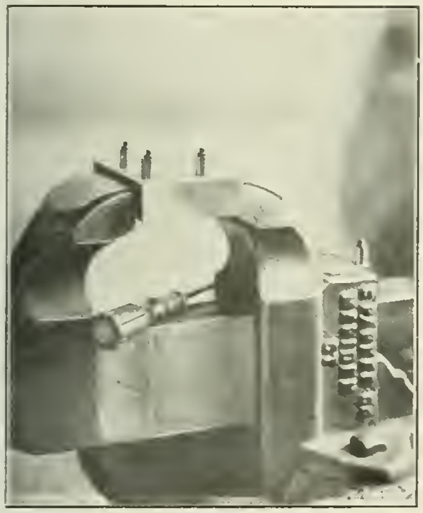
Fig. 9. The Buttons in Place

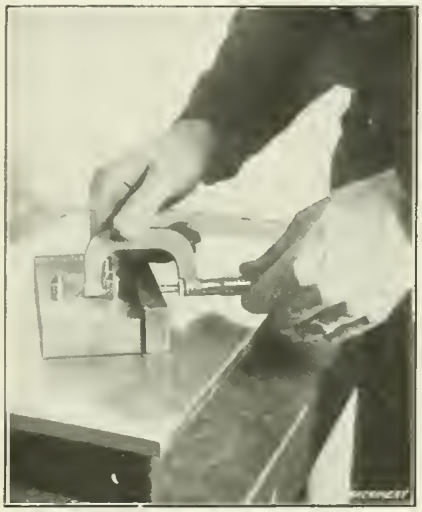
Fig. 10. Accurately Adjusting the Buttons with relation to the Side of the Plate

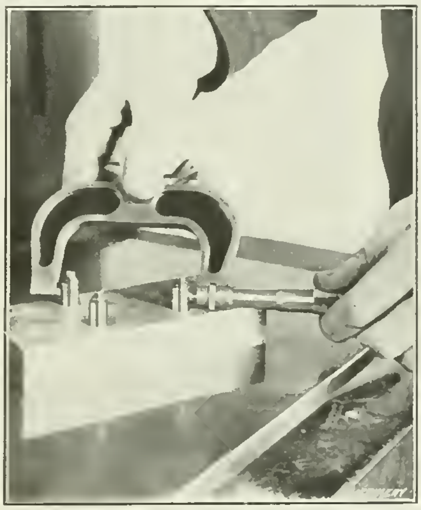
Fig. 11. Using a Micrometer for the Adjustment of the Buttons

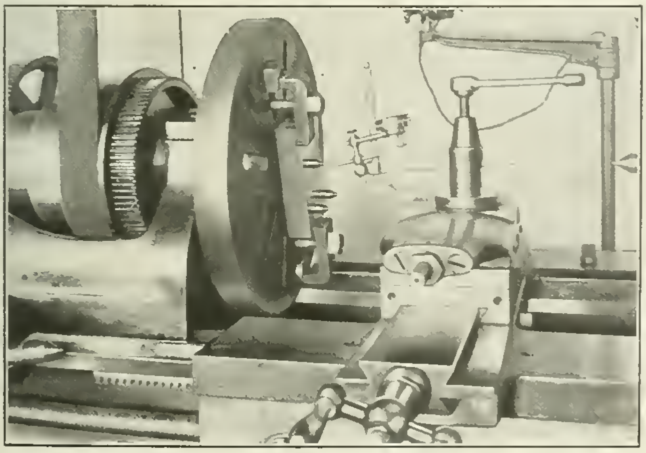
Fig. 12. Indicating the Buttons on the Lathe

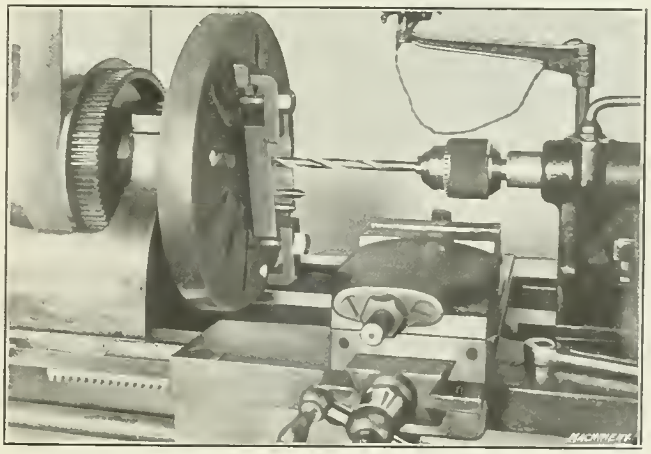
Fig. 13. Drilling the Bushing Holes

Clamp the buttons in their approximate positions by means of the button screws, as in Fig. 9. In doing this, remember that at this stage these positions are only approximate, and that the tension placed upon the screws must admit of further adjustment. Adjust the buttons by micrometer to the desired distance from the edge or side of the plate, as shown in Fig. 10. Note that the micrometer reading from the edge of the plate, when made as shown in this halftone, is as much greater than the distance from the center of the hole to be bored to the edge of the plate, as the sum of the thickness of the straightedge and the radius of the button. Adjust the buttons correctly with regard to the distance *OD* by micrometer and shift the button at *E* until the center to center distances *OE* and *DE* are those designated. It is possible, in this manner, to locate the buttons where desired within an error too small for the micrometer to indicate. If the holes to be bushed can be bored concentric with the buttons as located, the greatest accuracy can be obtained by this method. While the writer uses micrometers for all possible measurements, the proper use of a high-grade height-gage will assist the toolmaker in many cases. The surface plate used must then have an especially smooth surface, and it is a delicate job to determine just when contact between the surface of the button and the feeler is made. Instead of depending upon "feel," the toolmaker often uses some thin pigment on either surface, and indicates contact by sight rather than by "feel."

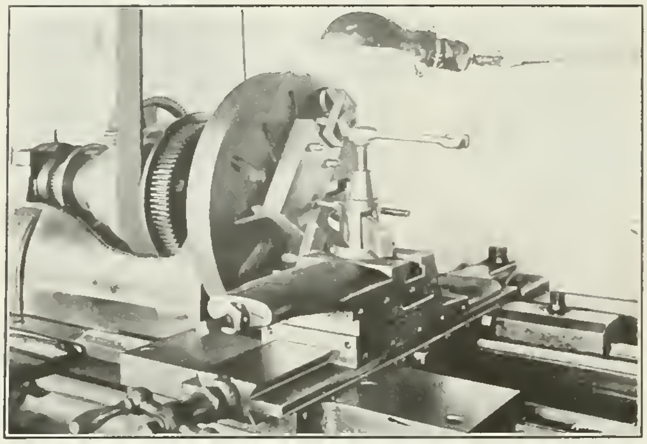
Fig. 14. Boring the Bushing Holes

Next, clamp the cover plate, which carries the buttons previously located, upon a lathe faceplate. The clamping should be sufficiently firm to retain the position and yet allow adjustment. Using a copper or lead hammer, adjust the cover plate upon the faceplate until one of the buttons indicates "dead true." Fig. 12 shows one of several indicators designed for this purpose. After the faceplate is screwed firmly upon the nose of the spindle, and before mounting the work upon it, its face surface should be indicated, and if appreciably out of true, a light finish cut with a lathe tool should be made, starting at the center and feeding to the outer edge. This is commonly known as "truing up the faceplate."

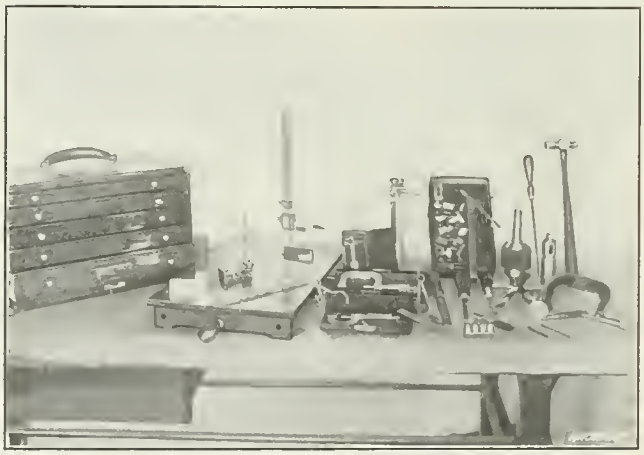
Fig. 15. Tools used by the Jig-maker

After the button is indicated dead true, it is removed and the bushing hole drilled to approximately the desired size, as in Fig. 13. Where a suitable milling machine is accessible, the plate can be drilled and bored in that machine. In fact, this job can be done upon any machine in which it is possible to indicate the button concentric with the center line of the spindle. Then, for boring the hole (see Fig. 14), use an inside boring tool with a keen cutting edge to avoid error due to its springing. An inside boring tool ground to correct clearance and cutting angles, properly set and run at the correct speed, will turn out a hole that will indicate dead true. If the work when clamped to the faceplate throws it out of balance, a weight should be clamped to the "light" side, sufficient to restore the balance. Fig. 15 shows some of the tools needed by the toolmaker. In closing, the writer offers no defense for the button method of locating holes for drill bushings, as none is needed, but submits it to young toolmakers as probably the most accurate method for the purpose.

* * *

STRENGTH OF STEEL TUBES UNDER INTERNAL FLUID PRESSURE*

In order to arrive at some definite conclusion as to the formulas which ought to be used for calculating the strength of tubes, pipes, and cylinders subjected to internal fluid pressure, a number of different formulas were investigated and compared. These formulas were the so-called "common" formulas generally found in books on mechanics and based directly on the tensile strength of the material, and the formulas given by Barlow, Lamé, Clavarino and Birnie. It was found that of the five formulas considered, that of Barlow is the best suited for all ordinary calculations pertaining to the bursting strength of commercial tubes, pipes, and cylinders. The theoretical error on the side of safety resulting from its use will generally not exceed the actual combined error on the side of danger resulting from the use of either Birnie's or Clavarino's formulas. This is true, at least up to the yield point of the material, for any ratio of thickness of wall to outside diameter less than 0.3. In this respect, Barlow's formula is superior to the common approximate formula which gives errors that are entirely too large on the side of danger for very thick walls.

Barlow's formula assumes that because of the elasticity of the material, the different circumferential fibers will have their diameters increased in such a manner as to keep the area of cross-section constant, and that the length of the tube is unaltered by the internal fluid pressure. As neither of these assumptions is theoretically correct, the formula, of course, gives only approximate results; but, as already mentioned, the errors are on the side of safety.

Assume that

D = outside diameter in inches,
t = average thickness of wall in inches,
p = internal fluid pressure in pounds per square inch,
f = working or safe fiber stress in pounds per square inch.

The Barlow formula is then as follows:

$$\frac{p}{f} = \frac{2t}{D}, \text{ from which}$$

$$p = \frac{2ft}{D};\ t = \frac{Dp}{2f};\ f = \frac{Dp}{2t}$$

It should be observed that while the Barlow formula is similar in form to the common formula, it gives results quite different when applied to tubes and pipes having walls of considerable thickness. This is due to the fact that the Barlow formula is expressed in terms of the outside diameter, whereas the common formula is expressed in terms of the inside diameter.

The average ultimate tensile strength of seamless steel tubes may be assumed at 60,000 pounds per square inch; that for butt-welded steel pipe at 40,000; that for lap-welded steel pipe at 50,000; and that for wrought-iron pipe at 28,000 pounds per square inch.

The investigations undertaken also indicated that if seamless steel tubes are assumed to have a strength of 100 per cent, butt-welded steel pipe has a comparative strength of 73 per cent, and lap-welded steel pipe of 92 per cent. From this it will be seen that the strength of a butt-weld is only about 80 per cent of that of a lap-weld. The relative strengths of wrought-iron and steel pipe are as follows: Butt-welded wrought-iron pipe has 70 per cent of the strength of similar butt-welded steel pipe, and lap-welded wrought-iron pipe has 57 per cent of the strength of similar lap-welded steel pipe.

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* Abstract of a paper by Mr. Reid T. Stewart, of Pittsburg, Pa., read before the American Society of Mechanical Engineers.

TURNING CHILLED IRON ROLLS[*]

By F. B. JACOBS[†]

Ordinary soft steel which contains 0.25 per cent carbon and up is rolled from a steel billet in a mill generally called a finishing mill. Different rolling mills have different methods of "setting-up" finishing mills; the following method is often used for small mills, say twelve-inch mills, or those where the rolls are twelve inches in diameter. First there are three roughing rolls. These are set one above another and are made from steel castings with 0.70 to 1.20 per cent carbon. Next there are three pony rolls set the same as the roughing rolls and made from the same quality of steel. The next set consists of the so-called "strand rolls," which are set "three high" in the same manner as the roughing and pony rolls. Strand rolls are made of ordinary cast iron for rolling flat stock, and of chilled iron for rolling rounds and squares. After the strand rolls come two edging rolls, set one above the other, these being made of chilled iron, and finally come the two finishing rolls which are relied upon to finish the bar stock to the correct dimensions. These rolls are also made of chilled iron.

All the rolls have grooves turned in them termed "passes," the passes in the roughing rolls being a little smaller than the billet to be rolled. Down through the mill the passes decrease in size to the finishing rolls, where the passes are just a trifle larger than the size of the finished bar. The frames or housings that carry the rolls are set side by side, the wobblers or ends of the rolls being connected in the same manner as the two rolls shown in the roll lathe in Fig. 1. The mill is generally driven by a direct-connected steam engine, steam being considered the most economical means of driving the mill, as it is generated by the waste heat from the furnaces.

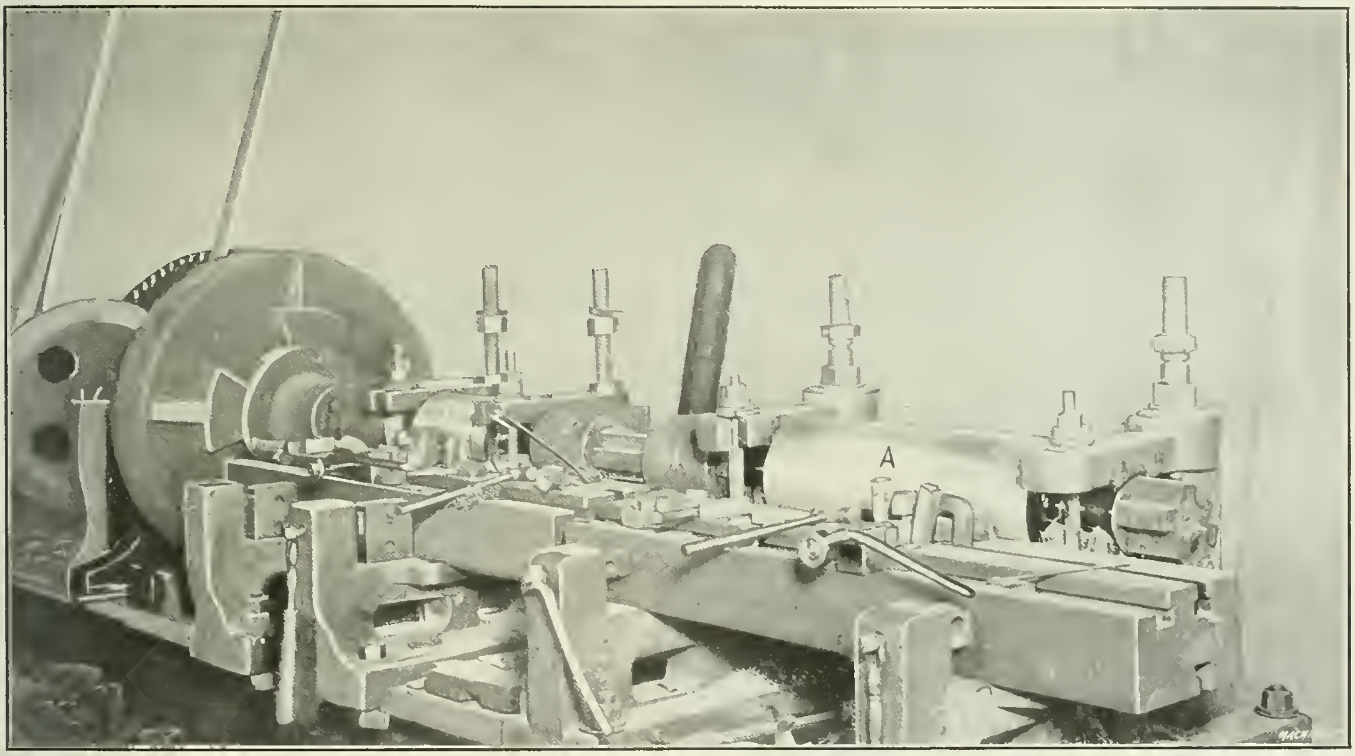

Fig. 1. A Roll Turning Lathe with Work in Place

The process of rolling steel is quite simple and can be briefly described as follows: One roller starts the billet of white-hot steel through the roughing rolls; a roller on the opposite side of the mill grabs it with a pair of heavy tongs and starts it back. In this manner it is sent through all the sets of rolls, and after coming from the finishing rolls it is laid out flat to cool. As may be imagined, rolling is a dangerous occupation; it calls for a sure hand, a rapid eye, and great strength. In spite of reasonable precautions, serious accidents sometimes happen. Rolling is, without a doubt, the best paying of all the mechanical pursuits, good rollers earning from eight to fifteen dollars[*] a day, depending on the locality, and the quality of the material worked on. It takes at least six years of hard work and close attention to become an expert roller.

The constant rolling of hot metal soon wears the passes of the rolls, which makes it necessary to re-finish them. The turning of new rolls and the re-dressing of worn ones is, in itself, a trade calling for skill and, especially, patience. A roll lathe, as shown in Fig. 1, differs widely from the ordinary engine lathe, as it has neither carriage, ways nor cross-slide, the tools being clamped securely to the tool bed, directly in front of the roll to be turned. The tools are set up to the work by means of screws working through blocks set in the tool bed. Roll lathes are generally triple-geared, and the roll is always located from its necks or journals while turning the face and passes, this being necessary to avoid chattering.

In Fig. 2 are shown several roll turning tools. These are made of a good quality of tool steel, hardened in brine and drawn only enough to relieve the internal strains. The tools marked *A* are used in turning passes for square stock. The tools used for roughing and finishing the face of rolls are shown at *B*. The tools marked *C* are used in turning passes for angle-iron rolling. The shape of these tools is worked out by hand to fit the templets shown at *D*. The shape of tool generally used in roughing cast-iron rolls is shown at *E*. When the tools require grinding it is done by hand as shown in Fig. 3, the wheel used in this case being "Aloxite," 16 inches in diameter, 3-inch face, 24 grit, H grade, D 333 bond.

The operation of roughing a strand roll is shown at *A*, Fig. 1. This roll is 26 inches long and 9½ inches in diameter. A chip 6 inches long is taken at a time, the tool being fed directly to the work. The time for roughing this roll, removing ⅝ inch of stock, is ten hours. To many this may seem rather slow work; however, it must be taken into consideration that the material is chilled iron, which is extremely hard and therefore calls for a slow speed—in this case one revolution in 55 seconds.

The roll shown at *B*, Fig. 1, is a small finishing roll for T-iron. The grooves or passes being turned are 3/16 inch wide and ¾ inch deep. The tool used in this case has the appearance of an ordinary cutting-off tool. Let the average machinist consider for a moment what it means to cut grooves of the above dimensions in chilled iron, and he will realize why the roll turner has to have plenty of patience. It is quite necessary that the passes in all finishing rolls be of the required dimensions, and that the corners be square. In Fig. 4 is shown a large chilled iron strand roll, 48 inches long and 18½ inches in diameter. The time for roughing this roll, removing ¼ inch, was ten hours, the roll being revolved at one revolution in one minute and forty seconds. Another ten hours was consumed in turning five passes for 1¼ inch square stock. The photographs and data for this article were obtained in one of the smaller rolling mills that are to be found scattered all over the Middle West, and give a fair idea of the time required to turn chilled iron rolls under ordinary conditions.

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[*] See MACHINERY, September, 1895, "Roll Lathes and Roll Turning."

[†] Address: Care of Carborundum Co., 826 Arch St., Philadelphia, Pa.

[*] Wages paid rollers in the Pittsburg district run from $8 to $15 a day depending on the material rolled. The rollers are paid according to the tonnage they turn out, the $15 rate being earned in the large plate mills where the tonnage production is heavy. In sheet mills, tin-plate mills and bar mills, the rollers get from $10 to $12 a day. In hoop mills and other mills rolling light materials the rollers make from $8 to $10 a day. In union mills the wage scale is set on all materials by the Amalgamated Association and in the non-union mills the wage scale runs closely parallel to the union scale. Of course the stated wages are earned only when the day or night run is made without interruption from breakdowns or other causes.—EDITOR.

When we stop to consider the fact that in the majority of the industries using chilled rolls they are invariably finished by grinding, either on a regular roll grinding machine, or on a heavy plain grinding machine of the type embodying a stationary platen and a traveling wheel carriage, the question naturally arises, why do not the rolling mills rough and finish the straight portions of their rolls by grinding? There are several reasons why they do not, one being that the roll turner who has had no experience at grinding is prejudiced against any method of finishing rolls other than the time-honored method of turning. He also argues that as it is necessary to have a roll lathe for turning the passes, it is more economical to finish the face of the roll by turning, the face and passes thus being finished at one setting of the roll. With the roll shown in Fig. 4 the time for roughing the body, as before stated, was ten hours, the amount of stock removed being approximately 384 cubic inches, or 38.4 cubic inches per hour.

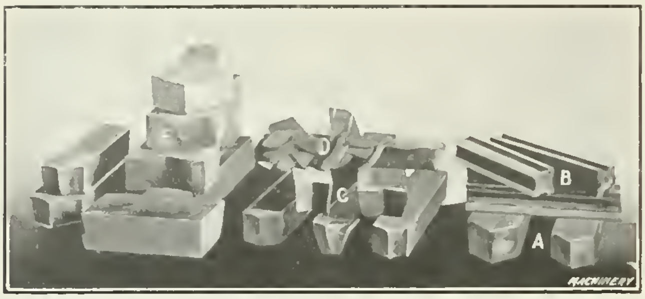


Fig. 2. Tools used in Turning Chilled Cast-iron Rolls

Some time ago the writer witnessed a very interesting roll-grinding operation on a heavy plain cylindrical grinding machine. The roll in this case was of chilled iron 32 inches long and 32¼ inches in diameter. The grinding time for removing ¼ inch from this roll was four hours. As approximately 192 cubic inches was removed, this equalled 48 cubic inches per hour. This work was done with a carborundum wheel 24 inches in diameter, 2-inch face, 403 grit, P grade, run at a speed of 950 R. P. M. The work speed was 6 R. P. M., and the advance of the traverse feed 1¼ inch for each revolution of the work. The finish left was superior to the finish left by the process of turning.

Fig. 3. Grinding the Tools for Roll Turning

From these data it is evident that the grinding machine shows an increase of 25 per cent in the amount of stock removed in a given time. Another point in favor of the grinding machine is that the wages of a skilled roll turner are about 30 per cent higher than the wages of a grinding machine operator. From this it would appear that the most economical method of finishing the straight portions of rolls used in rolling bar stock would be by the use of a grinding machine equipped with the proper wheels.

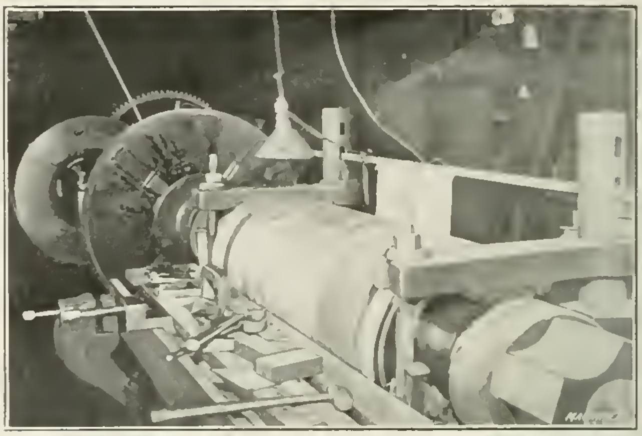
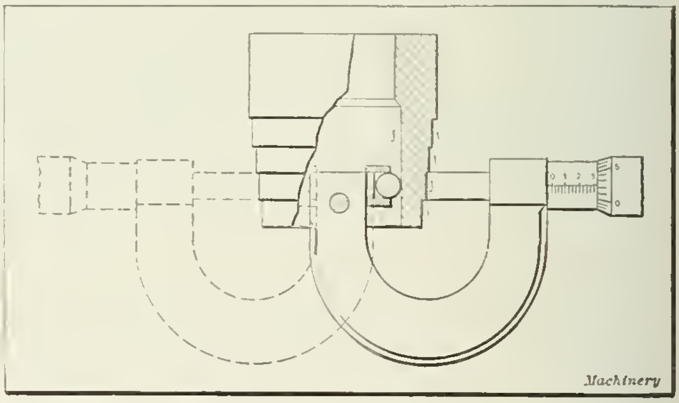


Fig. 4 Turning a Roll 48 Inches Long, and 18 1/2 Inches in Diameter. The Rough-turning removing 1/4 Inch, requires Ten Hours

* * *

METHOD OF TESTING LATHE SPINDLE ALIGNMENT

The accompanying line engraving shows a convenient and accurate method of testing the spindle alignment of New Britain-Prentice turret lathes. This method is used in the trying-out department of the New Britain Machine Co., New Britain, Conn., but is equally applicable to testing machines in use in manufacturing departments.



Method of Testing Spindle Alignment

A brass bushing is held in the chuck and bored out to any convenient internal diameter by means of the No. 1 spindle. With the same spindle a shoulder is turned on the outside for a distance of approximately ¼ inch. With the No. 2 spindle a second shoulder is turned of about the same width but of a slightly larger diameter. Likewise, with the No. 3 and No. 4 spindles, similar shoulders are turned, leaving the bushing, when finished, about as shown in the engraving.

By means of a micrometer, arranged as shown in the engraving, the variations in thickness at different points of each shoulder may be ascertained, and by taking readings of the diametrically opposite thick and thin portions of any one shoulder, the amount of spindle error for that particular spindle may be determined, bearing in mind that the difference in the two readings will be *twice* the amount of spindle error.

INTERFERENCE IN HALF-NUTS

By HERBERT S. FULLERTON*

All who have had anything to do with the type of nut commonly found engaging the lead-screws of lathes know that it is impossible to have these nuts in contact all around the screw. They are usually made in pairs and arranged to slide simultaneously into and out of contact with the screw. Ordinarily, a pair of these half-nuts is made by cutting a whole nut in two after chasing the threads. Should the halves be finished separately and then chased while clamped together, it would be found impossible to seat them over the screw, especially if the workmanship were good and the lead not too fine; or if screwed onto the screw, it would be found impossible to lift them away.

This peculiarity is due to an interference or interlocking of the threads of the screw and the nut. The amount of the interference depends on the relation of the lead to the diameter of the screw and on the shape of the threads. The interference occurs at four points on the circumference, on each end of the threads in each half-nut, being greatest in amount at the parting line or joint between the halves, and tapering away as it extends along the thread. The point on any diameter where the interference ends—considering it to begin at the parting line—may be called the "critical point" for that diameter, and the line formed by points on a series of diameters, the "critical curve."

Some years ago the following formula locating the critical points came to the writer's attention:

$$\tan \alpha = \frac{\tan \phi}{\tan \theta}$$

in which α = angle between parting line and radial line passing through critical point,

ϕ = lead angle of thread,

θ = angle between side of thread and a perpendicular to the axis of screw.

It will be noted that as the angle ϕ varies from the root to the outside diameter, the angle α must also vary. Therefore, the critical points for a series of diameters do not lie along a radial line. By calculating angle ϕ for several diameters the respective values of angle α may be determined and the critical curve located.

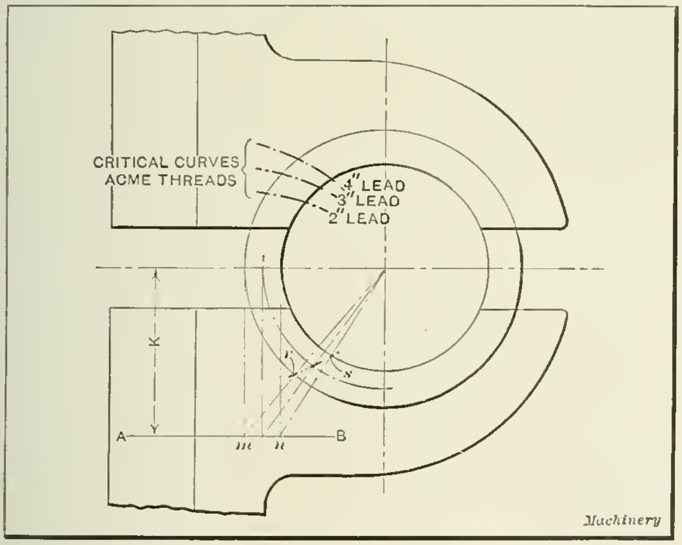


Fig. 1. End View of Half-nuts showing Method of Determining Points of Interference

The following method of determining the curve will probably, however, be found more convenient. Perpendicular to the line of motion of the nuts and parallel to the parting line, draw a line AB, as shown in Fig. 1, at a distance K from the center.

$$K = \frac{l}{2\pi \tan \theta} \text{ generally, or } K = \frac{8l}{13} \text{ for Acme threads,}$$

where l = lead of screw threads.

Tangent to the outside and root diameters, draw perpendiculars cutting AB at m and n. Produce to these points radial lines cutting the outside and root diameters, respectively, at r and s. These are the critical points of the respective diameters. Points for intermediate diameters may be located in like manner and a curve drawn through them. For all practical purposes a straight line drawn through the critical points located on the outside and root diameters will be found a sufficiently close approximation. For screws of the proportions commonly used, where the lead is not greater than one-quarter to one-third of the outside diameter, it will be found that while slightly concave and inclined, the curve approximates closely a straight line parallel to the parting line.

Fig. 1 shows in the correct proportions an end elevation of a pair of nuts for a screw 4 inches in diameter with 1-inch lead single Acme threads. The dot-and-dash lines on one side are the critical curves for 2-, 3-, and 4-inch lead Acme threads. From these curves some idea may be had of the extent of the interference and form of the critical curves for different leads.

All the curves are concave toward the parting line, the amount increasing with the lead, but even for the coarsest it is but slight.

As the interference occurs only on one side of the threads at each point it is sometimes the practice to chip and file it away by hand, in order to save the bearing on the opposite side. This is a rather longer and more expensive operation than the cutting away of all the material back to the critical curve. The latter method, aside from being the cheaper, gives a nut that will always be right, whereas by the former method, the nut will in time by wear tend to return to its original shape on the sides of the threads. When the bearing between the threads of the nut and screw extends beyond the critical curve, the nut, in disengaging from the screw, will throw forward the carriage an amount equal to the interference, and on this account it becomes difficult to operate.

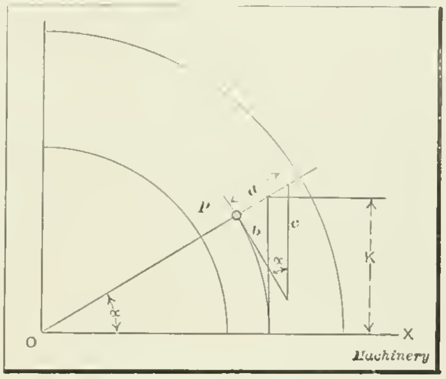


Fig 2. Mathematical Analysis of Problem of Interference in Half-nuts

The mathematical expressions in the foregoing may be derived as follows: Tangent to the surface at some point p, Fig. 2, on the side of the screw thread, assume a right-angled triangle abc in which a is radial, b perpendicular to a, and c perpendicular to OX. If OX is the parting line of a half-nut, side c parallel to the line of motion of the nut, and p a critical point, then c must lie in a plane perpendicular to the axis of the screw, side a make an angle θ, and b an angle ϕ with the same plane. Therefore,

$$a \tan \theta = b \tan \phi, \text{ and } c \sin \alpha \tan \theta = c \cos \alpha \tan \phi$$

$$\frac{c \sin \alpha}{c \cos \alpha} = \frac{\tan \phi}{\tan \theta} = \tan \alpha$$

$$\text{But } \tan \phi = \frac{l}{\pi d}. \quad \text{Hence } \tan \alpha = \frac{l}{\pi d \tan \theta}, \text{ in general,}$$

$$\text{or } \tan \alpha = \frac{l}{0.8125\, d} \text{ for Acme threads. Hence}$$

$$K = \frac{d}{2} \tan \alpha = \frac{l}{2\pi \tan \theta}; \text{ or } K = \frac{l}{1.625} \text{ for Acme threads.}$$

Therefore K is constant for a given lead and side angle, but independent of the diameter.

[A graphical method of determining the maximum embracement of a lead-screw nut was published in the *Home Study Magazine*, January, 1898, by Mr. Carl G. Barth. This method employs the factors of screw diameter, depth of thread, lead-screw pitch angle and thread section angle to find the location of a tangent to the curve beyond which the inner edge of the half-nut cannot go toward the middle plane of the screw without interference. That and the foregoing geometrical solution are, we believe, the only solutions of this common problem in machine tool design ever published.—EDITOR.]

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INVENTIONS THAT REVOLUTIONIZE WORKING CONDITIONS

Few of the younger generation realize the change wrought by electric lighting in the working condition of shops and factories. Some fifty years ago it was necessary to so arrange the working hours that no artificial light need be employed. In order to average a ten-hour day for the whole year, the working hours in the summer had to be made unusually long, to make up for the short winter days. In New England shops the average length of the working day was about eight and one-half hours in December, while the men worked eleven hours a day in May, June, July and August.

Now conditions are in many cases reversed. The men in the shop are willing to work overtime, if necessary, during the winter months, but when summer comes they prefer as short a working day as possible in order to have an opportunity for outdoor recreation. This change has been made possible by the invention of effective artificial light—electric light, principally —which makes it easy to light a shop at night almost as well as it is lighted in the daytime. The advantages gained in improved working conditions from this source alone are manifold, and have added not only to the comfort and safety of the work in the shop, but to the rational enjoyment of the leisure hours as well.

* * *

COMPLAINTS DUE TO IGNORANCE

Manufacturers of machinery and tools are often put to considerable inconvenience and expense attending to unfounded complaints about their products. Often these complaints are due to the "fussy" or "cranky" disposition of the customer, but frequently they are simply due to the buyer's ignorance of the proper use of the machine or tool bought. As a rather extreme example, perhaps, may be mentioned the following case: A customer ordered a number of die hobs from a firm manufacturing small tools. In a few weeks complaints were received stating that the hobs were practically useless, that they would not cut freely, and that a great many had been broken while in use. An investigation showed that the purchaser had used the hobs to cut the threads in the die blanks without previous rough-threading by a die tap. As the hob is intended for a light finishing and sizing cut only, and consequently is fluted in a manner that gives very little chip room, it was a foregone conclusion that the chips would clog and the tools break when used in the manner mentioned.

Similar cases are not unusual. It is to the interest of every manufacturer to educate the users of machinery and tools in the proper and efficient use of his product. The best medium for this education is the mechanical journal. Special articles of general interest containing information of permanent value do more to increase the knowledge of the users of machinery than any other agency. The manufacturer who never cooperates with the technical journal in its work of education, and who then complains of the ignorance of his customers and the users of his machines and tools, has really little just cause for complaint. The more that is done to educate mechanics through the medium of mechanical journals, the fewer will be these exasperating complaints which are due purely to ignorance.

* * *

NEW FACTORS IN MACHINE TOOL DESIGN

There are many things to be taken into consideration by the designer of machine tools—too many to be properly enumerated here—but a few new ones have come into the designer's realm since the advent of the automobile which are of special interest now to users and builders of machine tools.

First are ball bearings. Whatever prejudice still exists against the use of reputable makes of ball bearings on all revolving parts of machine tools, other than the main spindles, is disappearing. The chief objection is the cost, and that is not very serious. In the case of a machine tool lately put on the market having ball bearings throughout excepting the work spindle, and costing about $750, the cost of the ball bearings is about $75, or ten per cent of the whole. An offset is about $40 for the plain bronze bearings displaced, which brings the net cost of the ball bearings down to about $35 more than plain bearings.

Second are hardened gears. These, also taken from automobile practice, are one of the latest refinements in tool design. The advantage of hardened gears is that they can be run at pitch line speeds considerably higher than 1000 or 1100 feet per minute, the practical limit of soft steel gears. The cost is more than unhardened steel gears and considerably more than cast-iron gears. In some machines built to order steel gears may have been specified without good reason, but that is not the case in the designs required to transmit heavy torques at high speeds efficiently.

Third is flood lubrication on the principal gears and important plain bearings carrying heavy thrusts. Whether it be of the splash or circulatory type, the essential requirement is to provide an amount of oil that will reduce friction to a minimum and carry away the excess heat generated without retarding effect. This is especially important in gear boxes, where, as has been demonstrated, too much oil has the effect of converting the gears into circulating pumps and thus wasting much power.

Why are ball bearings and hardened gears worthy of the serious attention of machine tool designers? The answer is because of the difficulty of conveying to the tool point sufficient power to utilize the best steels to the highest capacity when plain bearings and ordinary materials are used in the construction. Take, for instance, the case of a high-power drilling machine built to drive the best high-speed drills to the limit of their capacity, in which twenty-two horsepower is absorbed driving a one-inch drill. The machine is built with ball bearings, hardened gears and splash lubrication. Had plain bearings, cast-iron gears and common oil cup lubricators been used, the power required would have been considerably greater. But of more importance is the fact that belt widths and speeds, and face widths of gears, and lengths of bearings would have been so great as to be practically prohibitive. Ball bearings, hardened gears and flood lubrication may be regarded as essentials in the design of machine tools that are required to work the best high-speed steels to the limit of their capacities.

LEARNING BY TEACHING

There is no better way to acquire a thorough knowledge of a subject than to try to teach it to somebody else. In doing this, one will realize one's own shortcomings and find out that there are many points on which it is necessary to acquire more information. If this teaching of others is done in writing, one's own deficiencies will become all the more apparent, and that is the reason why writing for the technical press is, in itself, an excellent means of education. A man writing upon any subject usually digs up a number of questions that he cannot answer, and as he proceeds with the work he is thus impelled to acquire the information necessary to perfect the article. It is surprising how many details are involved in the preparation of even a simple but thorough treatise on machine shop work, and how necessary it becomes to study each one in order to acceptably present the subject to the readers of a mechanical journal.

Nystrom advised the mechanical engineer to collect the data for his own handbook. In giving this advice he probably did not consider every man capable of collecting the data he requires and putting it in better shape than could a trained compiler of handbooks. He thought, rather, that the educational advantages resulting from such a course are so great that, even in this day, with the large number of handbooks available, it would be of great educational value for any young man to collect for himself the data on his work which he considers especially useful to him. Should he then, in addition, try to put this data into form for publication, it would become his own mental property to a greater extent than if studied in any other way.

* * *

SPECIALIZATION IN LUBRICATION

The efficiency and working life of most machines are vitally affected by the lubricant provided for their bearings. If oil of poor quality or of insufficient quantity is supplied, the life will be short and the power wasted will be relatively great as compared with the friction loss under proper lubrication. The theory of friction between sliding surfaces is based on the fact that the smoothest metallic surfaces are relatively rough, and that the opposing inequalities interlock and shear off when rubbed together. The resistance to motion, known as friction, converts power into heat; and if the surfaces in contact are under considerable pressure and in rapid motion they will be quickly destroyed by the resulting attrition and high temperature. To prevent wear and reduce friction, an intermediary or lubricant is introduced which separates the opposing surfaces with a film that fills the inequalities of journal and bearing surfaces, making them smooth and supplying countless numbers of balls or rollers that support the load and move under heavy pressure with little resistance. There are many oils and greases and some mineral solids that have marked lubricating qualities, but which vary greatly in the characteristics necessary for the best results under certain conditions.

Years ago when machinery was generally run at comparatively slow speeds, the bearings being subjected to low unit pressures, the choice of lubricants was not of such great importance as now when high speeds and heavy unit bearing pressures are common. Specialization in lubrication has become necessary, and is carried out to a marked degree in textile mills, railway cars, locomotives, steam engines, gas engines, rolling mills, etc. Everyone knows, instinctively, that a lubricant which is satisfactory for watch pivots is not suitable for a rolling mill journal, but few are aware of the extent to which specialization in lubrication has been carried.

For example, take the automobile, which is essentially a road locomotive with an internal combustion motor. A natural inference is that a cylinder oil suitable for one make of car would be practically all right for all cars having gasoline engines, but the experts in lubrication say not. They claim that it is necessary for the highest efficiency to provide different oils for different makes of cars, and that even the various models of the same maker's cars may require different oils. "The correct oil for a Fiat, for instance, is absolutely wrong for a Packard. The spring strength of the piston rings must be considered, the fit of the piston ring in its recess, the length of the crankshaft and connecting-rod bearings, the feed systems and the length of the vacuum period while intake and exhaust valves are both closed, must be known and studied before the correct lubrication can be determined."

The users of all machinery, and especially automobiles, are advised to care for the bearings with the idea of reducing the friction loss to a minimum. While a car may have ample power when indifferently oiled, it should be remembered that the power wasted in overcoming friction is surely wearing it out. When it is considered that with indifferent lubrication the cylinder and bearing wear or general deterioration in mechanical fitness of a car may be as great in one season as it should be perhaps in three seasons with the best lubrication, the importance of proper attention to this feature can be better realized.

* * *

DEFINITIONS OF ENGINEERING

The public in general has a rather vague idea of the meaning of the word engineering, and of the work and duties of an engineer. Many definitions have been given, some of which have become classical, while others are quoted merely on account of the terse way in which the meaning the author intended to convey has been expressed. Thomas Tredgold's definition is well known. In 1828 he defined engineering as "the art of directing the great sources of power in nature for the use and convenience of man." This definition has been incorporated in the constitution of the Institution of Civil Engineers of Great Britain. There is a deeper meaning in this definition than is ordinarily appreciated at the present. The words "for the use and convenience of man" are especially intended to draw a distinction between the civil engineer and what was at that time termed the "military" engineer, whose work was confined mainly to the building of forts and the design of means for destruction. Tredgold aimed in his definition to show how the civil engineer was one who used the power in nature for the good of mankind and for the progress of civilization.

In 1885, A. M. Wellington, who was for many years editor of the *Engineering News*, defined engineering as "the art of doing that well with one dollar which any bungler can do with two, after a fashion." This definition differentiates the trained engineer who has specialized in any one particular line and devoted time and study to ascertaining the best methods of doing certain work, from the man who may be able to accomplish the same results, but on account of his lack of training, at an excessive cost.

A third definition by an unknown author, quoted in Ernest McCullough's book, "Engineering as a Vocation," defines an engineer as "a compound of common sense and mathematics. If he has not enough mathematics his lot in life will be hard. If he has not enough common sense, God pity him." This last definition brings up the importance of the theoretical training of the engineer. While there is not a great deal of mathematics used in the ordinary routine work in engineering, and while there are many "rule-of-thumb" and "pocketbook" engineers who advise that theoretical training is by no means as important as the college professors would want us to believe, yet it remains a fact that, as a rule, the men who have received the broadest training in mathematics and similar theoretical subjects, afterwards, when they have acquired the requisite practical training, become the most reliable, and frequently the most successful men, in the engineering field.

* * *

An engineering education is not only an introduction to strictly engineering work but is also becoming recognized as a useful preparation for numerous lines of business. More and more, technically educated men are making good in administrative and executive positions, because, along with business ability, their engineering knowledge, even though it has been fixed by only a very brief practical experience, gives them an advantage over those who are without such information. A knowledge of men is needed for even moderate success, but when it is coupled with a knowledge of rational construction, the two make a most forceful combination for getting many things done well.—*Engineering Record.*

SCIENTIFIC MANAGEMENT FROM A SOCIAL AND ECONOMIC STANDPOINT*†

The author of this paper wishes it to be understood that he is not an authority on "scientific management." His viewpoint is that of an outside observer with an investigating turn of mind. This position of outside observer is often a very advantageous one. An inside view alone gives us no perspective or sense of distance.

To be strictly scientific we should begin with definitions, but it is difficult for an outsider to attempt to define this new movement. In a general way, one might say, however, that the scientific management of a manufacturing concern involves the direct control by the management of every detail, and of every, even the smallest, move of every person employed, and the management of every piece of equipment or apparatus—all in accordance with thoroughly investigated and applied standards—to the end that the profits of the employers and employes alike may be increased to the highest degree possible.

Capable men all through the country are striving to put into actual working form the ideal roughly stated above. They are meeting with a large measure of success in their work, and in their enthusiasm they are making claims that look forward to great social reforms and the permanent betterment of industrial conditions. Among the things hoped for are: the permanent increase of profits and wages; the decrease of unemployment; and the growth in character and intelligence of those now classed under the general term "unskilled labor." These are the claims it is now proposed to investigate.

Comparison between Scientific Management and Labor-saving Machinery

We cannot reason about a thing whose qualities are unknown. The object must be thoroughly studied, and almost invariably when this is carefully done we find that the particular object of our study is in no sense unique, but belongs to some clearly defined class. By studying the past history and the recognized present effects of that class, we can form a clear idea of the future history and the effects of the new object or movement under consideration. This is the way in which we can investigate scientific management. The more we analyze and study its nature the more clearly do we see that it belongs to the class of labor saving machinery. All that labor saving machinery has done for the world, scientific management will do; that which labor saving machinery has failed to do, scientific management will fail to do. It should do as much—it can do no more.

Let us first ask what is the effect of scientific management on the worker. As with almost any labor-saving machine the effect is that of specialization. In place of broad, general skill and a wide range of activities, the work is confined to a few regulated motions, the necessary information for which is presented to the worker in blueprinted, typewritten or printed form. This complete specialization has aroused opposition of workers everywhere, especially where scientific management has never been tried, or is just about to be tried, or has been only half tried, or has been unwisely and clumsily tried. Where the scheme has been worked out with scientific thoroughness, the workmen have finally received it in a friendly spirit.

The reasons for this are plain: In the first place, the goal should be, and usually is, more work with the same effort; that is, easier work—not harder—but more of it. In the second place, the vast increase of the so-called "non-productive" labor, foremen, clerks, etc., necessitates in the end a change of employment throughout the whole force. The man with brains and experience enough to be a skilled mechanic, and who would object to minute supervision, is too valuable to waste on the mere mechanical machine work. He becomes a functional foreman or a productive specialist of some other kind. The unskilled man is raised from his lowly position to that of a trained machine operator, and the still less experienced man takes his former place as a helper. Of course, there are some skilled and intelligent men—but not many—who are unable to adapt themselves to the change. That has always been the case when new labor saving machines or processes have been introduced. These men may be assisted individually until they have re-adapted themselves, but, since the beginning of things, it has never been possible nor wise to stop the course of improvement for their sake.

When we consider the effect of scientific management on the profits of the employer, the analogy with labor saving machinery is especially striking. This analogy has been fully developed by Mr. Fred J. Miller, of the Union Typewriter Co. A few of his analogies are as follows:

Scientific management, like labor saving machinery, is best adapted to shops manufacturing in large quantities where the separate operations are comparatively simple, or may be made so.

Like the machine, it must be specially and skillfully adapted to the particular work in hand. An adjustable machine, supposed to be adaptable to a wide range of conditions, is likely to prove a failure. The expert designer must construct his machine or system for some particular work and for no other.

The first cost and operating cost of the machine or system must not be greater than any possible saving to be made by its use.

The most important analogy, however, is that from the business or financial point of view. The likeness between scientific management and labor saving machinery in its effect on wages and profits is absolute. Says Mr. Miller:

> "When a labor saving machine has been designed for certain work and put in operation in a certain factory, which factory is only one of a number of factories doing similar work, the profits from the use of the machine may be very large because the price obtainable for the work done by it will be based upon the cost of doing the work by the least efficient of the older machines still necessary to be employed on that work in order to supply the demand. But when all the manufacturers have similar machines at work, competition will lower the price to the ordinary return on capital invested in that general line of manufacturing.
>
> "Similarly, those who first successfully install a system of management materially better than that possessed by their competitors, may make higher profits until such efficient systems become the regular thing—and no longer. Those who are among the last to adopt a labor saving machine do not make more than regular profits. They simply are obliged to take the forward step in order to make any profit at all, or to remain in business. It is the same with systems of factory management.
>
> "Workmen who operate new labor saving machines may receive more than the ruling rate of wages, one of the reasons for this being the lowered cost of production and greater relative ability to pay higher rates; but in the end, sooner or later, the law of supply and demand will regulate this as it does all other competing or unmonopolized businesses. When the use of the labor saving machine has become general, an owner of such a machine can no longer continue to pay materially higher wages than other and competing users of similar machines.
>
> "In every way, so far as I can see, the effect upon factory employes of the use of labor saving machines and of labor saving systems of management is exactly the same, and their attitude toward them should be the same."

So we see that a system, wisely planned and carried out, may effect a substantial though temporary increase in the earnings of employer and employe alike, and it should be welcomed by both at its face value. Least of all should the workman in the engineering trades—machinery building and the like—place himself on record against it. His business in life is the building of labor saving devices for others to use; and can he object when an improvement of the same type is introduced into his own field?

Some Difficulties of Scientific Management

We have seen that substantial benefits, even though of a temporary kind, may be expected from the introduction of scientific management. We have found no logical reason for the objection of either employer or employe to a wise use of this new labor saving device. Are there any positive dangers in the idea itself or in the operations of those who are promulgating it? That there are such dangers and errors, is beyond question.

The first error is a purely commercial one, born of the zeal of the organizer. The system is not in itself the end, but only the means to an end. The true object is the simultaneous increase of the profits, wages, and good-will for all concerned, but a few organizers have mistaken this goal and have focussed their eyes on their pet system, instead of on the results to be obtained.

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* Abstract of paper read by Mr. Ralph E. Flanders, of Springfield, Vt., before the American Society of Swedish Engineers, Brooklyn, N. Y., April 20, 1912.

† For information previously published on this subject, see "Industrial Efficiency," May, 1912, and articles there referred to.

The second danger is that of obstructing invention and development along new lines. Two tendencies are constantly opposed to each other in management—the tendency toward new invention and the tendency toward standardization. Each is profitable in its place, but it takes ability and courage to balance the two properly. Consider the conditions. An immense mass of data collected at great cost is at hand. This data relates to the most efficient performance of certain operations which have been standardized for years. A new machine or process is then developed which attacks the problem in an entirely new way and with superior results. It is then difficult for the organizer to see his years of standardizing overthrown without making a struggle to save the system.

The introduction of a new system must not tend to block the development of automatic machinery by the desire to preserve the costly data for older processes. The improvement of mechanisms, after all, should be the larger vision of industrial management. With the increase of skill in our designs, the reign of the automatic machine will become supreme. With the hand-fed machine, the workman is like a slave to a master of steel and iron; but not so with the fully automatic, self-feeding mechanism. More and more will our shops approach the ideal shop of the future where the workman, as master, shall move among his servant machines, adjusting this one, changing the work of that one. In such a shop the system organizer would find his work reduced to the minimum, but progress is in that direction and the system must not stand in the way.

The third possible source of weakness in the work of the systematizer, if he has not a clear conception of the fundamentals of his work, is the misunderstanding of the most important element in his problem—the human element. Some fifteen or twenty years ago, during the height of what might be called the "biological period" of philosophy, an engineer might have been pardoned for believing that man is a machine, subject to invariable action under the laws of cause and effect, but we are now beginning to perceive that the laws governing man's actions are infinitely more complex and far beyond the powers of his own intellect to comprehend in their fullness.

There are two sources of trouble from the human factor. One is misunderstanding on the part of the workman. To overcome this requires first of all that the systematizer shall have firm assurance of the justice of his position; and then he must have tact, determination, and a real liking for the men he deals with. Confidence, willingness and enthusiasm must be built up on the solid foundation of square dealing. The second source of trouble from the human factor is a corollary of the first. The organizer must have the right attitude toward the men under him. The cause of scientific management has suffered much in this matter from some of its chief exponents. Originating as it did in the steel mills, with their vast armies of ignorant and unskilled workmen, it is natural that the system in its origin should have treated these men as so many machines, but even these men are mighty reservoirs of spiritual forces, before which laws of averages and tables of motion study are mere straws in the wind; and when the same attitude is carried into dealings with skilled and intelligent men, the scheme becomes hopelessly unworkable. It would have been better for the cause if some pages of its most authoritative tracts had never been written. There breathes through them, in spite of their protests, the feeling that the mission left to the workman is the mission of a machine—that his effectiveness to himself, his country, and the world, is measured accurately and absolutely by his output per hour in the factory. Such a view is false. The aim of the existence of the meanest laborer and the greatest captain of industry are alike—growth in individuality, character and social service. Scientific management may and sometimes does include all of these; where it does not, it is doomed to failure and deserves it.

Does Scientific Management solve the So-called Industrial Problem?

Scientific management, so far as its social and economic effects are concerned, stands, as we have seen, in exactly the same category as labor saving machinery. For a century or more the labor saving machine has been infinitely multiplying the efficiency of the individual workman. Even with the old systems of haphazard management, the labor saving machine has raised the individual efficiency to an exceptional degree. This new labor saving machine—scientific management—again multiplies this efficiency by a new factor. But does it solve the industrial problem—the labor problem? As stated, scientific management will do all that labor saving machinery has done to solve our problem—it can do as much; it can do no more.

What then has labor saving machinery done? It has multiplied the capacity to produce wealth. It has given to the workman comforts and conveniences of which the most wealthy were ignorant a century ago. So far it has done well; but it has done vastly more for the few than for the many. The difference between the wealth of the highest and the lowest has been vastly accentuated. The number of those who reap where they did not sow has been increased, and the sense of injustice in the breasts of those who are allowed to sow but not to reap is rendered keener by the greater intelligence of the present age. Hence, the doctrine of efficiency solves no problems—it makes them; it has never leveled inequalities and injustice—they have kept pace with its growth.

We will, therefore, have to look elsewhere for the solution of the industrial problem. Fortunately, the world is beginning to look elsewhere, and is beginning to see the outlines of monopolies and special privileges which have used the blessings of efficiency for their own satisfaction. We are beginning to understand that the problems that cause industrial disturbances are not the problems of production, but problems of just distribution. The immediate need of our age is not more efficiency, but better distribution of the products of the efficiency already at hand and here the engineer meets with a new responsibility. He has made the modern world what it is, but he does not ride the creature he has formed. His logical brain, his executive hand, his sympathetic heart, are all needed in the work of changing conditions for the better—in introducing greater efficiency in the distribution of wealth as well as in production. The management of society has been left long enough to the lawyers, merchants and financiers. They are good enough in their way, but the time has come when we must also call upon the engineer to take his part in the work of social service.

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LIFE SAVING AT SEA

The American Museum of Safety has just made public the fact that Judge Elbert H. Gary, on behalf of the United States Steel Corporation, has presented the museum with $5000 toward obtaining a collection of the best devices for saving life at sea, as a permanent exhibit for demonstration and study, free to the public. Dr. W. H. Tolman, director of the museum, and its safety inspector, have gone abroad to attend the International Congress of Accident Prevention at Milan, and to study the best European methods for life saving at sea, and the prevention of injurious effects of occupational diseases. The policy of the museum is now being guided by Arthur Williams, who has just assumed the presidency, succeeding Philip T. Dodge, who felt obliged to withdraw on account of ill-health and absence from the country. President Williams announces another gift of $5000 from an "unknown friend" for research work in connection with industrial poisons. Dr. Charles A. Doremus is chairman of this section of the museum's activities. The public is not only invited to visit the museum, at 29 W. 39th St., between 9 A. M. and 5 P. M. every day to study its collections, but in addition, its jury on exhibits, requests inventors and anyone else with practical ideas for life saving at sea, to submit them at the museum.

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The executive committee of the American Brass Founders' Association decided at a recent meeting to propose changing the name of the organization to the American Institute of Metals. It is stated that the reason for the proposed change is that the present name does not adequately describe the scope of the association.

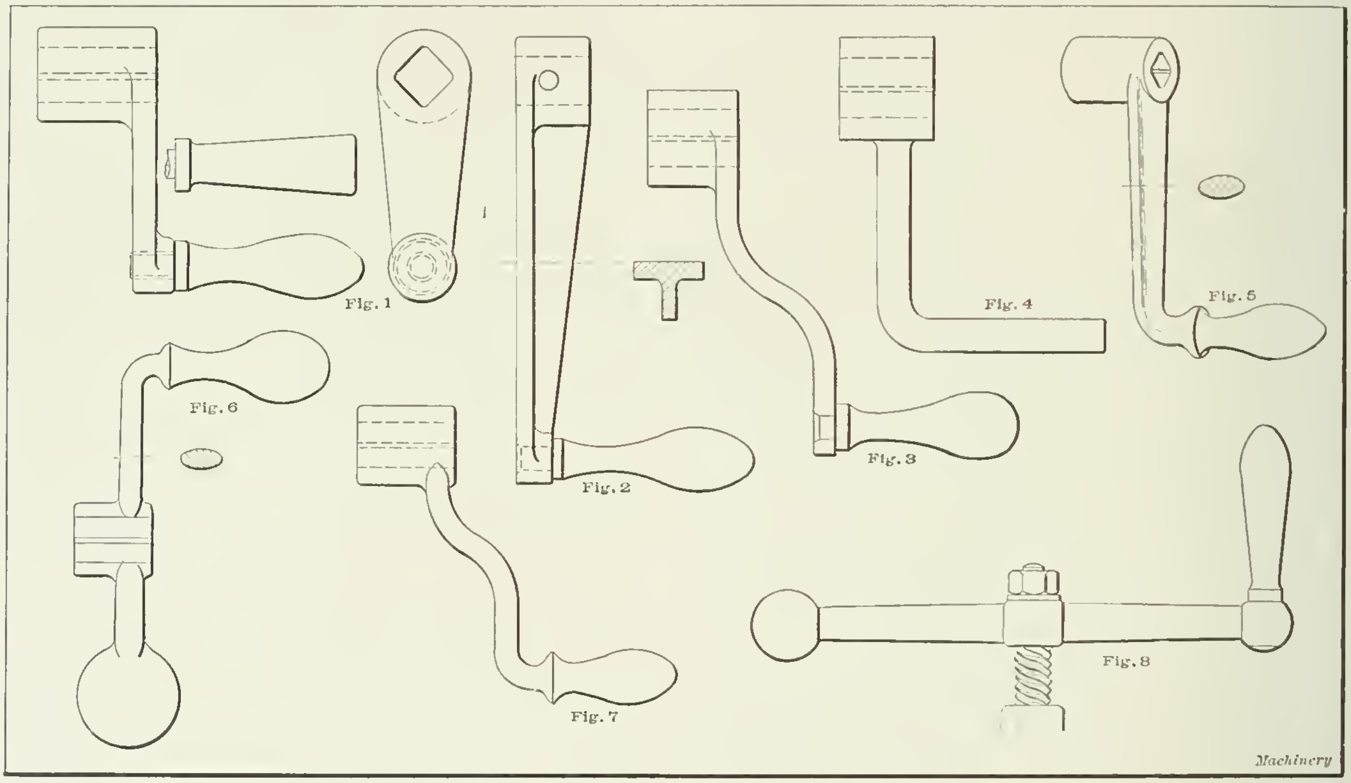
MACHINE HANDLES—1

A STUDY OF THE VARIOUS TYPES OF HANDLES AND HANDWHEELS USED ON MACHINE TOOLS

By FRED HORNER*

Handles and handwheels constitute important elements in the design of machine tools and machinery in general. Many different types and modifications are met with. Different types are required according to the particular function of the handle or wheel, and sometimes the differences are due to the individual ideas of the designer. In order to facilitate manufacture, however, the variations in the forms of handles should be limited whenever possible.

Certain types of handles, one might say, are almost national in character, as, for example, the ball handle, which was first introduced in America on account of the convenience with which it could be turned from the bar. At one time it was seldom found on English or Continental machines, although at the present time it is frequently found in Europe. On the other hand, there are many English firms which have not been influenced by American or Continental practice, and which use forged handles of a particular type on practically all machines. This peculiarity is specially noticeable in the Manchester and Glasgow districts. The size of a machine tool also has an influence on the type of the operating handles, because the conditions of work are essentially different in a large and small machine. In small machines there are many hand movements for which convenient ball handles are suitable, while in large machines the power feeds eliminate most of the hand operations, and star handles are better suited for the less frequent movements required. Frequently some kind of a wrench or ratchet lever is all that is necessary for the occasional movements or adjustments to be made.



Figs. 1 to 8. Types of Handles used on Machine Tools

The question of whether or not a handle should be loose on its shaft or fixed to it is sometimes settled by the conditions of service, while sometimes it is a question that can be decided according to the designer's fancy. If it is impossible or inconvenient to give a complete revolution to a handle it should be fitted loosely, or a ratchet employed. Occasionally, when a number of screws or shafts are adjusted at infrequent intervals, it is the practice to supply but a single handle for their manipulation. A combination of a fixed and a loose arrangement is sometimes desirable, and is accomplished by a friction or other clutch arrangement, so that the handle or wheel can be coupled to the shaft or disconnected from it at will. Sometimes, when the ends of two or more of the shafts come close together, a single handle must be used, which is slipped onto either shaft as required. The waste of time involved in this has caused some designers to so modify the arrangement as to eliminate this proximity of the shafts, and to place them so that the distance between them is sufficient to permit a fixed handle or handwheel to be attached to each. When adjustments are required frequently, it is more convenient to have individual handles on every shaft.

In the following is given a selection of the more typical designs of handles. It should be understood that these are intended to illustrate types only, and that slight differences in design are frequently met with. However, it is believed that this collection of handles shows practically all of the types that are in more or less common use.

Perhaps the simplest, and, at one time certainly the most commonly used handle, is that shown in Fig. 1. The lever part was in the past usually made of an iron casting, but is, at the present time, often cast in gun-metal. It is used generally for small lathes and other small machines. The handle is either riveted or screwed in. The plain straight handle also shown in the illustration is not as comfortable to the hand as the rounded shape. The cast-iron handle shown in Fig. 2 is occasionally used, but does not present a very neat appearance. In Fig. 3 is shown a handle with a bent lever. This form is necessary when the handle comes inconveniently close to projecting parts, such as nuts and adjacent bearings, etc. Long handles are occasionally bent out in a straight line and then bent just at the tip where the handle portion is screwed in. A handle or "screw-key" frequently used in English designs is shown in Fig. 4. This is forged in one piece with the handle portion formed simply by bending the circular stem. It is not a very good looking handle, but seems to be a favorite among many machine-tool makers, particularly in the Manchester and Glasgow districts.

The solid drop-forged handle, with a shaped portion for the hand, shown in Fig. 5, is probably employed to a greater extent in America than elsewhere, although, with the spread of drop-forging practice, its use is continually extending. The type shown in Fig. 7 is necessary in designs where on account of clearance, or for other reasons, the straight shape is impracticable or at least inconvenient. The most popular style of handle for ordinary use on slides and other parts that have to be frequently adjusted or manipulated is the balanced ball handle shown in Fig. 12. This is turned out of solid stock with forming tools and provided with a screwed-in handle, as shown. Sometimes the handle is fitted with a taper, as indicated in the detail view. Ball handles with much longer arms, as in Fig. 8, are used to a moderate extent where greater leverage is required. French makers are particularly fond of using them, the example shown being taken from a French screw machine. The drop-forged style, shown in Fig. 6, has the handle formed in one with the body. This handle has a pleasing appearance, and the choice between this and the turned type depends entirely upon manufacturing conditions.

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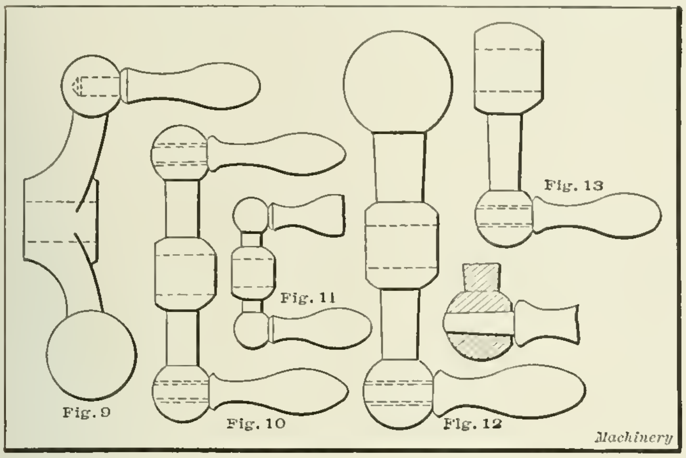
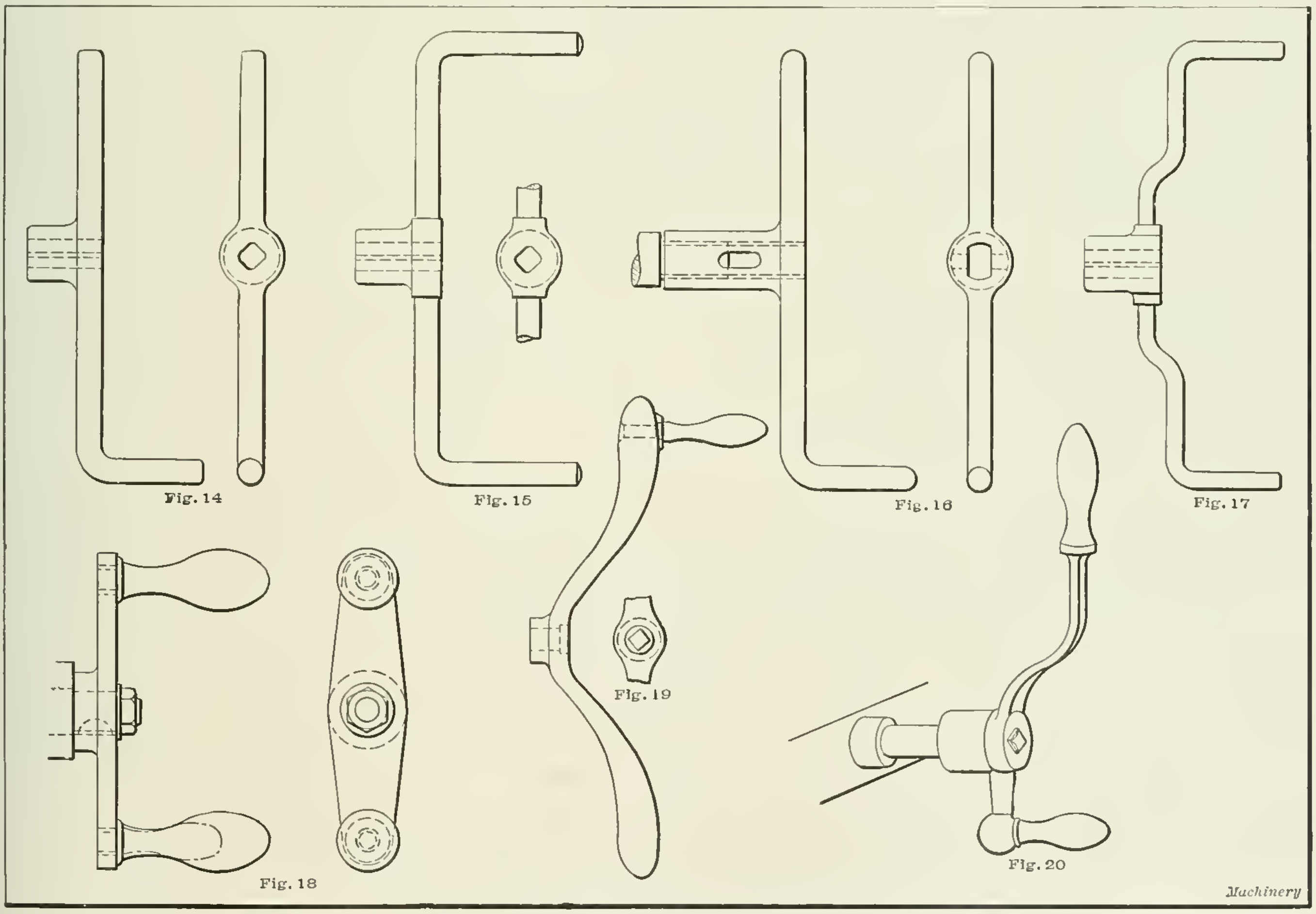


Figs. 9 to 13. Types of Handles used on Machine Tools

Ball handles are seldom used in cases where the unbalanced action is of no consequence, as, for instance, when the screw to be operated stands in a vertical position, as the feed-screw of a shaper tool-box. The handle shown in Fig. 13 would, however, be objectionable where the extra weight on the one side would tend to let the handle gradually drop under the influence of vibration, so as to move a screw or other portion and thus alter the adjustment. The balanced ball handle, if accurately designed, obviates this tendency. Ball handles with the balls on the ends in line with the center of the hub cannot always be used where the clearance space is limited, and the forged type shown in Fig. 9 is then employed.



Figs. 14 to 20. Types of Handles used on Machine Tools

The double-ended ball handles, shown in Figs. 10 and 11, give a more perfect control over the movements of a slide, and the handle is always within easier reach than in the case of the single-handled form. A type of double-ended handle much used in certain English and Scotch machine tools is that shown in Fig. 14, which is forged with round bar ends, one being bent as indicated. The type shown in Fig. 15 is also employed to a large extent; in this, both ends are bent. It is sometimes made in the shape shown in Fig. 17, when the clearance is limited. Handles of this type are sometimes fitted upon flatted spindles, as indicated in Fig. 16, and are also made with a cotter-way cut through it as illustrated. The object of this is to enable a cotter to be driven in to draw the handle off, if it should be jammed in place.

A frequently used type of double handle, having a web or plate body with the handles screwed or riveted in place, is shown in Fig. 18. The handles are either of equal size as shown, or one is made smaller than the other, as indicated by the dotted lines, so as to leave the hand and wrist less encumbered for rapid rotation. A different type intended for the same purpose is shown in Fig. 20. This is used on a hand milling machine; the leverage for one handle is long and is intended to give the required power for feeding, while the leverage of the other is short for rapid turning when making quick adjustments. A similar principle is embodied in the handle shown in Fig. 19, intended for turning a chuck, in which the ends are alike, but one has a transverse handle riveted to it for rapid rotation.

In Fig. 21 is shown how the movement of a handle is conveyed to a vise on a Lincoln milling machine, where the square on the vise screw happens to come over the table, thus preventing the full rotation of the handle were it attached directly to the end of the screw. A supplementary spindle is, therefore, provided for rapid manipulation, this spindle being supported in a bracket bolted to the table, and the handle applied to it.

Loose handles which turn on a stem or central spindle are used to a considerable extent. These can be rapidly operated with less friction and fatigue to the hand. Either steel, glass, horn, wood or other similar substances are employed for the loose part; horn is more durable than wood, and is a very popular material for this purpose. A steel or brass handle, as shown in Fig. 22, fits directly on the pin fastened to the handle or wheel, but wood and horn handles require a bushing, as indicated in Fig. 23. In Fig. 22, it will be noticed that an oil groove is provided for lubrication.

The two-ended type of handle, shown in the previous illustrations, and also illustrated in Figs. 24 and 25, does not meet with all requirements in machine-tool operation, particularly when rapid movements are desired, and where considerable power must be exerted, as, for example, in the operation of turret lathe slides, lathe carriages, drilling and boring machine slides and spindles, etc. Star handles or "spiders" are then employed for this purpose. The simplest type of star handle is shown in Fig. 34. It is made of a steel forging with flat handles, which are either straight or bent as shown in the alternative design in the upper part of the right-hand view. A more neatly designed type, forged with round tapered handles, either straight or bent, is shown in Fig. 33. In Figs. 27 and 29, other forms are indicated.

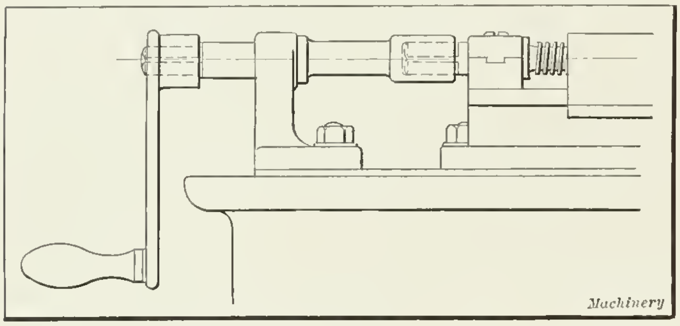
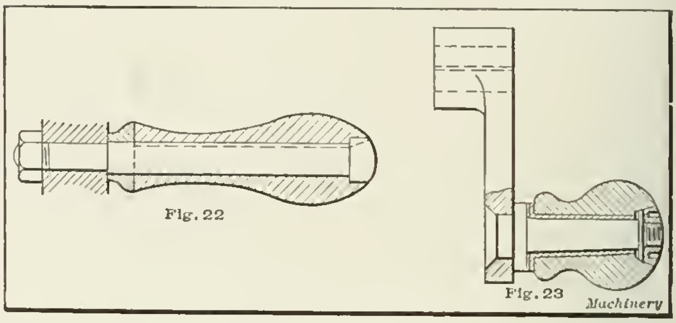
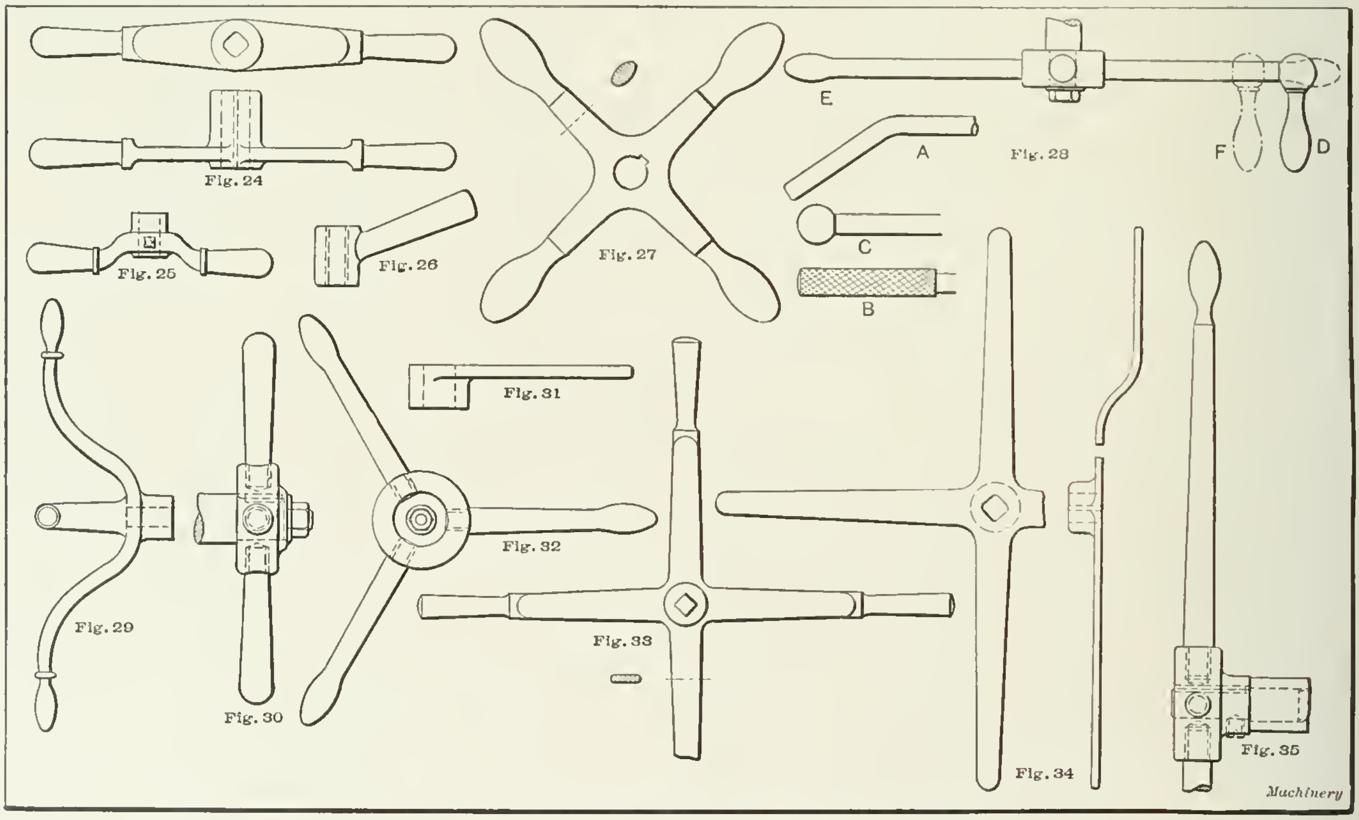


Fig. 21. Extension Spindle and Handle on Lincoln Milling Machine

In very large spiders, such as those sometimes used on boring mills and large turret lathes, the four or more star handles are screwed into the short arms of the central cast-iron boss. This type is used on account of the simplicity in making. As these star handles grow larger, however, the usual design takes the form of a central boss of cast iron into which forged or turned steel handles are screwed or pinned or held with nuts, making a graceful and light design, and one that is easy to manufacture and assemble. Handles of this type are shown in Figs. 30 and 32, the one having four and the other three handles. The handles are tapered or formed to prevent the hands from slipping off too easily, or are sometimes knurled. In Fig. 35 is shown a large "spider" for a chucking-lathe turret slide where the bearing of the spindle is brought out so as to avoid the necessity for bending the star handles outward. When it is necessary to bend these handles, however, this is done either as indicated at *A* in Fig. 28, or by putting them in at an angle as indicated in Fig. 36, the dotted lines showing a case where the angularity is considerable. Returning to Fig. 28, this figure shows the alternative designs *B* and *C* for the handle ends, the first being knurled for a certain distance, and the second having a knob or ball end. All these handles are used on turret lathes and for similar purposes. The handle shown at *D*, Fig. 28, provides a means for rapidly rotating the spider. This handle is attached to but one of the star spokes. This arrangement is varied by leaving all the handles as indicated at *E* and putting handle *D* further in on the spoke, as shown by the dotted lines at *F*. This leaves the star for feeding and provides a handle for rapid rotation.



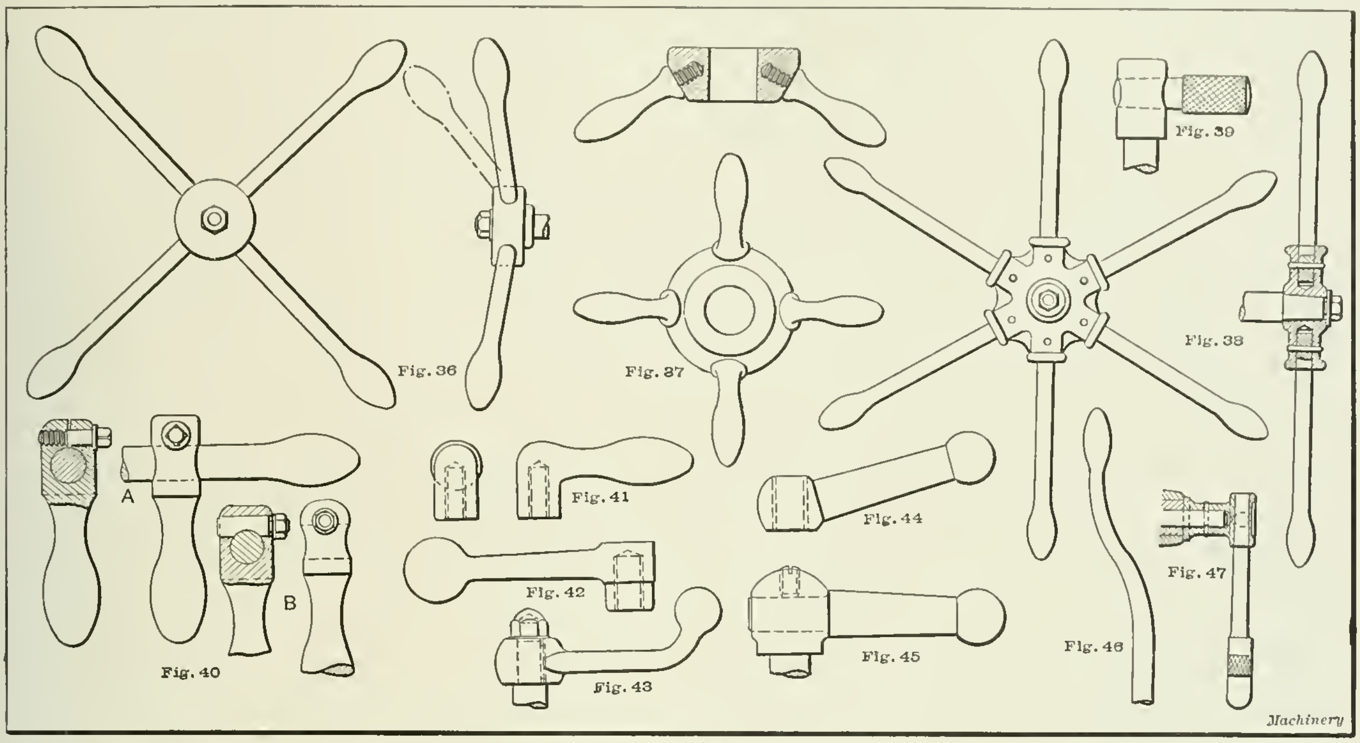
Figs. 22 and 23. Examples of Loose Revolving Handles



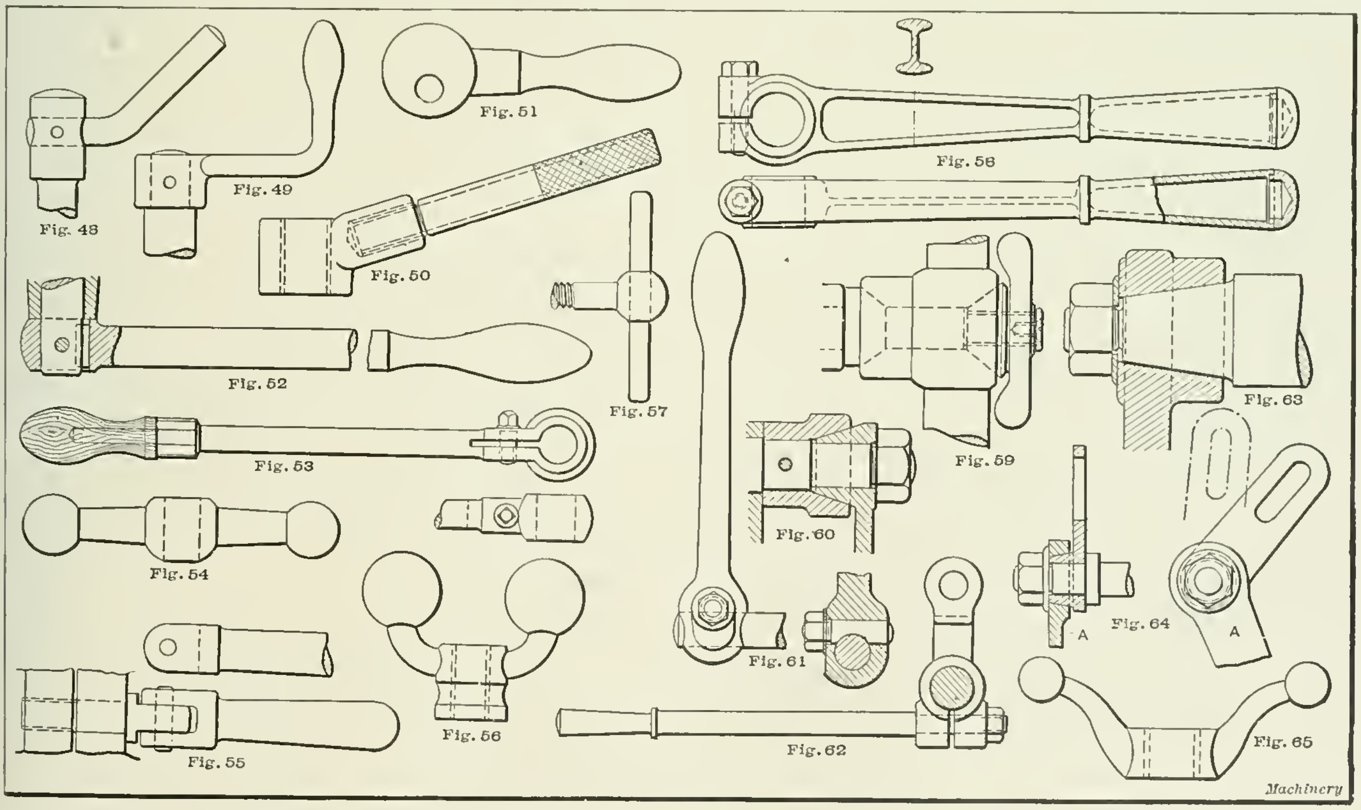
Figs. 24 to 35. Types of Handles and Star Wheels used on Machine Tools

A practice still more common is that of fitting handles *D* or *F* loosely, so that *D* can be attached to any plain bar and also adjusted for radius, to suit the throw which each particular operator prefers. The usual method for designing such a handle is with a split and a set-screw, as shown at *A*, Fig. 40. Occasionally a plain set-screw bearing on the bar is used. Another method is to use a grip-bolt as shown at *B*, drawn up by its nut to press on the bar and thus lock the handle.

Other types of star handles are illustrated in Figs. 36, 37 and 38. The first is a simple design of star handle with a cast-iron boss, the handles being screwed in at an angle. This type is largely used in connection with certain feed motions. That in Fig. 38 is used for large turret lathes, the handles fitted having plain or slightly tapered ends and being fastened by taper pins. Star or pilot handles of this design are provided with up to eight or ten handles, and when two of them are placed adjacent, one in front of the other, on a shaft and a sleeve, respectively, the number of handles in each is occasionally varied, and the outer handle is provided with shorter arms than the inner, for convenience in manipulation.



Figs 36 to 47. Types of Handles and Star Wheels used on Machine Tools



Figs. 48 to 65. Types of Handles used on Machine Tools

The handles so far illustrated have been principally intended for operating screws, pinions or other parts requiring a complete revolution, but there is a large and more varied class employed chiefly for partly rotative movements of a fraction of a circle. These are for such functions as locking or for throwing movements into operation, clutches into gear, giving part revolution to a pinion, for locking a larger main handle, a slide, or a quadrant, feeding a slide, operating a chuck, and many similar functions. Some of these are really wrenches in the forms of handles, and are used to avoid the frequent application of a loose wrench. Others are wrenches, pure and simple, with a square or hexagonal hole, and with the usual handle portion of a different type from that of the ordinary wrench. Others, again, are nothing but nuts, with some kind of handle, wing, or ear. One of the plainest kind of handle of this type is shown in Fig. 31, and consists of a boss with a threaded, square, or hexagonal hole and a flat handle. Sometimes the handle is circular and tapered as shown in Fig. 26; this type of handle is more convenient to manipulate and is used when it is frequently operated. A drop-forged type with a nut portion is shown in Fig. 41. Ball-ended handles, Figs. 42 and 43, are most suitable for the operation of mechanisms where a decided throw is required from one extreme position to the other, as for clutches, clasp-nuts, and similar mechanisms. The ball end is also well suited for larger handles or levers in places where a belt-shipper or clutch or similar striking gear is thrown in very suddenly. Figs. 44 and 45 show two variations of turned ball-handles, the one made solid and the other fitted into the head of the screw or spindle, and locked with a headless set-screw.

When but a small leverage is required, an arrangement like that in Fig. 39 is often adopted; or like that in Fig. 48, if the space for the hand is obstructed at the surface of the slide or other part of the machine, by nuts or other outstanding objects. Not only nuts, but other details are frequently made solid with their handles, pinions or quadrant teeth, or eccentric or cam portions, as indicated in Fig. 51. This makes a solid construction and eliminates the key or other fastening required.

Lightness is not usually a point in handle designs except when the handles are used in portable machines, and for certain devices, as opening dies. In certain instances, however, a piped form of handle may be provided, as shown in Fig. 50. In Figs. 47 and 49 two types of handles are shown, one for operating the tailstock spindle of a bench lathe, and the other for turning a vertical feed-screw, where occasional rapid complete revolutions are alternated with slight adjustments. A handle long familiar on certain designs of upright drilling machines, is shown in Fig. 46. This handle is forged directly to an extension of an adjusting screw. It is, of course, nothing but a bent forging, but illustrates that in certain instances even long handles may be made in one piece with the part being operated.

Longer levers for operating movements requiring considerable power are either of the plain type shown in Fig. 52, which is simply keyed or pinned onto the spindle or screw, or they are attached by a split boss and set-screw, as shown in Fig. 53. This latter design permits of adjustment in radial position to suit the convenience of the operator, and is met with in the feed lever of cross-slides and vertical forming slides on hand-milling machines, etc. The wooden handle on the end of the lever is used because it is more comfortable than a steel handle for constant operation. Fig. 58 illustrates a cast handle with a web of H-section, and a hollow handle portion with a cap screwed onto it. Instead of using a split boss for clamping, the draw- or grip-bolt method, as shown in Fig. 61, may be utilized.

The adjustment of the radial position of the handle is provided for in other ways besides those just illustrated. A favorite method is that of utilizing a cone as shown in Fig. 63, the handle being forced on by the nut. Another method is shown in Fig. 60, where the cone is fitted inside a collar which is pinned on the spindle. In Fig. 64 an arrangement is shown which is adopted for a turret lathe cross-slide. The handle *A* is locked to a slotted link (which moves the slide) by a cone and nut, so that the relative angular setting can be varied to bring the handle *A* into a higher or lower position, according to the setting of the tools and the diameter of the work. Another method for making a handle adjustable, or for allowing it to swing freely, is by a friction clutch device, as shown in Fig. 59.

The shapes of double-ended handles for the same purposes as those just mentioned depend chiefly on the size and the function of the handle. For simply tightening a plain cross-handle, the type shown in Fig. 57 is sufficient, or a more comfortable ball-handle, Fig. 54, may be employed. Two varieties of ball-ended handles are shown in Figs. 56 and 65. The ball ends give a flywheel effect that helps in rapid tightening and loosening, which is a feature of value when these operations are repeated at frequent intervals.

A handle attached to the end of the spindle, for operating a belt-shifting mechanism for a small countershaft, is shown in Fig. 62. When it is necessary to hinge handles so that they may be folded back out of the way after use, the type illustrated in Fig. 55 is used.

* * *

One of the few available materials that will stand the high heat of the blow-pipe used for melting platinum, is lime, and this material is almost exclusively used for crucibles for melting platinum. The lime used is regular burnt lime and not limestone. Large pieces free from fissures and foreign matter should be selected.

SOCIETY OF AUTOMOBILE ENGINEERS SPECIFICATIONS FOR STEEL*†

In a report by the Iron and Steel Division of the Society of Automobile Engineers, January, 1912, very complete specifications for the composition, heat treatment and properties of various kinds of steel, are given. In the following article the most important parts of these specifications will be reviewed. Tables relating to the composition, heat treatment, etc., of carbon, nickel, nickel-chromium and chromium-vanadium steels are given in the accompanying Data Sheet Supplement.

The steels specified may be of open hearth, crucible or electric manufacture, and must be homogeneous, sound and free from physical defects, such as pipes, seams, heavy scale or scabs, and surface and internal defects visible to the naked eye. The figures given in the tables for physical characteristics or properties of the various steels refer to sections common in automobile construction that is, to bars from 1 to 1½ inch round. The high elastic limits can be obtained only on small sections with very careful heat treatment, while the low elastic limits can be expected on heavy sections with less refined or severe heat treatment.

Carbon Steels

The 0.10 per cent carbon steel is usually known to the trade as soft, basic open hearth steel, and is commonly used for seamless tubing, pressed steel frames and brake-drums, sheet steel brake-bands, etc. It is soft and ductile and will stand a great deal of deformation without cracking. In its natural or annealed condition it should not be used where a great deal of strength is required. The quality of this material, however, is improved by cold drawing or rolling. An important fact to remember is that this steel when cold drawn or rolled is returned to the characteristics of the annealed material by heating. This remark also applies to all materials the elastic limit of which has been increased by cold working.

The 0.10 per cent carbon steel in its natural or annealed state cannot be easily machined. It will tear badly in turning, threading and broaching operations. Heat treatment has little effect upon it, and does not increase its strength but only the toughness. The heat treatment which will produce some stiffness is to quench it in oil or water at a temperature of 1500 degrees F. No drawing is required. This steel will caseharden but is not as suitable for this purpose as 0.20 per cent carbon steel. This latter steel is often known to the trade as machine steel and is intended primarily for casehardening. It forges well and machines well, but is not suitable for screw machine work. Its particular use is for forged, machined and casehardened parts, where strength is not of especial importance. It can also be drawn into tubes and rolled into cold rolled forms and is a good frame material. It can be interchanged with 0.10 per cent carbon steel for cold pressed shapes.

Heat treatment of 0.20 per cent carbon steel does not increase its strength to any degree, but causes a refinement of the grain after forging and increases the toughness; all that is necessary is to quench it in oil at 1500 degrees F. The casehardening treatment specified in the accompanying Data Sheet Supplement is the most important treatment for this quality of steel. The heat treatment specified as "A" is for parts which do not need to carry a great deal of load or withstand shock, but simply must have a hard surface. Heat treatment "B" is for the parts which must not only be hard on the surface but also must possess strength, as, for example, gears, cam rollers, steering-wheel pivot-pins, etc.

The 0.30 per cent carbon steel is primarily a structural steel. It forges well, machines well, and responds to heat treatment in regard to strength as well as toughness. It is used for such forgings as axles, driving-shafts, steering pivots and other structural parts. This quality of steel is not intended for casehardening, but, by careful treatment, it may be safely casehardened, although it is used for this purpose only as an emergency. In that case, it should be given a double heat treatment, followed by a drawing operation.

The 0.40 per cent carbon steel is a structural steel of greater strength than that previously mentioned. Its uses are more limited and generally confined to such parts as demand a high degree of strength and a considerable degree of toughness. It is commonly used for crankshafts, driving shafts and propeller shafts. It has also been used for transmission gears, but is not quite hard enough for casehardening, and when casehardened, not tough enough to make safe transmission gears. When properly annealed it machines well, but is not suitable for screw machine work. The 0.50 per cent carbon steel differs but little from that just described, although owing to its higher carbon content, it is somewhat harder to machine and also somewhat stronger.

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* With Data Sheet Supplement.

† See MACHINERY, September, 1911, "Composition and Heat Treatment of Carbon and Alloy Steels."

The 0.80 per cent carbon steel is ordinarily known to the trade as spring steel, and is generally used for springs of light sections. The 0.95 per cent carbon steel is also generally used for springs. When properly heat treated extremely good results are possible. The quenching temperature, as specified in heat treatment "F" in the Data Sheet Supplement, should, if anything, be lower than that specified. Because of the high carbon content, the steel is used considerably for heavier types of springs.

Screw Stock

The composition of ordinary screw stock is not given in the accompanying Data Sheet Supplement, but should, in general, be about as follows: Carbon from 0.08 to 0.20 per cent; manganese, 0.30 to 0.80 per cent; phosphorus, not to exceed 0.12 per cent; sulphur, 0.06 to 0.12 per cent. The characteristics and heat treatment of this steel were given in an article on "Composition and Heat Treatment of Carbon and Alloy Steels," published in MACHINERY, September, 1911, engineering edition.

Nickel Steels

With regard to the use of all alloy steels it should be borne in mind that such steels must be heat treated and not used in the annealed or natural condition. In the latter condition they are but slightly superior to plain carbon steels. In the heat-treated condition, however, a marked improvement in physical characteristics is shown.

The 0.15 per cent carbon nickel steel, the analysis of which is given in the accompanying Data Sheet Supplement, is suitable for carbonizing purposes. Steel of this character properly carbonized and heat treated will produce a part with an exceedingly tough and strong core and a hard exterior. This steel can be used for structural purposes, but is not especially suitable for this purpose. It is intended for casehardened gears and for such other casehardened parts as require both strength and hardness. The 0.20 per cent carbon nickel steel may be used interchangeably with that just described. It is intended primarily for casehardening purposes, but may, with suitable heat treatment, also be used for structural parts. The 0.25 per cent carbon nickel steel may also be casehardened successfully and is satisfactory for gears—either of the transmission or the rear axle bevel type. The treatment for carbonizing must be slightly modified to meet the increase in carbon content. It can also be used for many structural parts if subjected to heat treatment "H" or "K."

The 0.30 per cent carbon nickel steel is primarily used for structural parts where strength and toughness are required, for example, such parts as axles, crankshafts, driving-shafts and transmission shafts. Wide variations as to elastic limits are possible by varying the quenching mediums—oil, water or brine—and by variations in the drawing temperatures. This material may be casehardened, but is not suitable for that purpose. The 0.35 per cent carbon nickel steel is very similar to that just described.

The 0.40, 0.45 and 0.50 per cent carbon nickel steels are not widely used, but are available for certain purposes. A greater hardness is obtainable in these steels than in those of the lower carbon contents, but as increased brittleness accompanies the greater hardness the treatment given must be modified to meet these conditions. For example, the final quenching must be at a lower temperature in order to produce the desired toughness and other properties. The strength of these steels depends upon the heat treatment and may be controlled closely over a wide range.

Nickel-chromium Steels

There are three types of nickel-chromium steels in common use, known as low, medium, and high nickel-chromium steels. In general, it may be said that the heat treatment and properties of these steels are much the same as those of the plain nickel steels, except that the effects of the heat treatment are somewhat augmented by the presence of chromium. The low nickel-chromium steels with carbon contents up to 0.20 per cent are intended primarily for casehardening, while those with carbon contents from 0.25 to 0.40 per cent are intended primarily for structural purposes. Those with carbon contents from 0.45 to 0.50 per cent may be used for gears and other structural parts where a high degree of strength and hardness is demanded and where toughness is not of first importance.

The medium nickel-chromium steels are of the same composition as the low nickel-chromium steels except that they contain more nickel and chromium. Their general usage is practically the same as already mentioned for the low nickel-chromium steels.

The high nickel-chromium steels require different heat treatments from the other two types mentioned on account of the amount of nickel and chromium that they contain. Annealing before machining will be found necessary for these steels. The higher percentages of nickel and chromium make machining in a natural condition difficult. The steels with low carbon contents are casehardened the same as in the case of low nickel-chromium steels, and those with higher carbon contents are used for structural parts. In general, these steels are used for parts of an important character, and where unusual strength is demanded. The 0.45 per cent high nickel-chromium steel, for example, is used for gears where extreme strength and hardness are necessary. The carbon content is sufficiently high to cause the material to become hard enough to make a good gear when quenched, without being casehardened. This steel, however, is difficult to forge. During the forging operation it should be kept at a high or plastic heat and should not be hammered or worked after dropping to ordinary forging temperatures, as cracking is liable to follow. On the other hand, too high a temperature is not advisable, as the steel then becomes red-short and breaks.

Chromium-vanadium Steels

Chromium-vanadium steels are used for many automobile parts, particularly springs, axles, driving-shafts, and gears. They are used interchangeably with carbon steels, nickel steels and nickel-chromium steels. Those qualities which contain from 0.15 to 0.20 per cent carbon are intended primarily for casehardened parts, while those of from 0.25 to 0.50 per cent carbon are used for structural parts. The 0.25 per cent carbon steel may be casehardened, but is not suitable for this purpose. The 0.40 per cent carbon steel is of a very good quality, to be selected where a high degree of strength is desired coupled with a moderate measure of toughness. It is a first-class material for high-duty shafts. The 0.45 per cent carbon steel may be used for gears and springs. When used for structural parts, if an exceedingly high strength is desirable, heat treatment "T" should be used instead of treatment "U." The 0.50 per cent carbon chromium-vanadium steel is suitable for springs and gears. The final drawing temperature must vary with the section of material being handled; it must be taken into account, for example, whether light spiral springs or heavy flat springs are being heat treated.

Valve Metals

Specifications for valve metals are not given in tabulated form in the Data Sheet Supplement. Nickel valve metals, however, may be made to two specifications: Valve metal No. 1, which should contain not less than 96 per cent of nickel, and valve metal No. 2, which should contain from 28 to 35 per cent of nickel. These metals also contain carbon, not over 0.50, manganese, not over 1.50, and phosphorus and sulphur, each not exceeding 0.04 per cent; the remainder to be iron. These metals do not respond to heat treatment. The best that can be done with them is to treat them for the purpose of securing uniformity of structure by annealing or quenching at 1500 degrees F. or thereabouts.

Steel Castings

The specifications for steel castings are not given in the Data Sheet Supplement, but the following composition is desired:

Carbon, from 0.30 to 0.40 per cent (0.35 per cent desired);
Manganese, from 0.50 to 0.80 per cent (0.65 per cent desired);
Phosphorus, not to exceed 0.05 per cent;
Sulphur, not to exceed 0.05 per cent;
Silicon from 0.10 to 0.30 per cent.

This composition refers to genuine steel castings and not to malleable iron or complex mixtures often found in the market masquerading under the name of steel. Genuine steel castings should be annealed and may be heat treated to great advantage. A steel casting of the composition given in the specifications should be tough enough to bend to a considerable angle without breaking. The elastic limit of such a casting in an annealed condition is in the neighborhood of 35,000 pounds per square inch. Like other castings, steel castings are subjected to blow-holes. They are, therefore, not to be used in vital parts of the mechanism. It is impossible to inspect against blowholes, and steel castings for axles, crankshafts and steering-spindles are used only at great risk. The specifications given furnish a fair commercial analysis. Freedom from blowholes and proper physical conditions are of more importance than the exact adherence to the analysis given.

* * *

THE TITANIC TRAGEDY

Immediately following the wreck of the White Star steamer *Titanic*, which sunk April 15, a few hours after colliding with an iceberg 800 miles off the coast of Newfoundland and carried down over 1600 of the passengers and crew, an investigation was started by a United States Senate committee appointed to determine the facts of the disaster. Appalling as is the tragedy the facts of the contributing causes brought out in the sworn testimony of survivors are no less so:

It was shown that the captain had received wireless warnings of the proximity of icebergs, that a speed of approximately twenty-one knots was maintained in the face of the known danger, that the vessel was undermanned, that the passengers were not promptly warned of the imminence of sinking after the collision, that the lifeboat equipment was sufficient for less than half the passengers and crew, that the crew had not handled the lifeboats and were unfamiliar with the vessel, that the boats were not systematically filled, and that the wireless equipment of this and other vessels is inadequate.

The theory of the unsinkableness of modern vessels fitted with bulkheads dividing them into compartments, is based upon the supposition that collision would, at most, cause the rupture of not more than two compartments, but the experience with the *Titanic* shows the fallacy of the idea. When the iceberg was sighted a quarter mile dead ahead, the helmsman immediately shifted the rudder hoping to avoid the obstruction but instead the vessel "sideswiped" it and tore her side open, making a great rent probably over two-hundred feet long. Foundering was inevitable.

Great as is the loss of life, it is but a small fraction of the total annual human destruction due to accidents of the industries in the United States alone, which goes on year after year, creating hardly a ripple of protest in the world at large. To the average engineer the fact that this great vessel could be lost so quickly and so hopelessly is probably a greater shock than the loss of life. His pride of achievement is humbled; he is brought face to face with the grim fact that all the practicable improvements in marine vessels so far devised will be of little avail if the commanding officers are required to break speed records when dangers of fog, derelicts and icebergs are imminent. The energy of a vessel displacing 66,000 tons and moving at twenty knots is so great that almost any structure that can float will be torn asunder if that force is suddenly expended on it. Airtight compartments, that is bulkheads and airtight decks between, with pipes connected to a compressed air supply, might have saved the *Titanic* had the crew been disciplined to act promptly in a great emergency, but under the conditions existing as brought out by the Senate committee, it is doubtful.

* * *

Idler gears should be made as large as possible, because the wear on the teeth of these gears is twice as great as on the driving or driven gear.

HEAT-TREATMENT OF STEEL BY THE ELECTRIC FURNACE*

By H. RALPH BADGER†

In properly managed shops, the heat-treatment of steel is today receiving thorough attention. To produce a tool of such high quality that it will give several times the service of a tool that has not been properly heat-treated, is an important factor in shop economy. To accomplish this result it is necessary to know the laws governing the hardening of steel. If we clearly understand the causes underlying the changes which take place when steel is subjected to various heat-treatments, we have the basis for a positive control of the quality of the finished product. "Electric heat" is a new and important means to this end.

Heat-treatment of Steel

We heat and quench a tool because we want it to be harder. In every case the object of this treatment is to change, in some degree, certain of the physical properties of the steel. The effect of heat upon a piece of steel depends on the nature of the steel—that is, upon its composition, its form or external shape, and its internal structure. The raising of the temperature of the piece sufficiently will produce a change in the form, so as to increase its volume by causing a lengthening in some directions. In the structure of the steel itself this may introduce mechanical strains in the fibers. Mostly, however, these are but temporary changes, and, with proper heat-treatment, they disappear when the piece is again cooled.

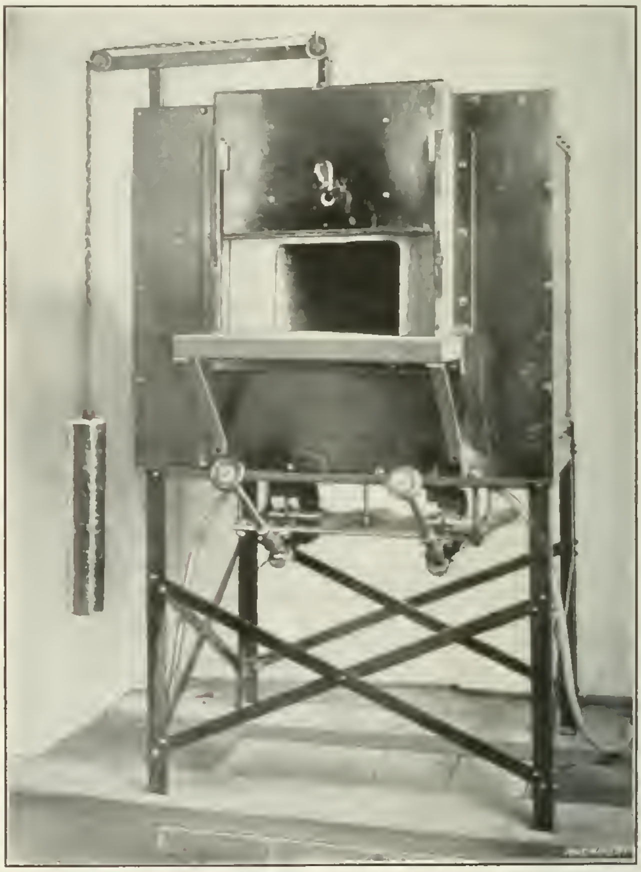
Fig. 1. Hoskins Electric Furnace for Use in Hardening and Tempering Carbon and High-speed Steel Tools

Changes in the chemical arrangement of the elements composing the steel are produced when the temperature of the piece is raised to a sufficient degree. These are the changes that are effective in hardening and tempering. If the piece, once heated to a sufficient temperature to produce hardening, is allowed to cool very slowly, these "changes" of chemical arrangements revert to their original condition; but if the piece is cooled quickly — quenched — immediately upon removing it from the source of heat, the changes are made permanent.

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* For additional information on this and kindred subjects see the following articles previously published in MACHINERY: February, 1912, "Enamelite for Selective Hardening," and "Notes on Quenching Fluids"; January, 1912, "Hardening Solution for Tool Steel," "A Hardening Solution," and "Mixture for Hardening Tool Steel and Casehardening Machine Steel"; December, 1911, "Cramer Process for Hardening High-speed and Carbon Tool Steel"; November, 1911, "The Correct Use of Hardening-room Terms"; September, 1911, "Composition and Heat Treatment of Carbon and Alloy Steels"; April, 1911, "The Use of Barium Chloride for Heating Steel for Hardening"; August, 1910, "Hardening High-speed Steel"; June, 1910, "Heat Treatment of Carbon Steel," and "Apparatus for Hardening Milling Cutters"; June, 1910, engineering edition, "The Hardening of Carbon Steel," and "Hardening Carbon and Low Tungsten Steels"; March, 1910, "Hardening Small Blanking Dies"; January, 1910, "Hardening Carbon Steels." See also the previously published information referred to in connection with the last-mentioned articles, and MACHINERY's Reference Book No. 46, "Hardening and Tempering," and No. 63, "The Heat Treatment of Steel."

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For steels of different composition, that is, made up of either different elements or of different proportions of the same elements (iron, carbon, etc.), there are different critical temperatures at which these changes take place. Corresponding differences in the heat-treatment are, therefore, necessary to produce the best results. Even two pieces of the same steel which vary greatly in their form must be treated differently. This is true also of two pieces of steel whose composition and form may be identical, but whose ultimate use may be different.

Examples of all three of these conditions occur constantly in shop practice. The intelligent hardener knows that a complicated die must be handled differently from a straight lathe tool, and a shaper tool for soft metal need not be as hard as one for hard metal, even though all of these pieces be made from the same steel. The next step ahead is to treat different kinds of steels according to their particular requirements. Various high-speed steels, high-carbon steels, and low-carbon steels are given individual treatment. Each is subjected to the conditions of heating and subsequent handling that will bring out the maximum of its useful characteristics. To meet the wide range of requirements and to avoid the losses of tools spoiled in hardening, there are three factors in the heating of steel which should be observed: First, the quality of the heat; second, its uniformity; and third, its degree.

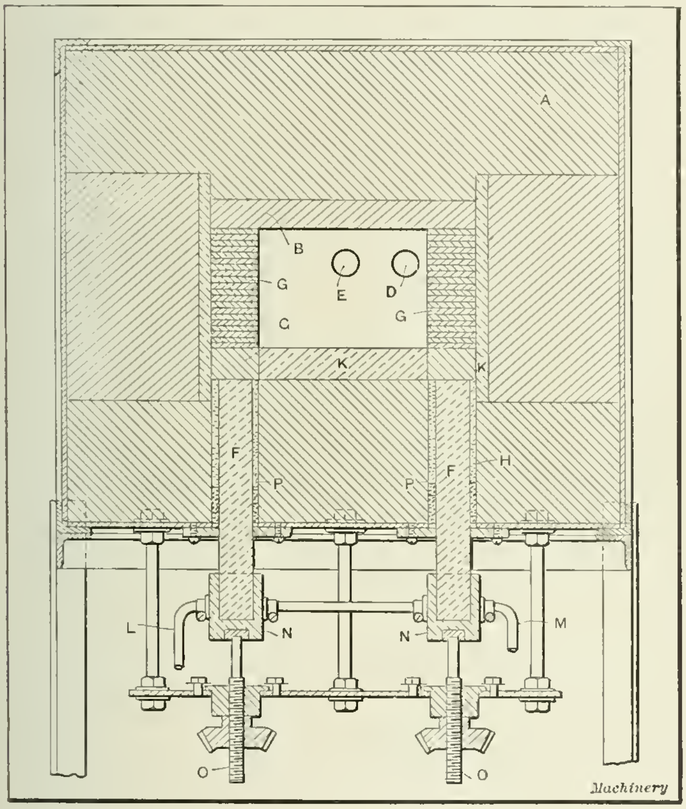

Fig. 2. Section through Electric Furnace

Under ideal conditions the steel would be subjected to a heat effect only, as this alone is necessary to produce the desired changes. In practice, however, it is difficult to produce heat of the necessary intensity without having the quality of it impaired by the presence of flames or oxidizing gases and sulphur and other injurious fumes. Freeing the heat from such attendant defects would obviously greatly improve the quality of the finished product; also the more uniformly heat can be applied to all parts of the piece, the more uniform will be the hardening or tempering. These two factors are positive and constant in their desirability for all ordinary work. The third factor—the degree of heat—is the variable quantity. It is this factor, the temperature, that is chiefly manipulated to meet the requirements of different steels and of the same steels for different purposes. While other conditions have a certain influence, the temperature is the controlling factor in all heat-treatment. The evil effects of too high a temperature—the common failing—are well understood.

The length of time during which the steel is actually heated is an important point closely connected to that of the temperature. With a heating chamber of sufficient size to supply the necessary heat to the piece, the internal change in the steel that results in hardening can be effected, in general, in one of two ways; either the piece may be heated for a short time at a relatively high temperature, or for a longer interval at a lower temperature. Both may produce hardness. The writer has seen fractures of small pieces of steel which after preheating were heated for but thirty seconds at a temperature 300 or 400 degrees higher than the hardening point, that compared very favorably with similar fractures of the same steel heated for four or five minutes at a temperature but little above the critical point. Thus the quantity of heat absorbed by the piece being treated is seen to be practically a product of the temperature of the heating chamber and the time the piece is left in it. In other words, the time of heating varies inversely as the temperature of the chamber in which the piece is heated. This still further emphasizes that "temperature should be the controlling factor," because, of the two extremes, the ordinary dangers of burning the steel on account of too high a temperature, and of causing it to crack due to too rapid, irregular heating, are far greater than those of "over-soaking" at lower temperature. To heat at the lower temperature is plainly the safe course, due both to its cutting down the grave danger of over-heating and to the greater uniformity with which heat is absorbed by the piece.

It is clear, then, that the heat-treatment of a particular steel can be greatly improved by definitely knowing beforehand the correct temperature at which it should be hardened. Also, when a large number of tools of approximately uniform sizes and shapes are being handled, the time necessary for proper heat absorption should first be determined, using an experimental tool that represents a fair sample. It will be found that the time element varies practically in proportion to the thickness of the steel. From the furnace standpoint, therefore the accurate and flexible control of the temperature is a most important consideration. A positive means, such as a pyrometer, for indicating at any time just what the temperature is, becomes, of course, an incidental requirement.

Until recently, the only known way of producing heat of the required intensity was by combustion—the burning of some fuel. The attendant disadvantages of this are well known. The crude open coal forge is capable of heating the steel, but leaves much to be desired as regards the quality of the heat, its uniformity, and the temperature control. In order to produce heat at all, the carbon in the coal must be combined with the oxygen of the air, and a strongly oxidizing flame is unavoidable. The steel exposed to this action, or to the inevitable results of it suffers accordingly. The coke-burning furnace offered some improvements, but only in detail. Now there are highly-perfected furnaces for burning oil and gas, and some of these offer still further advances, but the principle at the basis of all of these is the same—there must be a "burning" process to produce the heat; oxidization must be present with all fuel-combustion furnaces.

Through what means, then, may we obtain the proper quality of heat, uniformly applied, and of the right degree? The electric furnace for the heating of steel brings the answer. It overcomes all the objections to the "combustion process" by introducing a new principle.

Electric Heat

The heat of the electric furnace is produced in an entirely different way from that of the process of combustion. Electric heat can be produced by means of the electric arc, as in the arc lamp, and by the resistance of a conductor, as in the incandescent lamp. It is the latter principle—due to its greater flexibility and convenience—that was utilized by Albert L. Marsh in the electric furnace developed by the Hoskins Mfg. Co., Detroit, Mich., for the heat-treatment of steel. Fig. 1

shows a complete furnace of one of the larger sizes, the chamber in this being 18 inches deep (front to back), 12 inches wide and 8 inches high. The two hand-screws, directly under the operating shelf, are for the temperature regulation. In Fig. 2 the relation of the various constructional parts is clearly shown; *A* shows the fire clay insulation; *B*, the carbon connector plates; *C*, the graphite bottom plates; *D*, the draft hole; *E*, the pyrometer hole; *F*, the electrodes; *G*, the resistor plates; *H*, fire sand; *K*, cement filling; *L*, the inlet for the water used for cooling the electrode clamps; *M*, the outlet for this water; *N*, the electrode clamps, and *O*, the pressure regulating screws. The electrodes are surrounded by asbsetos at *P*.

The full length of the side walls and the entire roof of the chamber are formed by the heating elements; the walls are composed of a series of thin carbon plates resting on the top of a heavy block of the same material, and the roof, of a thick graphite plate connecting these two columns at the top. One graphite electrode projects up to the middle of each side-wall plate and connects electrically, through water-cooled clamps at the lower end, with the source of energy. The chamber floor is of cement. Outside of the carbon plates there is a lining of the same material. This lining, with a carefully designed backing of heat resisting material, retains the heat developed within the furnace. The counterweighted door fitted with a peep-hole serves as a quick access to the chamber, while in the rear wall are holes for the insertion of a pyrometer tube and for draft regulation. A rigid enclosing case of steel holds all parts securely.

The principle of operation is simple. A heavy low-voltage electric current is supplied through the electrodes to the resistor plates forming the side walls of the working chamber. Heat is generated here, due to the resistance offered by these plates to the passage of the current. The electrical "resistivity" of the carbon causes each plate to heat exactly as the carbon filament in the incandescent lamp "lights" when the current is turned on. In addition to this action, advantage is taken, in the furnace, of a second form of electrical resistance —that of the contact of one plate with another. This may be readily varied by altering the mechanical pressure on the plate columns by means of the hand-screws. The turning of these, changes the resistance of the circuit and hence the resulting temperature produced.

While the furnace is "electric" in its nature, it is not at all necessary that the hardening man handling it be an electrician. The simple electrical features of the furnace are quickly grasped. It is also safe, both because it practically eliminates the fire hazard and because it brings a corresponding protection to the operator. Normal working temperatures are acquired in a little over an hour's time after the switch has been closed. An average of 12½-kilowatt energy consumption will maintain the chamber at approximately 2250 degrees F.; higher temperatures, up to 2500 degrees F., which is even above the requirements of high-speed steels, or lower, as desired, may be obtained by increasing or decreasing the energy supply.

The life of the various parts of the heating unit is shown to be from 150 to 200 operating hours (for the side-wall resistor plates) to 500 hours (for the electrodes). Based on ten hour day operation, it is found that the upkeep cost of these items, even on this larger-sized furnace, is less than 40 cents a running day. The rest of the furnace does not depreciate rapidly.

The Advantages of Electric Heating

The atmosphere in the heating chamber of the electric furnace is inherently "reducing" in its nature, due to the fact that the hot carbon plates absorb all of the atmospheric oxygen. By raising the door slightly, and opening the draft-hole at the rear, a slight current of air may be admitted which will counteract this tendency. Leaving the door open slightly more would allow an excess of air to enter, so that an oxidizing atmosphere could be produced. Between the extreme points fine shades of atmospheric conditions can be obtained. Thus the quality of the heat can be absolutely and easily regulated.

Because of the arrangement possible with the electrical resistor, the heat may be generated within the working chamber itself. In the furnace described, the very walls of this chamber constitute the heat-generating device. The "resistivity" of the carbon plates is uniform—the same electric current runs through them all—with the result that an equal radiation of heat into the chamber takes place from practically every point in the walls.

In any type of furnace the temperature is varied, within limits, by varying the amount of energy transformed into heat. The regulation of the energy supply thus becomes the means of the temperature control. The electric energy control lends itself with exceeding exactness to meeting this principle. In the furnace described both a very fine and a wide regulation of temperature may be obtained by slight variations in the mechanical pressure between the carbon plates.

Commercial Importance

Mr. Samuel S. Roberts, testing engineer of the Carnegie Steel Co., is among the men who are carefully investigating the subject of steel heating furnaces. In an interesting report of a series of tests which he, together with a number of steel experts, recently made on the heat-treatment of carbon and high-speed steel tools in the electric furnace, he says in part:

> "A realization of the inadequacy of the prevailing furnace designs usually employed for the specific purpose of hardening and tempering specially formed tools of high-speed steel, such as formed milling and gear cutters, twist drills, taps, threading dies, reamers and other tools that do not permit of being ground to shape after being hardened, and where any melting or fusing of cutting edges must be prevented, has created a demand rather than prompted the large tool steel consumers to welcome the advent of refined heating appliances, whereby the destructive influences hitherto encountered, are eliminated.
>
> "The modern electric resistance furnace, with its perfect heat control, evenly distributed heat maintenance at any desired point, reducing atmosphere, absence of all products of combustion, and thermo-electric pyrometer for measuring the temperature, offers not only the most attractive method whereby the consumers of tool steel are insured maximum efficiency, but has caused the science of treating the rapid cutting tools, to take a long step forward."

The commercial importance of increasing the endurance and efficiency of the some 2400 cutting tools that Mr. Roberts points out require special heat-treatment monthly at the Homestead Steel Works, is self-evident.

Practical Application

As to the cost of operation, it is a demonstrated fact that the higher the temperature it is desired to produce, the lower the cost of electric heat in comparison with fuel heat. At the lower ranges, considering only the production of the necessary heat alone and with electric power at the usual commercial rates, heat from this source costs considerably more than heat from fuels, especially the cheaper ones. Where water-power supplies of electric current are available, this ratio decreases in favor of electric heat; but the cost of producing the energy for the heat-treatment is only a part of that of the whole operation involved. When we consider that this broad factor includes the resulting service of the finished tool, as well as the labor, material and overhead charges to produce it, we see how comparatively small this part is. It is from such a view of the entire cost of production that the improved hardening of steel in electric heat is seen to be a real economy. The electric furnace, due to its advantages, makes possible a higher quality of product than is possible with fuel heating.

* * *

The immense inertia overcome and the speed developed in electrically-driven machinery of recent years is almost inconceivable. One example is that of the reversing motor drive for a large plate mill installed by the Crocker-Wheeler Co. last year in the works of the American Sheet & Tin Plate Co., at Gary, Ind. The weight of the revolving parts of the reversing motor is about 100,000 pounds, and it is ten feet in diameter. The reversing of this motor and of the rolls from fourteen revolutions per minute in one direction to fourteen revolutions per minute in the other is accomplished in the amazingly short time of nine-tenths of a second. This means that this electrically-driven mill reverses more quickly than any other of its class. Thus a point on the face travels in one minute a distance of 15,708 feet or practically at a rate of 180 miles an hour. Power for operating this reversing motor is supplied by a motor generator set having a 60,000-pound steel flywheel ten feet in diameter running at 500 revolutions per minute.

HOW CAN THE MECHANICAL JOURNALS BE MADE OF THE MOST VALUE TO THEIR PATRONS?[*]

By FRED E. ROGERS[†]

The answer to the question can be put in one word, and that is cooperation. This paper will then be for the most part an explanation of my views on what cooperation between the reader, advertiser, publisher and editor means and how it can be promoted. I am, of course, addressing men who are chiefly interested in the machine business, but much that is said applies to technical journalism generally.

Trade and Technical Journals.—The term "trade journal" is indiscriminately and improperly applied to many specialized publications. A trade journal is one that is exclusively devoted to the news of a trade, giving prices, sales, accounts of new projects, changes in personnel of concerns, combinations and other matters of a purely commercial nature. This term cannot be properly applied to the leading mechanical journals, as they are really technical publications containing little of a purely news character, as news is regarded by the daily papers. They are chiefly given over to the science and practice of a specialized business and are recognized mediums for the exchange of the best ideas on theory and performance. They are, in short, the invaluable records of progress which have materially assisted in the upbuilding of the industries they represent.

Specialization in Journalism.—Not many years ago the leading journals in the mechanical field published matter on railway operation, locomotive running and repairs, car building, machine shop practice, general manufacturing, steam engine and boiler design and construction, foundry work, bridge building and many other topics with which the old-time engineer was supposed to be generally conversant. In America there is now a well-defined specialization among engineers, and the technical journals are sharply differentiated by the subjects to which their pages are chiefly devoted.

Printing and Publishing.—Contrary to a not uncommon belief, the business of publishing periodicals is quite distinct from printing them. Not all publishers are printers any more than all printers are publishers. I mention this to show that the business of publishing a technical journal is somewhat intangible, consisting essentially of an organization having three definite objects—first, to produce a journal which readers will subscribe for; second, to obtain a circulation which makes the advertising space valuable to manufacturers in its field; and third, to secure advertising patronage from the manufacturers in the field which the journal represents. This is the logical order in which these different departments of the business should be placed, but frequently inexperienced publishers endeavor to reverse the order, putting the advertising first and the circulation last. Advertising is necessary for any periodical under present conditions, and the advertising income is more than three-quarters of the total. The subscription income is barely sufficient to pay for the white paper and postage.

But though I have placed the editorial function, that is, the collection and presentation of suitable reading matter in the first place it is really one leg of the tripod on which a publishing business is supported. The reading matter is that which gains and holds a paid circulation among the men to whom the products displayed in the advertising pages appeal; without circulation the advertising will not bring returns; and without advertising patronage the modern trade journal cannot be maintained.

Value of the Reading Pages.—For the sake of emphasis we will expand a little in following around the circle of relative values. It is the circulation of a paper which gives the advertising pages their value, and it is the reading pages which maintain that circulation, although we are not unmindful of the fact that a paper may be of little value, or it may contain no matter at all, and still have a circulation. There is a vast difference, however, between a paper containing high-grade technical matter and one having little or no material that would interest an engineer, superintendent or foreman. One is creative, the other a drone in the hive; one educates and contributes much toward mechanical development by the interchange of ideas between superintendents, designers, foremen and machinists, whereas the other is a non-producer and contributes nothing. The real value of a mechanical journal, then, can be gaged to a large extent by the educational value of its reading pages, because the demand for modern equipment is directly proportional to the knowledge possessed by those who are to use the equipment. A journal without interesting reading pages has no backbone. What that means is clearly stated in the little girl's definition: "The backbone is something that holds up the head and ribs and keeps one from having legs clear up to the neck."

Technical Advice.—Every technical journal acts in an advisory capacity to many readers who look to it as being an authority on machine design, mechanics, kinematics, patent law, mechanical history, etc. We have no fault to find with this attitude, but encourage it, as we believe that while it is not the province of a technical journal to run a free consulting bureau on every topic, we do feel that there are many subjects on which the readers naturally turn to us for information, and which is practically their inherent right. To make our work of greater usefulness we have recently retained a well-known engineer in a consulting capacity to advise upon those technical matters in which he is especially proficient. I mention this to show you what our conception is of the relation of a trade or technical journal to its readers.

While it may be that the problems that stump you will also stump the editor unaided, remember that he is in close touch with an army of men—machinists, toolmakers, draftsmen, engineers, superintendents and others—who are up against almost every conceivable problem in the world of mechanics. Your mechanical perplexities turned into the editorial sanctum will act as suggestions, if nothing more, for articles and editorials on subjects of timely and vital interest. You probably know that the mechanical journals receive many more contributions than they can publish. The ratio of articles rejected to those accepted in the case of the journal I represent is about as one to one. More than fifty per cent of the number offered cannot be used. Many of these articles are well written and sound in argument. Their rejection is mainly due to lack of available space. No doubt in some cases we return articles that would be very helpful to some and which we would have used in preference to others had we received an intimation from any reader that he was interested in the subjects treated.

Make Advertising Interesting and Instructive.—The advertising pages of a mechanical journal should be and can be made as interesting and as instructive to the progressive and ambitious mechanic, whatever his position may be, as the so-called reading pages. Years ago mechanical journal advertising was stereotyped and lifeless; it was hardly changed from one year to the next. Electros were run until worn out and changed only when the advertising solicitor came around to secure a renewal of the contract. We believe no advertisement should be repeated consecutively, and that the copy should be changed every issue; also that those who devote as much attention to the furnishing of live copy as to any other branch of their selling organizations will realize as definite results.

The advertisers should cooperate with one another as well as with those who publish the journal. It may seem strange to speak of cooperating in an arena where you are seeking to gain advantage over competitors, but it can be done. To show what I mean let us think of a plant that is to be equipped with machine tools for building, say, gas engines. The engineer who selects the equipment will first decide on a certain number and size of so-called standard machine tools to be installed. In other words, he plans an ideal shop according to his understanding of the needs of the case and then specifies in general terms the equipment that should be purchased. He has planned for that which certain ones of you will furnish. Now why can there not be established an understanding between groups of machine tool builders to the end that they will advertise in harmony, having in mind certain combinations of equipment which are most often specified? Take, for example, ten machine tool builders. They could use ten pages of advertising space in conjunction to much greater advantage than when working independently. In this space plans and specifications of much value could be set forth and the references to the various makes of tools would be read with an entirely different understanding by a large part of those whom you seek to interest. This, of course, is a very rough idea, but I leave it with you as a suggestion for cooperative work in plant engineering that may be worthy of your consideration.

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[*] Paper read before the semi annual convention of the National Machine Tool Builders' Association, Atlantic City, N. J., May 16-17.

[†] Editor of MACHINERY.

Photographing Work of Interest.—You should know that a camera and a dark room properly fitted up is one of the best investments for publicity that you can make. It is not necessary to hire a regular photographer, if the amount of work is comparatively small; the equipment can be turned over to one of your men who has a taste for photography, with instructions to photograph every interesting job of work having features out of the ordinary; also to photograph the erecting floor regularly, say once a week. These photos should be dated, and a sure way to prevent confusion is to display the date in the foreground, using a suitable changeable sign for the purpose. These photographs will serve you in more ways than one. They will give you a record of the shop conditions from week to week and in the case of special work often secure valuable publicity. Editors traveling in the interest of their publications are hungry for such photographs and will often gladly publish them with descriptions. To make these photographic records of the greatest value they should be accompanied with memoranda giving the main features of special work, such as weight of castings, time of operations, nature of operations, tools employed, etc. These photographs are, of course, valuable also for your catalogues and advertising.

Editors and Advertising Men.—One of the things that distresses the editor is to be mistaken for an advertising man and to be treated as such. In the first place he feels that his salary is not commensurate with the responsibilities of that exalted job, and in the second place his training has not given him that confidence of approach which is one of the best assets of your successful "ad" man. But although the editor does not come to you as an "ad" man, he nevertheless believes in advertising and will gladly advise you about advertising copy and the best way to obtain the widest publicity for your new machinery and tools.

This subject of publicity for new products is, by the way, one of the greatest importance to you. Every manufacturer should know how to introduce his new products to possible customers to the best advantage. He should know that a description of a machine embodying new principles or combinations is news matter to the field covered by the journals and is so regarded by their editors. But news is no longer news to an editor when it has been published by his contemporaries weeks or months before being offered to him. It may be argued that the competing journals do not go to the same general readers, which is in the main true, but they do go to the same advertisers; and the moral effect of stale news is detrimental in the long run to the journals that publish it.

"Write-ups" and Descriptions.—All of you, of course, are aware of the great change that has come about in the ethics of technical journalism during the past few years. Twenty years ago an advertising contract in a mechanical journal virtually carried with it the right to publication of "write-ups" of any old tool or machine at the discretion of the advertiser, without regard to the value of the matter or the truth of the claims made for the machines. The technical journals were worked to take as much of this free advertising as the editors would stand for. One firm of machine tool builders actually used to send electros requiring a full page space. Today none of the leading technical journals will insert anything of this character; the use of reading matter is strictly based on its merit, and if this policy is consistently adhered to no manufacturer has just cause for complaint. No journal that is filled with write-ups can obtain or hold any considerable number of readers, and without the readers of course the advertising space has no value.

You can help the editors and that means benefiting yourselves when writing descriptions of new things to include all matters that a customer is likely to inquire about. No doubt many points obvious to you may seem trivial, but on the plan of leaving nothing in doubt, put it down in black and white. A specification list is the most useful data you can furnish if disinclined to write letters fully describing the features, but never omit to call attention to those points in which the machine differs from its predecessors. Standard engine lathes are about the most difficult things to describe enthusiastically, but even these can be made interesting to possible buyers by giving spindle bearing dimensions, weights, back-gear ratios, power of motors required, etc.

Eligibility of Descriptions of New Products.—The specialization of technical journals and consequent narrowing of the fields to which the editorial pages are principally devoted, of course restricts descriptions of new machinery and tools generally to those classes displayed in its advertising pages. This may at first appear to be a narrow policy, but it is founded on very good reasons. First the demands for space in the reading pages for descriptions of new products often tax the available space to the limit, and second the appearance of those things that are distinctly foreign to the general character of the reading matter lowers the tone, being, of course, uninteresting to the average reader. For example, a description of a new road roller in a journal devoted principally to machine shop practice, machine design and closely related topics could not be justified on the ground that the subject is of general interest to the readers of that publication. The only justification for publication of a description would be that the mechanism is inherently interesting and that novel principles are employed that might be applied in other machines, and for that reason would be of interest to designers.

The test that you can readily apply to determine for yourselves whether a description of a new product would be welcomed by the editor of a technical journal is to decide whether or not you would advertise it in that journal. If you believe that advertising would pay, that means the general character of the journal should appeal to the class likely to be interested in your new machine.

Syndicate Matter.—If you have a piece of general news matter for distribution among technical journals it should be sent to the selected publications with a letter stating frankly that it is being sent to several and setting a release date, that is, a date some days or weeks ahead when it is to be published. This practice of syndicating, borrowed from the daily and weekly newspapers, is not favorably regarded by the editors of technical publications. Newspapers circulate in a limited territory, having a radius of say three or four hundred miles. The technical publications go all over the world and though not two per cent of the ordinary subscribers regularly read more than one, manufacturers often subscribe to several and their engineers see them all. The cheapening effect of the same articles in all makes the distinction obvious. However, the distribution of syndicated matter will often result in publicity in many journals in the way of extracts, abstracts and editorials, and some will publish in full. The editors under such conditions feel free to make such use of the matter as their judgment dictates and if you play fair with them they will generally be good to you.

Illustrations.—Remember that the day of the electrotype for editorial purposes, in the mechanical field at least, has practically passed away. Don't waste postage by sending electrotypes of your new products to illustrate descriptions that are to be published in the reading pages. They rarely will be used. In the first place they are hardly ever of the right width to suit the columns, and in the second place the style is hardly ever in harmony with the style of illustrations used. Instead of sending electros, send good photographs, either gelatine prints or glossy velox for halftones and regular blueprints for line illustrations. If the photographs have required much retouching to bring out details clearly you can keep them in your possession and send photographs of the retouched photographs. For line illustration copy it is not necessary to go to the trouble of making special drawings without dimensions. Simply blue pencil the dimensions and parts you do not want used. All that the editor is generally concerned with are the principles of construction and operation, and dimensions are preferably omitted.

Changes in Personnel.—We welcome all news regarding changes of personnel in your organizations. These should be sent to the journals in all cases whether they are to be published or not. Of course important changes should always be published for the information of those who have dealings with you in any way. So much for the business side. Recognition of the personality of employes is a policy that almost invariably pays and often you can please a man immensely without unduly swelling his head by sending in a personal item on his promotion to a position of some importance.

Catalogues and Other Literature.—All new catalogues and other advertising literature should be sent to the journals in your field as soon as published. We strongly advise that a letter be sent at the same time advising that the matter has been sent and calling particular attention to the new machines and tools listed. You will be pleasantly surprised sometimes no doubt to have your own words used in the notice if you have taken pains to express accurately and concisely what the contents are. Now don't think that we want you to fix up everything nice and easy so that we will have nothing to do, but on the principle that tne knowledge anyone has on a given subject because of his intimate connection with it is better than that of one who can only devote a few moments to it, we ask for an expression of your ideas of what should be of general interest in your line to our readers.

Criticism.—Criticism is of two kinds—constructive and destructive. We call the latter "knocking" and no one relishes it, but all enlightened men, which, of course, includes all editors, welcome honest criticism of their publications, by which we mean the pointing out of mistakes and errors of statement. I suggest that you can do no greater service to the technical press than by systematically writing to the editors and telling them which articles you like best and which ones do not meet with your approval; by this I mean, the collective opinions of your men as well as of the management. These criticisms should be made with the knowledge that the editors endeavor to publish matter that will be helpful to men in every mechanical pursuit besides the building of machine tools.

Playing Favorites.—Don't believe that editors favor one concern at the expense of another. If your competitor gets considerable free publicity in the reading pages, you may be sure that "he has the goods" and has afforded the editors the opportunity to see his practice and describe it fully. They will be glad to do the same for anyone else and will be your willing slaves if you have stuff for good copy.

Discussions and Disputes.—Sometimes an article will be published, perhaps unconsciously, in the interest of a competitor which puts forth certain claims that you take exception to. You are entitled to a hearing and should take advantage of the columns of the same paper for a rebuttal if you have a good case, but that rebuttal should never descend to abuse or personalities, for it is not likely to be published if it does. Do not put the editor in the "undesirable citizen" class because of such outcome without carefully weighing the case and looking at it from all possible points of view.

Filing Articles for Future Reference.—Hardly any engineer commits to memory a large number of rules and formulas for deducing the strength and proportions of machine parts. The volume of specialized mechanical lore is so great that the human mind cannot retain in an orderly and workable shape the mass of data available. The engineer's education is chiefly on means and methods of applying a science, the record of which is mostly in books and periodicals. To apply the known laws accurately we must employ the methods of mathematical analysis. Hence the engineer is more or less of a mathematician in his manner of thought and the way he attacks a given problem. But in order to profit most from what others have done as recorded on the printed page, systematic records are necessary; hence the importance of keeping card indexes of the articles in the technical journals in your field. The present speaker is not in favor of clipping files where space is available to keep the bound volumes of the journals themselves. A clipping file is generally of value to the compiler only, and to even him its value is problematical. A change in his position, or a change in the activities of his concern may make necessary an entirely new line of research and if his bound volumes are available the articles that he previously cared nothing for may have become of great value.

Manufacturers should keep files of the leading journals in their industry properly arranged and indexed for the benefit of the engineers or draftsmen. The latter can hardly afford to do it for themselves. Many a man is working over a drafting-board for a draftsman's salary who is truly an engineer within the limited range of his activities and should be credited with all the ability he displays and be encouraged to keep records of engineering data at your expense.

Trade Secrets.—One of the troublesome things that gall editors is the attitude of many manufacturers toward "trade secrets" and alleged trade secrets. We realize that commercial prestige and success in some cases depend upon keeping certain processes and methods closely guarded, but in the manufacture of metal products there is very little indeed that is not known to a large number of men who are well-versed in their trades. The plant that excludes visitors in order to keep its specialized knowledge *in*, by that policy generally keeps *out* the knowledge of what is going on elsewhere. A close corporation—close in the sense of keeping its methods secret—will eventually die of dry rot. A policy of secrecy puts the management at the mercy of its superintendent and foremen and workmen. The writer has found in a few cases that superintendents foster the idea that many of the methods introduced by them are original and should be carefully guarded, when as a matter of fact they originated elsewhere. These employes build themselves up by deceit and lull the management into a state of fancied security when their supposed monopoly of special processes has existence only in their imaginations.

Now as to the best policy to accord to editors in regard to real secret methods. It is our belief that the best way to guard them so far as general publicity is concerned is to take the editors of reputable journals into your confidence and show and explain to them the general principles employed. You will thus preserve the methods from publication in the first place if they are actually known only in your plant, or in the second place you may learn that you have been deceived and that your supposed secret is no secret at all.

To illustrate how effectively the confidence of a manufacturer may safeguard his interests, the following example is taken from personal experience:

A manufacturer of small tools notable for his courtesy to visitors some years ago personally conducted the speaker through his plant and in the course of the inspection showed him the principal features of the toolmaking practice followed in making certain tools. This work was of extraordinary interest, and permission was asked to publish a description, which was courteously denied for good and sufficient reasons. In the course of a few weeks the editor received a contribution describing minutely a system of making tools that seemed strangely familiar and which upon reading closely was recognized as a literal description of the practice of the concern mentioned, although no name was given. Of course we could not publish that article, much as we wanted to. If our friend had not taken us through his plant and shown us his practice, we would have known nothing about it and would naturally have published the contribution. The fact that the article has never been published elsewhere leads us to suspect that other editors also have been muzzled in this very effective manner.

The Advantages and Disadvantages of Publicity.—A manufacturing enterprise that produces dividends for its stockholders has to solve two main problems which are: the making of a product and the marketing of it. That the manufacturing of most goods is easier than selling them is generally conceded. It is a curious anomaly of our present commercial system that to induce a customer to purchase a thing he wants and intends to buy often costs more than to produce it. Whether this condition is due to the machinations of the middlemen, the stupidity of customers, or economic relations too subtle to define, is not our province to determine. The fact is that publicity is the breath of life of modern business.

The cautious man objects that his competitors will find out all about his methods, and says that would never do. The cautious man is right in saying that his competitors will learn about his methods—but most of them they already know. They will know, however, what the methods of the cautious manufacturer are and that may be of some disadvantage, even if they are common to the industry. In fact, general advertising sometimes works to one disadvantage in that it usually stimulates competition; but that is unavoidable. The thing that must be kept clearly before the manufacturer's eyes is his public. What matter if he does give away some information to a few competitors, when at the same time he gains the appreciation of thousands of possible customers? Let the manufacturer educate his public and take them into his confidence and never mind about the competition. When he has the public tagging after him the competitor will have to do some shouting for himself to keep the wolf from his door.

Technical Journals Educational Forces.—The technical journals should be recognized as one of the most valuable aids in selling machinery and accessories. The reason is, they are educational. To sell anything you must first create a demand. There are several ways of creating a want for that which you produce. Your salesmen can go to manufacturing plants and tell their managers all about the economy and accuracy of your machines; you can tell the same story by advertising, but lastly and most effectively your representative journals by editorials, descriptive articles and discussions of the principles of design create in the minds of your possible customers ideals which you will be required to fulfill. In other words the educational force of the technical journals rightly directed influences users of machinery unconsciously to want the best that is produced. Thus the more you help to make the mechanical journals more valuable to their readers, the more you contribute to your own success.

Help us to help you.

* * *

AN EXPERIMENT IN EXTRUSION[*]

By CHESTER L. LUCAS[†]

The success with which aluminum, copper, and brass tubes and shells have been made by the extrusion process led the writer to experiment with the extrusion of wing-nuts and similar articles. While the results of these experiments were not wholly satisfactory, an outline of the work done may be of interest, and should be of value to others working along the same lines.

Most of this experimenting was done in trying to produce a brass wing-nut similar to that shown at *A*, in Fig. 1. The wing-nut, with its principal dimensions, is also shown in the line engraving, Fig. 2. The desire to produce such a piece arose from the fact that on the outside of each of certain instruments that were being manufactured at the rate of two thousand per week, two of these wing-nuts were required. Cast brass wing-nuts were being used at the time, and as the rest of the instrument was finely finished, the contrast between the rough cast wing-nuts and the rest of the instrument was marked, especially as the wing-nuts were not polished. A small wing-nut is a difficult piece to polish cheaply.

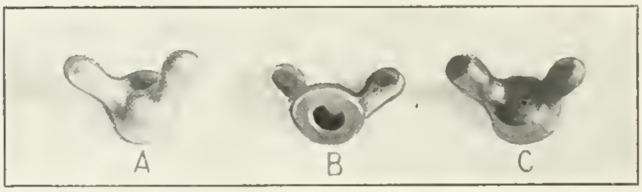

Fig. 1. Extruded Wing-nuts—A, Aluminum; B, Zinc; C, Brass

An experimental pair of dies was first made on the principle shown in Fig. 4. This first set of dies, however, was not as large in proportion to the size of the wing-nut as that shown in the illustration. First, a ring was turned from carbon steel, hardened and tempered to a very dark straw color, after which the interior was ground out true with the bottom face. Within this cylindrical opening were fitted the two die sections, which, together, fitted the interior of the ring closely. In the face of each of these sections one-half of the shape of the wing-nut was cut, so that together the two halves comprised a steel mold. It was very necessary to have the outline in one half match perfectly with the outline in the other half. Referring to Fig. 3, it will be noticed that the impression for the cylindrical part of the wing-nut was made considerably longer than that part of the nut itself. This was done to provide a guide for the extruding punch as it acted upon the metal.

The extruding punch was made of one piece of carbon steel, with its largest diameter ground a sliding fit for the ring; the smaller diameter was a sliding fit in the circular impression in the two die-sections, and the purpose of the pilot on the end of the punch was to form the central hole in the wing-nut. This pilot was made slightly tapering, so that it could be easily withdrawn from the finished work. Both sections of the die, as well as the punch, were hardened, and the temper was drawn to a light straw color, except for the tip end of the punch, which was drawn to a purple color.

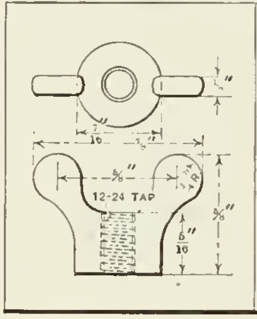

Fig. 2. Dimensions of Wing-nut to be extruded

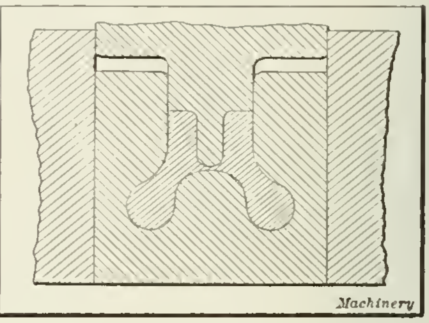

Fig. 3. Section of Die and Wing-nut after Extrusion

While the object of this die was to ascertain whether or not it would be possible to extrude a brass wing-nut, the softer metals were tried first, to see how the dies would work. Accordingly, a piece of lead was turned to 7/16 inch diameter, and several pieces, each about ½ inch long, were cut off. One of these pieces was placed in the die cavity as shown in Fig. 4, the punch placed on top and pressed in under a hand screw press. The dies were then pushed out of the ring, separated, and a perfect lead wing-nut was picked out of the dies. Aluminum was then tried in the same manner, with equal success, being extruded in the hand screw press very easily. Zinc, which is looked upon as a "dead" metal, extruded without trouble. Aluminum and zinc extruded wing-nuts are shown at *A* and *B*, Fig. 1. It was also found that several small scrap pieces of any of these metals could be used in place of a solid blank, and the resulting wing-nut was apparently as homogeneous and strong as one made from a solid blank. The pressure required for extruding seemed to unite the particles

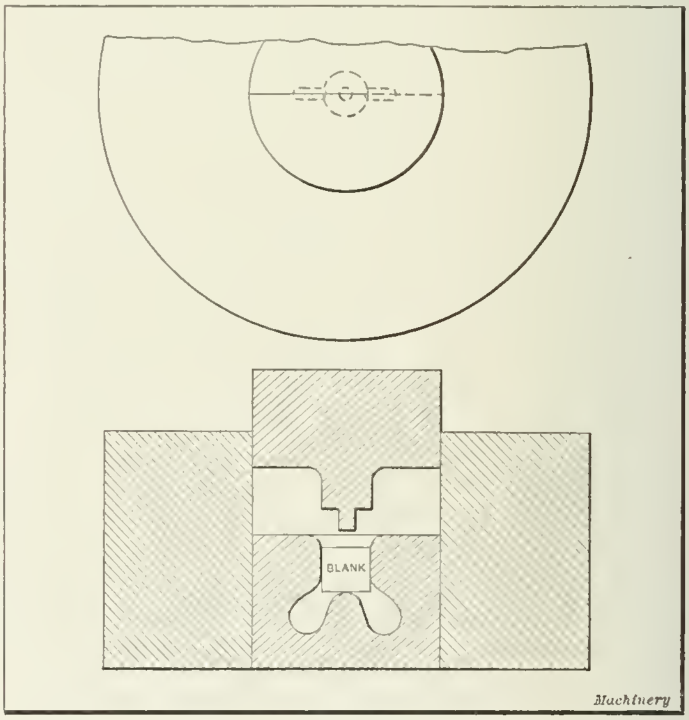

Fig. 4. An Extrusion Die, Punch and Ring, with Blank in Position

of metal in a permanent manner. By varying the amount of metal in the blank, the body of the wing-nut could be made longer or shorter as desired. It was not considered practical to put the hole entirely through the wing-nut when extruding, on account of possible injury to the die or punch; the idea was to put the hole nearly through and rely upon the tap in tapping to push through the remaining 1/64 inch of metal.

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[*] See MACHINERY, October, 1911, engineering edition, "The Extrusion Process"; November, 1911, "The Extrusion of Shells and Tubes"; December, 1911, engineering edition, "Making Collapsible Tubes by the Extrusion Process."

[†] Associate Editor of MACHINERY.

The extrusion process gave the nuts made of these soft metals considerably more strength than the cast brass wing-nuts possessed; in fact, the zinc and aluminum wing-nuts were very much stronger than the cast brass wing-nuts, but "their color was against them." As the studs upon which the wing-nuts were used were made of brass, and as the other instrument trimmings were also of brass, it was thought desirable to have these parts of brass also.

When experimenting in brass, however, the troubles began. Although the softest brass possible was obtained, and although all methods of annealing were tried, the pilot on the punch would invariably break before the extrusion had fairly begun. After making several new punches of different degrees of temper, it was decided to omit the pilot, drilling the hole in a subsequent operation. Next, trouble in the extrusion itself arose; the brass would extrude about half way into the wings, at which point the limit was apparently reached. In order to make the brass flow at all, a power screw press was necessary, and upon forcing the metal beyond the point mentioned, the dies cracked.

A pair of dies was then made from Ajax high-speed steel, and in the meantime the leading brass manufacturers were applied to for samples of their softest brass rod. The new dies proved to be all that could be desired, but the brass would not go beyond the apparent limit—half way into the wings of the nut. Upon striking harder blows with the press, a wing-nut, shown at C, Fig. 1, was produced. This wing-nut, except for the tip of one point, was "full," and several others, all more or less defective, were extruded. The few brass wing-nuts that were made were found to be extremely hard and close-grained; in fact, they were a great deal harder than necessary and would have been very difficult to drill and tap. After making two or three of these brass wing-nuts, however, the dies broke, owing to the excessive stress.

About this time it was decided that the extrusion of a brass wing-nut was impracticable, and the experimenting stopped. It would, however, seem as if it should be possible to obtain a grade of brass or composition having a faint yellow color that possesses some of the extruding qualities common to zinc and aluminum, or that at least would be softer than commercial brass. With such a metal, wing-nuts and similar articles could be easily extruded, and dies could be made that would work automatically, receiving the blanks from a hopper feed, and permitting the press to be continuous in its operation. If anyone else has had experience along this line, the results would undoubtedly be of interest and value if published.

[The question may be raised as to the propriety of including the foregoing experiment as an example of extrusion. The extrusion process ordinarily produces shapes conforming to the opening of a die, the product taking its ultimate form as it is ejected by pressure, exerted through a punch or ram. In this case the ears of the wing-nuts are not extruded beyond the die but are forced, by the pressure exerted through the punch, into cavities in the die which have the shape required to be reproduced. This process seems to be a combination of extrusion, and cold swaging or die-forging.—EDITOR.]

* * *

The U. S. S. *Florida*, which has just won the title of the world's fastest battleship, broke all speed records off the Atlantic Coast with propellers of monel metal. The *Florida* attained a greater speed than its sister ship, the *Utah*, which was not equipped with that material. Monel metal is very suitable for propellers. It has the strength of steel, shines like silver, and is less corrodible than bronze. The non-corrodibility is a strong asset, as it assures the propeller's cutting the water cleaner. Propellers of this material have been furnished battleships of the United States and foreign navies.

WUEST HERRINGBONE GEARS

Having read the article in the January, 1912, number of MACHINERY, engineering edition, entitled "Herringbone Gears," the writer is prompted to make a few remarks. Let

P = normal diametral pitch,

P_n = normal circular pitch measured on the normal helix (pitch measured on the pitch cylinder perpendicular to the face of the teeth),

P_c = circular or circumferential pitch measured on the circumference of the pitch circles,

N = number of teeth,

d = pitch diameter,

D = blank diameter,

a = angle of teeth with axis of gear. (In this case $a = 23$ degrees.)

Then, for spur gears, with teeth cut straight, we would have:

$$d = \frac{N}{P} \qquad (1)$$

and for spiral gears:

$$d = \frac{N}{P \cos a} = \frac{N P_n}{\pi \cos a} = \frac{N P_c}{\pi} \qquad (2)$$

As herringbone gears are spiral gears, Formula (2) will hold true. In the article mentioned, however, Formula (1) is applied. Apparently, the author of that article assumes the pitch to equal a certain quantity p, as follows:

$$p = \frac{\pi}{P_c} = P \cos a = \frac{\pi \cos a}{P_n}, \text{ and } d = \frac{N}{p}$$

This, however, is not standard practice, as it is not p but P which is the quantity commonly called the diametral pitch in spiral gears.

Furthermore, in order to keep the center distance to some even dimension, the author simply reduces the pitch diameter of the gear to suit the center distance. By doing this, and keeping all the other quantities the same as before, the pitch of a gear is changed without changing the pitch of the pinion; hence, the gears will not mesh perfectly. The difference may be small, but interchangeability cannot be claimed on this basis.

Rheydt, Düsseldorf, Germany. G. R. HULSBERG

Reply by Percy C. Day, Milwaukee, Wis.

Your correspondent, Mr. G. R. Hülsberg, evidently finds it difficult to regard herringbone gears as spur gears. He has applied the same methods as are used for calculating ordinary spiral gears, and has complicated the problem to an unnecessary extent. Spiral gears are usually employed for connecting shafts which are not parallel to each other. Under these conditions the circumferential pitch of gear and pinion may be quite different, but the *normal* pitch of both must be the same.

In herringbone gears, if the spiral angle is made constant, there is a definite and fixed relationship between the normal and the circumferential pitch. This is the case with Wuest herringbone gears. It is a great convenience to discard all reference to the normal pitch and treat the gears just like spur gears on the basis of the circumferential pitch. When this is once done, it makes no difference whether the circular or diametral pitch system is used. It is, of course, necessary for the gear cutter to set his calipers to the normal tooth thickness, and if circular cutters or inclined hobs are used they must be designed for the normal pitch; but the designer of machinery involving the use of these gears need not be troubled with any such complications.

Wuest herringbone gears are cut by specially constructed hobs which are used with the hob axis perpendicular to the gear axis. The pitch of each hob, measured along the axis in the same way as the pitch of a screw is measured, is the same as the circumferential pitch of the gears which it cuts. The normal pitch line thickness of the hob is a matter for the toolmaker alone.

The point raised in regard to the use of enlarged pinions is not so easily understood and requires a clear definition of what constitutes the "pitch diameter" and the "pitch" of a gear.

Let us suppose that we wish to connect two shafts *a* and *b* by means of a pinion and gear. Let

L = distance between shaft centers,

$$V = \text{velocity ratio} = \frac{\text{R.P.M. of } a}{\text{R.P.M. of } b}$$

N_a = number of teeth in pinion,
N_b = number of teeth in gear,
R_a = pitch line radius of pinion,
R_b = pitch line radius of gear,
P_c = circular pitch of gear and pinion.

Then

$$V = \frac{R_b}{R_a} = \frac{N_b}{N_a};\ L = R_a + R_b;\ R_a = \frac{L}{V+1}$$

$$R_b = L\left(\frac{V}{V+1}\right);\ P_c = \frac{2\,\pi\,R_a}{N_a} = \frac{2\,\pi\,R_b}{N_b}$$

If the center distance and velocity ratio are given, then the true pitch diameters of the gear and pinion are fixed. Now it is well known that involute gears will run satisfactorily when set farther apart than the designed center distance. In other words, L may be varied to a limited extent. This variation of L does not affect either the number of teeth or the velocity ratio, but it alters the pitch. The foregoing arguments lead to the curious conclusion that the pitch of a pair of involute gears has no definite value, but depends on the center distance and velocity ratio. Conversely, if we maintain a fixed center distance and ratio for a given pair of gears, we can cut involute teeth in various ways without altering the pitch.

For instance, if we require a small pinion to mesh with a large gear, we may generate the teeth to standard thickness on their true pitch diameters or we may enlarge the blank diameter of the pinion and reduce that of the gear by a corresponding amount. The teeth will be generated from the same base circles in each case, and the true pitch diameters and pitch will be the same, but the shape of the teeth will be quite different in the two cases. The pinion which is cut on standard lines will probably have badly undercut teeth with consequent weakness and loss of wearing surface. The enlarged pinion, on the contrary, will have teeth with broad bases and unimpaired shape. Since the center distance and velocity ratio have not been altered, the true pitch circles and the pitch remain unchanged; but the change in outside diameters has increased the addendum of the pinion and decreased the addendum of the gear.

There is nothing new in this method,[*] as it has been in use on bevel and worm gears for many years; the most curious thing about it is that it continues to be so little understood by the majority of gear users. It is the writer's practice to give progressive enlargement to all pinions with less than twenty teeth and to reduce the corresponding gears in proportion, so as to maintain standard center distances.

An enlarged pinion will mesh correctly with any gear in its series, whether reduced or not, but if the gear is of standard proportions the center distance will be greater than standard by half the enlargement of the pinion. This applies to all involute gears with generated teeth, no matter whether they are hobbed, shaped or planed. When this method is applied to herringbone gears, the enlargement or reduction of the blank is left entirely out of consideration, and the machine is set to cut the correct spiral angle on the true pitch circle. Given a proper degree of accuracy in the cutting and reasonable care in setting up, such gears are perfectly interchangeable, bear evenly from end to end, and do not jam. There is no question of approximation. These methods have been in use for several years, and there are thousands of gears in service which bear eloquent testimony that your correspondent's misgivings have no foundation in fact.

* * *

It is stated in *Power* that hydro-electric installations in Switzerland have been developed and utilized to such an extent that there are some towns in that country where no coal is being used. Power, light, and heat are furnished by electricity throughout the towns.

MOTOR-DRIVE IN THE MACHINE SHOP[*]

By GEORGE H. HALL[†]

For the shop where electric power is already installed, all kinds of machine tools may be purchased completely equipped with individual motors. When, however, it is desired to institute a change in a shop that has been employing belts and shafting, and to substitute electric power, it becomes necessary to consider each of the belt-driven tools separately, so as to secure as nearly as possible the same results that are obtained with the tools built for motor drive. At the same time excessive expenditures in the alterations must be avoided. It is the purpose of this article to outline the principles of motor application, and to suggest methods by which the belt-driven tools may be accommodated to motor drive.

The first problem to consider is that of the transmission of the power. In large plants, covering acres of ground, alternating current is employed in order to permit the use of high voltages with the corresponding saving in the copper used for wiring. In plants consisting of but a few buildings, grouped fairly close together, the use of direct current possesses advantages in variable speed possibilities that far outweigh the gain to be secured by the use of the high-voltage alternating current. It is, therefore, the general practice at the present time to use 230-volt direct current for the operation of plants of the nature of machine shops, in which a large part of the load will consist of motors driving tools requiring variable speed. Where long transmissions make the distribution of power by alternating current a necessity, a motor-generator may be installed at the point of distribution for the purpose of supplying direct current to the variable-speed motors. This is often the system employed in the case of railway shops which are spread out over a considerable territory and contain a large proportion of constant-speed tools. Here the transmission current is 440 volts, alternating, and the constant-speed motors are operated on this current, while the motor-generator supplies 230-volt direct current for the operation of the variable-speed motors.

Types of Motors

In the first place the three types of direct-current motors should be thoroughly defined, so that the proper type may be selected for the particular tool to which the motor is to be applied. These three types are series-wound, shunt-wound, and compound-wound motors.

The series-wound motor is one in which the field winding is in series with, or forms a direct continuation of, the armature circuit, so that all of the current that passes through the armature passes also through the fields. The amount of current drawn from the line by a motor depends upon the work, or horsepower, which the motor is developing. It therefore follows that in the series motor the strength of the fields will depend upon the load which is placed on the motor, and as the speed of the motor depends inversely upon the field strength, the speed of the series motor will be inversely proportional to the load. Since the speed of a motor also depends upon the voltage that is impressed upon the armature, the speed of a series motor may be controlled by introducing resistance in series with the armature, and this is accomplished by means of a controller which is used also for starting the motor. The use of the controller enables the operator to start the motor slowly under light loads, and also prevents too great a flow of current when starting under heavy loads. The characteristics of the series motor are heavy starting torque and a speed dependent upon the load.

The shunt-wound motor is one in which the field winding is connected across the main lines, or is said to be in shunt with the armature circuit. The amount of current passing through the fields is inversely proportional to their resistance, and, except in the case of the variable-speed motor which will be treated later, remains practically constant under all conditions of load. This results in a constant-speed motor whose output, in horsepower, is dependent upon the current, in amperes, which passes through the armature. The characteristic of the shunt-wound motor is approximately constant speed under all conditions of load.

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[*] See also the article entitled "Noisy Gearing," published in MACHINERY, engineering edition, November, 1911.

[*] The following articles on this and kindred subjects have previously been published in MACHINERY: December, 1911, engineering edition, "The Selection of Direct-Current Motors for Factory Use"; April, 1911, engineering edition, "Electric Motor Supports"; November, 1910, engineering edition, "Wiring on Motor-Driven Machinery"; May, 1910, engineering edition, "Methods of Applying Motors to Machine Tools"; April, 1909, engineering edition, "Improvements made by Motor-driven Tools in a Repair Shop"; February, 1909, engineering edition, "The Application of Motors to Machine Tools"; June, 1908, engineering edition, "Reliability of Motor Drives for Machine Tools"; January, 1906, "The Simplicity of the Electric Drive."

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The compound-wound motor is one having both a shunt and a series field winding. The shunt field is connected to the main line as in a shunt motor, while the series field is in series with the armature and carries all of the current passing through it as in the series motor. The field of an average compound motor is composed of about eighty per cent of shunt winding and twenty per cent of series winding, although this proportion may be varied to suit the class of work for which the motor is to be used. The speed of a compound motor is more nearly constant than that of a series motor, but the drop in speed from no load to full load is considerably more than in a shunt motor, owing to the action of the series part of the winding. The characteristics of the compound motor partake of those of both the series and the shunt motors in about the same degree as the relative proportion of the two windings composing the field.

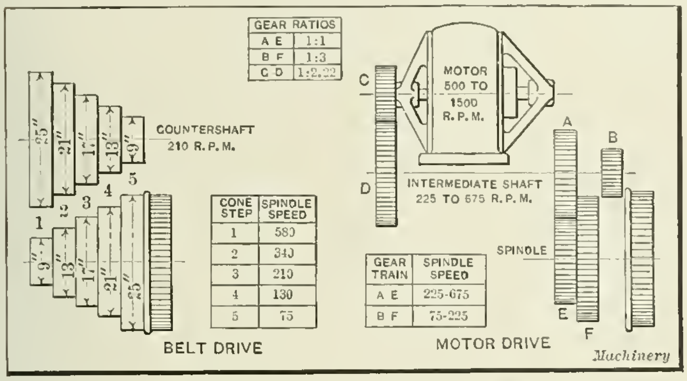

Fig. 1. Comparison of Belt and Motor Drive of Engine Lathe

Selection of Motors

To determine the type of motor to be employed for the different classes of tools in the machine shop, the character of the power requirements of the tools should be carefully analyzed. In the case of lathes, boring mills, milling machines, etc., in which the work of cutting is continuous, it will be seen that the tool is required to run at a speed which can be adjusted to the character of the work being machined, and when so adjusted, will remain practically constant. Also, the tool is usually started before the work of actual cutting begins, so that no excess of power is needed to start. The foregoing requirements correspond to the characteristics of the shunt motor, and for this class of work this motor should invariably be used.

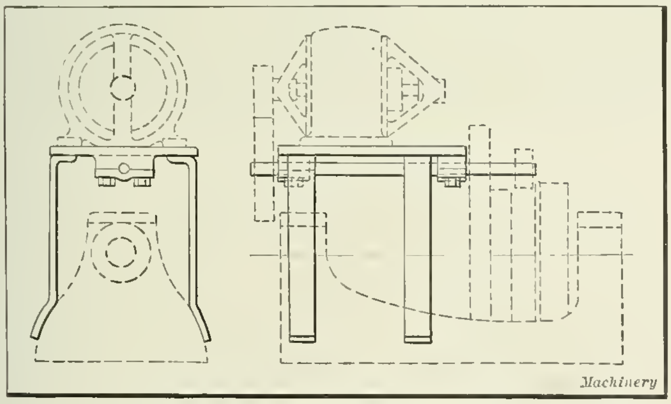

Fig. 2. Plate and Brackets for Supporting Motor

In the case of planers, shapers, slotters, etc., the work is intermittent, being far greater at some portions of the stroke than at others, and for this class of work the compound motor is best suited. The same type of motor is also used for the operation of punches, shears and other tools having heavy flywheels, as the motor will slow down at the period of greatest load, which is just after the completion of the stroke. The actual cut is effected through the inertia of the flywheel, and the maximum load on the motor is that of accelerating the flywheel and bringing it back to normal speed after it has carried the tool through the work.

When operating hoists and cranes, the motor must be started under the full weight of the load to be handled and at the same time slowly enough to prevent the shock of too sudden acceleration. These requirements are best met by the series motor with a controller having a heavy starting resistance, as it provides high torque at low speeds. This type of motor is also used for auxiliary purposes such as raising the cross-rails of planers and boring mills, traversing the carriages of large lathes, and elevating the tables of horizontal boring mills.

Constant-speed shunt motors are, of course, used for the operation of groups of machines that are driven by a common countershaft, but for individual drive the constant-speed motor is little used, as one of the greatest advantages of individual drive is the ability to vary the speed of the tool to suit the requirements of each piece being machined. This naturally brings up the question as to where the line should be drawn between tools that should be arranged for group drive and those which may advantageously be equipped with individual motors. No fixed rules can be laid down in answer to this question, but, in general, it is customary to group the smaller tools, as the initial expense of separate equipments for such tools as bench drills, tool grinders, emery wheels, and sensitive drills, often equals or exceeds the cost of the tools themselves. In the tool-room, also, the value of individual equipment is questionable, as the work on each tool is intermittent and there is not the demand for high efficiency from the tools that obtains in the case of tools used in the manufacturing departments. If the product of a given tool is especially valuable, or forms a very important part of the shop's output, the first cost of the drive is of minor consideration, and an individual equipment which will secure the greatest output is warranted.

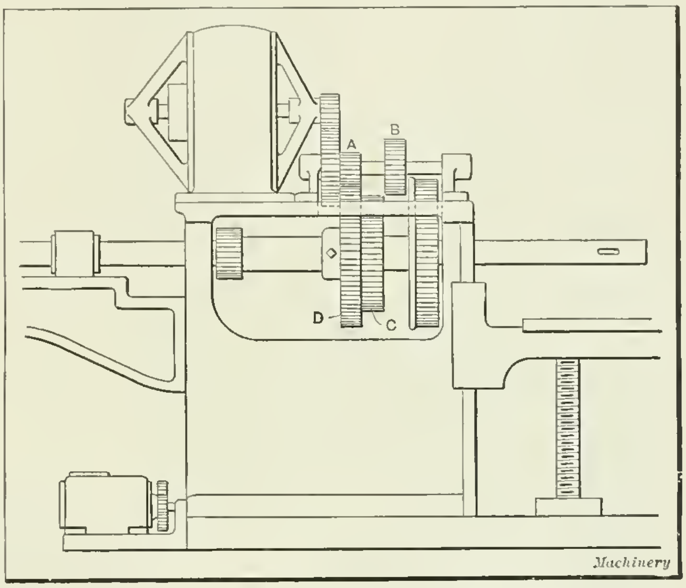

Fig. 3. Motor Equipment of Horizontal Boring Machine

Variable-speed Motors

Variable-speed motors, in the generally accepted use of the term, are, strictly speaking, adjustable-speed motors, in that the speed may be adjusted by means of a controller. There are two methods in common practice by which this adjustment of speed may be accomplished. These are known, respectively, as armature regulation and field control.

The first method consists of introducing resistance in series with the armature circuit, thereby reducing the voltage that is impressed on the armature. With constant field strength, as in a shunt motor, the speed of the motor will be directly in proportion to the impressed voltage. If the load on a motor remains constant, the speed will be inversely proportional to the resistance inserted in the circuit, as the torque is in proportion to the current in amperes, and the voltage equals the amperes divided by the resistance. From the foregoing it will be seen that if the motor load varies, the voltage and, therefore, the motor speed will, with a fixed resistance, vary with the load.

Now, consider the output of the motor when armature control is employed; the torque, or turning effort, is proportional to the amperes drawn by the motor, while the horsepower is a function of the product of the volts and the amperes. Thus a motor developing a given horsepower draws from the line a definite amount of current and produces a torque corresponding to that horsepower. If, now, we cut the speed in half, by halving the impressed voltage, while the torque remains the same, the product of the volts by the amperes will be but one-half, and the motor will be delivering but one-half its former horsepower, although it will be drawing just as much current as when delivering the full horsepower. Thus it will be seen that this method of control is uneconomical and gives a speed varying with the load, while the demand of most machine tools is for a drive that will give a desired speed regardless of the load. In employing the method described it is almost impossible to secure slow motor speeds with very light loads. For this reason this method of control is but little used in connection with machine tools.

The second method, that of field control, is most generally used for motors employed in the operation of machine tools. With the voltage impressed on the armature constant, the speed of a motor will be inversely proportional to the strength of the fields. This field strength is directly proportional to the ampere-turns in the field, and as the actual turns of wire must remain constant, the ampere-turns may be easily regulated by inserting resistance in series with the field winding and thus decreasing the current in amperes passing through the field. The torque of the motor is, in this case, proportional to the field strength, and, as the field strength varies inversely as the speed increases, the horsepower of the motor will remain practically constant.

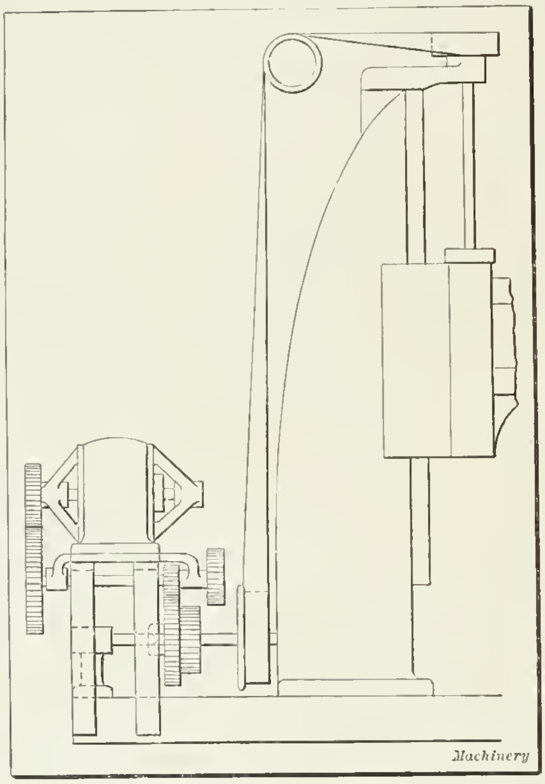

Fig. 4. Motor applied to a Radial Drill

Considering the average class of tools, such as lathes, boring mills, etc., we can readily see that the foregoing motor characteristics correspond to the requirements. When the cutting tool is run at a high speed, the cut taken by the tool is light, and when taking heavy cuts, the speed is slow, thus calling for a practically constant horsepower throughout the working range of the tool.

As the field current is but a small proportion of the total current used by the motor, the total current consumption of motors using this type of control is practically in proportion to the work being done, so that this is an economical method. The speed, also, being regulated by the field strength, is independent of the load, so that for a given controller position it will be practically constant regardless of the power developed. As a matter of fact, the shunt motor with constant field strength will vary about 5 per cent from no load speed to full load speed.

Application of Motors to Machine Tools

Considering the application of motors to specific tools, we can best divide the problems presented into two classes. The first class comprises those tools in which the removal of metal is continuous, such as lathes and drilling machines. The second class contains those tools in which the removal of metal is intermittent, as with planers, shapers and slotters.

For use with machine tools of the first class, variable-speed shunt motors will be employed, and the next point to be considered is the speed range for which they must be adapted. For a given horsepower the size of the motor will be inversely proportional to the minimum speed, and as the use of gearing or chain drives places a practical limit on the maximum speed, the minimum speed, and consequently the size of the motor, will depend upon the speed range. The best idea of the actual results that can be obtained with field controlled motors may be secured from a table showing the outputs and speed ranges of a standard line of such motors. Although different makes vary somewhat in their ratings from those given in Table I, this gives a correct average of the various lines upon the market.

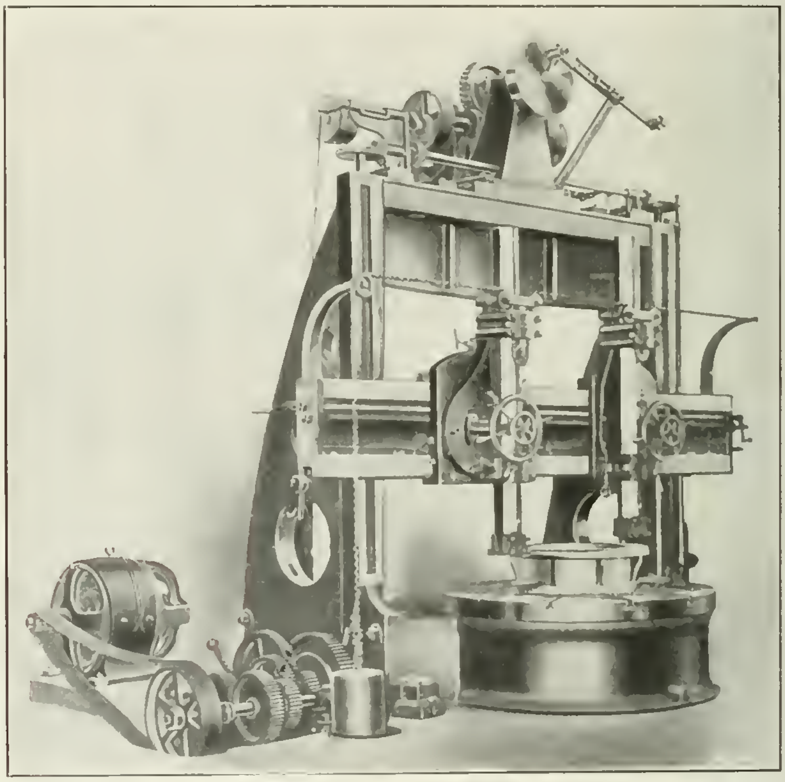

Fig. 5. Motor Equipment of Large Boring Mill

With a wide motor speed range, a larger part of the working range of the tool is, of course, covered than with a more limited range, but as it is impracticable to cover the entire working range of such a tool as a lathe or boring mill by a corresponding motor range, it is customary to use one or more mechanical speed changes to augment the electrical range. The problem is, therefore, to select a motor speed range that will give satisfactory results without involving too elaborate mechanical changes. Actual experience has shown that, under average conditions, a motor speed range of 2½ to 1 or 3 to 1, together with two mechanical speed changes, will cover practically any range of speed that is obtainable with a cone-pulley drive on any of the ordinary types of machine tools.

To show just how this works out, we will take an actual case of an engine lathe provided with a five-step cone pulley. In making applications to old lathes it is desirable to retain the back-gearing, while the cone is removed from the spindle sleeve and two gears mounted thereon as shown in Fig. 1.

The motor is placed above the headstock, on a bracket, and is geared to an intermediate shaft running directly below. This shaft carries two gears, *A* and *B*, either of which may be meshed with its corresponding spindle gear *E* or *F*. The engraving shows a comparison of the spindle speeds obtained with the original belt-drive and those that may be secured by the application of a 3 to 1 motor. Not only is the range of spindle speeds increased, but whereas in the belt range of 75 to 580 revolutions we obtained but five distinct speeds, with the motor and a twenty-step controller we obtain a range of 75 to 675 revolutions with forty different running speeds, varying by about 6 per cent. This calculation considers only the range of speeds obtained without the back-gearing of the lathe and the range is, of course, repeated at correspondingly lower speeds by the introduction of the single or double back-gearing with which the lathe is provided.

TABLE I. TYPICAL LINE OF VARIABLE-SPEED SHUNT MOTOR RATINGS

Frame	2 to 1 Range			3 to 1 Range			4 to 1 Range		
	H. P.	Min. R.P.M.	Max. R.P.M.	H. P.	Min. R.P.M.	Max. R.P.M.	H. P.	Min. R.P.M.	Max. R.P.M.
No. 1	½ ¾	625 800	1250 1600	⅜ ¾	475 800	1425 2400	¼	500	2000
No. 2	¾ 1¼	525 800	1050 1600	¾ 1¼	525 800	1575 2400	⅝	415	1660
No. 3	2 2½	675 900	1350 1800	1½ 2	500 675	1500 2025	¾ 1	450 550	1800 2200
No. 4	2 3½	400 625	800 1250	2 3½	400 625	1200 1875	2	400	1600
No. 5	2½ 3¼	500 725	1000 1450	2½ 3¼	500 725	1500 2175	1½ 1¾	450 550	1800 2200
No. 6	2½ 4	400 550	800 1100	2½ 4	400 550	1200 1650	2½ 3	400 550	1600 2200
No. 7	4 5½	400 525	800 1050	4 5½	400 525	1200 1575	5½	525	2100
No. 8	5½ 7½	650 800	1300 1600	3¾ 5½	450 650	1350 1950	3¾	400	1600
No. 9	5 7½	325 460	650 920	5 7½	325 460	975 1380	6	450	1800
No. 10	10 12	875 1000	1750 2000	7½	625	1875	3 5	300 450	1200 1800
No. 11	15	750	1500	12½	600	1800	5 7½	300 350	1200 1400
No. 12	20	800	1600	15	575	1725	10 12½	375 450	1500 1800
No. 13	25	750	1500	20	600	1800	12½ 15	375 425	1500 1700
No. 14	35	825	1650	20 25	500 600	1500 1800	15	375	1500
No. 15	40	675	1350	25 30	400 525	1200 1575	20	350	1400

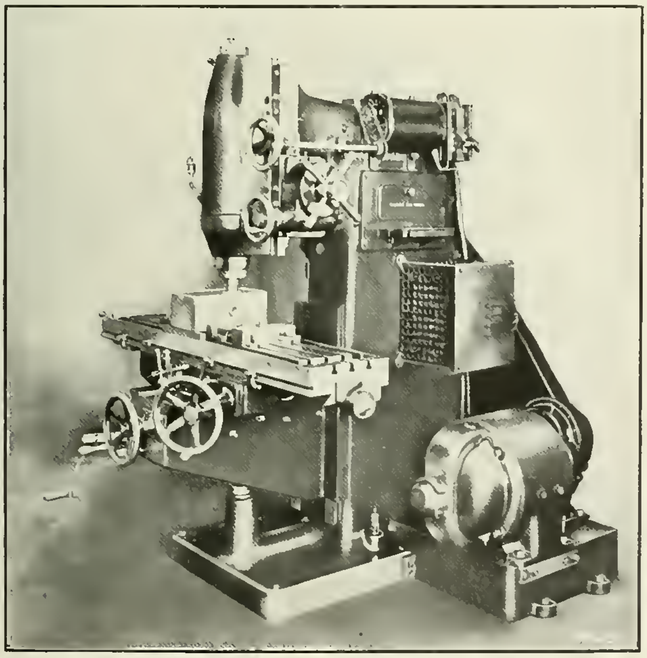

Fig. 6. Motor applied to a Vertical Milling Machine

Just here it may be well to point out one of the greatest advantages of the motor drive. It will be noticed that the belt drive, which gave a range of 75 to 580 revolutions, did so in five steps varying by at least 60 per cent per step. If the lathe is running on, let us say, the fourth step it may be found that the cutting speed, owing to the size of the work or the condition of the tool, is not as high as could be used to best advantage. To jump to the next speed, however, increases the cutting speed over 60 per cent, which will be too much, and the work will consequently be done on the fourth step, although this may be 30 or 40 per cent below that at which the best economy would obtain. With a motor drive giving speed increments of 6 per cent or less, the work can at all times be done at practically the best speed, and the increase of output that will be thus secured will be readily appreciated.

Another typical case where the advantage of the motor drive is clearly shown is in the facing of a large surface such as a flange. The ordinary practice is to adjust the speed properly for the cut at the largest diameter and then cover the entire surface at this speed, although, as the tool approaches the center, and the cutting diameter becomes smaller, the cutting speed will be too low. To be sure, an energetic lathe hand can shift his belt from time to time as the work progresses, but this is practical only after a reduction in speed of the 60 per cent made necessary by the large intervals between the cone steps. With the motor drive, requiring only the slight movement of the controller handle to adjust the speed, the operator will continually "notch-up" his controller, so that the entire surface will be covered at practically maximum speed.

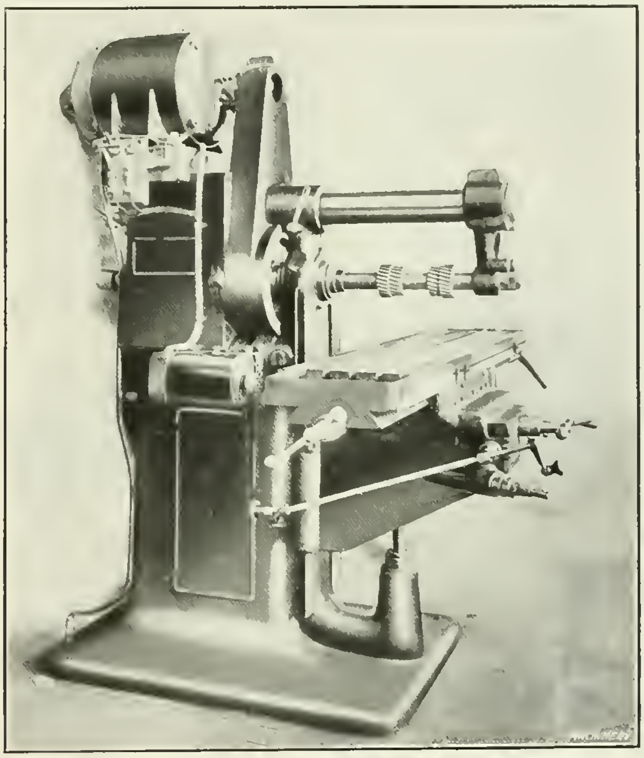

Fig. 7. Motor Equipment of Universal Milling Machine

In making this application to belt-driven lathes, if a considerable number are alike, it will be found economical to make a pattern and cast a bracket that can be attached neatly to the headstock. This bracket will be provided with bearings for carrying the intermediate shaft below the motor. As this entails expensive pattern work, it will be cheaper, if the number of similar lathes is small, to use wrought-iron brackets to support a plate on which the motor can be placed. This plate will require a very simple pattern which can be readily changed to suit different sizes of motors for various tools with which it can be employed. Fig. 2 gives a general idea of such a bracket, and indicates the method of supporting it over the headstock of a lathe.

The same scheme works out very satisfactorily for applying motors to other types of tools, although certain modifications may be needed in order to obtain the best results. Fig. 3 shows a horizontal boring machine which has been equipped in a manner similar to that of the lathe. The cone is replaced by the two gears *C* and *D*, but in this case the pinions *A* and *B* are fast on the intermediate shaft, while the gears *C* and *D* are free to slide on a feather in the spindle quill, so as to be engaged at will with their corresponding pinions. The intermediate shaft, in this case, is carried in brackets in front of the motor rather than beneath it. Fig. 4 shows how this type of drive, with underneath intermediate shaft, may be applied to a radial drill, and the same arrangement will be found readily applicable to upright drills.

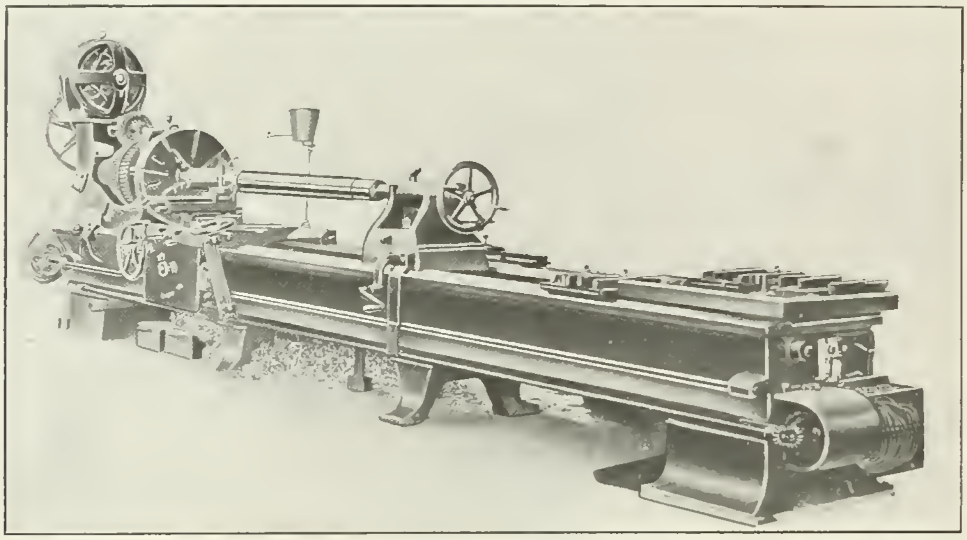

Fig. 8. Motor Equipment of Engine Lathe

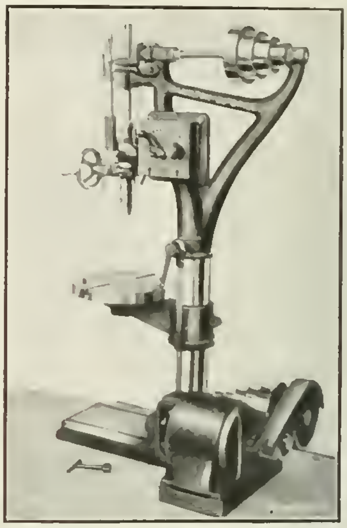

Fig. 9. Motor applied to an Upright Drill

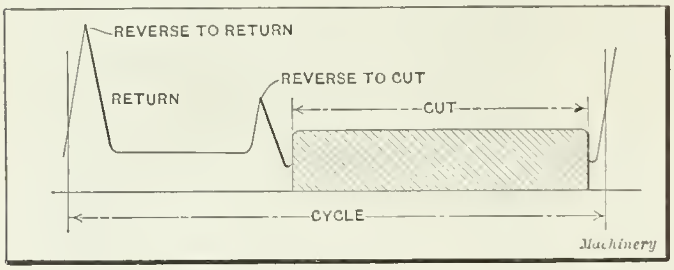

Fig. 10. Cycle of Operations of Planer

The halftone Fig. 5 shows the application of a motor drive to a large boring mill. The arrangement is extremely simple, consisting of replacing the driving pulley with a chain sprocket, and driving from the motor which is set at any convenient nearby point. The two pinions for the gear changes are seen in front of the original driving gears of the mill.

For operating milling machines the most successful applications are made with chain drives. The motor may be placed on a floor base attached to the base of the machine, or it may be bracketed onto the top of the machine, illustrations of both of these arrangements being shown in Figs. 6 and 7. The latter motor position is preferable, as the chips from the machine necessitate the use of a fully enclosed motor if it is placed below the table of the machine. The examples shown are offered mainly as suggestions, as the construction and speeds of each particular tool will call for separate consideration.

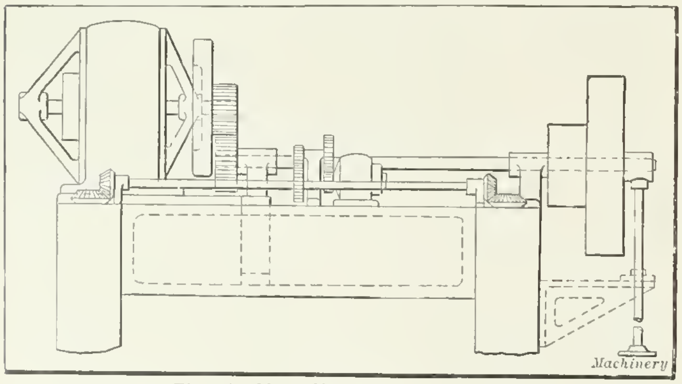

Fig. 11. Motor Equipment of a Planer

Horsepower Required

Having decided upon the desirable speed range and the mechanical details of the application, the next problem is the selection of a motor of suitable power. Upon this point no positive rules can be followed, as so many factors enter into the consideration. For the operation of a lathe for general work a 5 horsepower motor might be fully adequate, while for driving the same size of lathe for manufacturing purposes, and using only high-speed steel at maximum cutting speeds, a 10 or even a 15 horsepower motor might be needed. For running a milling machine, for example, it is obvious that a much smaller motor could be employed if the machine were to be used only for finishing work, with light cuts, than would be needed on the same machine if it were to be used for heavy roughing work. Any tabulated data, therefore, based on the size of the tool, must necessarily give averages only, and should be modified by one's best judgment, based on the actual conditions obtaining.

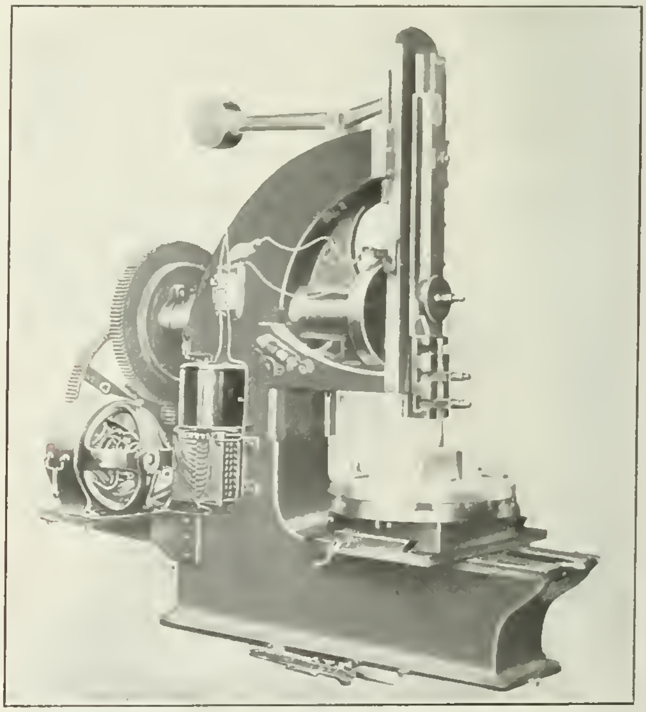

Fig. 12. Motor applied to a Slotter

A most excellent plan is to determine the power requirements, by actual test, before purchasing the motors. This can be done, at a comparatively small expense, by belting a test motor to each tool successively, and taking readings with a recording ammeter for a day or two while the tool is running under actual operating conditions. Remember that all good motors have a 25 per cent overload capacity for periods of at least two hours, so that if the day's run on a certain tool shows about 7½ horsepower as the average load, with occasional peaks, for short runs, of 8 or 9 horsepower, a 7½ horsepower motor will be sufficient. The following tables which have been compiled from the recommendations of the tool builders and from actual tests, will, with the modifications mentioned, serve as fairly accurate guides in the selection of proper motors.

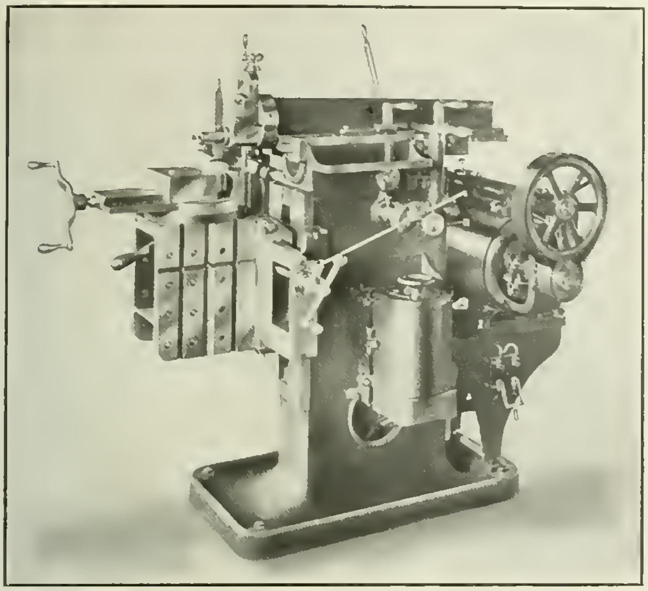

Fig. 13. Motor Equipment of Gear-driven Shaper

TABLE II. AVERAGE POWER REQUIREMENTS OF ENGINE LATHES

	Character of Work	
Swing, Inches	Light, H. P.	Heavy, H. P.
12	½	1
16	1½	2
18	2	2½
20	2½	3
24	3	5
30	3	5
36	5	7½
42	7½	10
50	7½	15
60	10	20

TABLE III. AVERAGE POWER REQUIREMENTS OF BORING MILLS

Swing, Inches	Horsepower	Swing, Inches	Horsepower
20	1 to 2	72	10 to 12½
30	3 to 4	84	12½ to 15
40	5 to 6	96	15 to 20
50	5 to 7½	120	20 to 25
60	7½ to 10		

TABLE IV. AVERAGE POWER REQUIREMENTS OF DRILLING MACHINES

Swing, Inches	Upright, H. P.	Radial, H. P.
18	1 to 1½	
24	1 to 1½	
36	1½ to 2	2 to 3
42	2 to 2½	2 to 3
48	2 to 3	3 to 4
54		3 to 5
60		4 to 6
72		5 to 6

As universal milling machines are usually rated by numbers, rather than by any dimension, a tabulation of their requirements is somewhat difficult, but for comparison the figures are given for the Brown & Sharpe machines, and these will serve as a guide for the equipment of machines of other makes.

TABLE V. AVERAGE POWER REQUIREMENTS OF BROWN & SHARPE UNIVERSAL MILLING MACHINES

Machine No.	Horsepower	Machine No.	Horsepower
1	1½ to 2	3	7½ to 10
1½	2 to 3	4	10 to 15
2	5 to 7½	5	

For horizontal milling machines the power requirements may be based upon the machine capacity as expressed by the width between the housings.

TABLE VI. AVERAGE POWER REQUIREMENTS OF HORIZONTAL MILLING MACHINES

Width between Housings, Inches	Horsepower	Width between Housings, Inches	Horsepower
12	3 to 3½	36	9 to 10
18	4 to 5	42	12½ to 15
24	7 to 7½	54	15 to 20
30	8 to 9		

Application of Motors to Planers, Shapers, etc.

The second class of tools comprises those in which the cutting stroke alternates with a non-cutting return stroke, as in the case of planers, shapers and slotters. Here the successive operations of the tool occur in cycles, as shown in Fig. 10. The highest points in the cycle are those which occur when reversing takes place. As the return stroke is taken at two or three times the speed of the cutting stroke, the power required to accelerate the bed of the planer or the head of the slotter to its return speed usually constitutes the greatest power-demand, while a somewhat lower point is reached on the reverse to cut. It is not, however, necessary to power the tool to meet the extreme peak, as the overload capacity of the motor will take care of this demand. Instead, the average cutting load represents the desirable nominal rating of the motor.

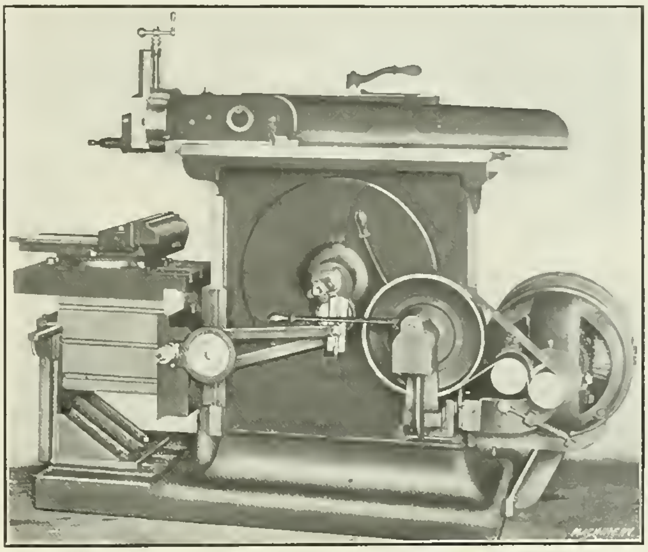

Fig. 14. Motor Equipment of Belt-driven Shaper

In this class of work, a constant speed of the motor is not of as great importance as with constant cutting tools, but it is, rather, desirable that the motor shall be designed to take care of the overloads that occur at the reversals, and for this reason motors for use with tools of this class should be compound-wound. The result is that, as greater demand is made on the motor, the increase of current that passes through the fields strengthens them, and thereby increases the torque of the motor. This also causes the motor to slow down, so that the speed for which the motor should be adjusted is that desired when operating under cutting load. On the return, when the load is light, the motor will consequently run faster than during the cutting stroke.

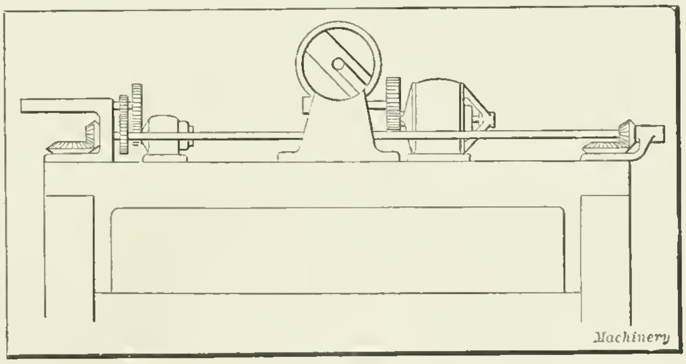

Fig. 15. Auxiliary Motors on Large Boring Mill

The average cutting speed of any of this class of tools will be between 25 and 50 feet per minute, so that a 2 to 1 range motor is sufficient for nearly all cases and often a range of 1½ to 1 will be found satisfactory. Compound-wound motors are not used for such wide speed ranges as the shunt-wound motors, since any considerable weakening of the shunt field so changes the relation of the shunt to the series winding as to cause the motor to attain the nature of a series motor, which is undesirable.

In some new planers on the market, pneumatic or magnetic clutches are used for reversing, but in equipping old tools it will be found more practical to retain the cross-belt drive with belt shipper. A diagram of such an application is shown in Fig. 11. The motor is mounted on the top of the planer housings, and geared to a countershaft which carries the driving pulleys. The use of the flywheel on the motor shaft is most desirable, as it greatly relieves the motor on the peak loads. By mounting it on the motor shaft, instead of on the slower running countershaft, the flywheel effect is much increased. It is also well to provide the driving pulleys with extra heavy rims for the additional flywheel effect that they will produce. On slotters it will usually be found convenient to place the motor on a bracket on the side of the frame, and employ a gear drive, while shapers may be either geared or chain-driven, or belt-driven by using an idler as shown in Fig. 14.

The remarks regarding the power requirements for constant-cutting tools apply with equal force to this class of machines.

TABLE VII. AVERAGE POWER REQUIREMENTS OF PLANERS

Width between Housings, Inches,	Length of Bed, Feet	Horsepower
20	6	4 to 5
30	8	6 to 7½
42	10	8 to 10
60	12	10 to 15
72	16	15 to 20
84	18	20 to 25

The figures in Table VII are based on the use of two toolheads and a return speed having a ratio to the cutting speed of about 3 to 1. If more than two heads are used, or if the planer has a longer bed than that given, the horsepower should be somewhat increased.

TABLE VIII. AVERAGE POWER REQUIREMENTS OF SHAPERS (SINGLE HEAD)

Stroke, Inches	Horsepower	Stroke, Inches	Horsepower
16	2 to 3	24	3 to 5
18	3 to 4	30	5 to 7½

TABLE IX. AVERAOE POWER REQUIREMENTS OF SLOTTERS

Stroke, Inches	Horsepower	Stroke, Inches	Horsepower
10	4 to 5	24	10
12	5 to 6	30	10 to 15
18	7½		

In addition to the motors employed for operating the tools of the above classes, there are a number of uses for auxillary motors as will be noticed in some of the illustrations. In Fig. 3 is shown an auxiliary motor used for raising and lowering the table of a horizontal boring machine, while Figs. 11 and 15 show similar motors employed for elevating and lowering the cross-rails of a large planer and boring mill, respectively. On large lathes auxiliary motors are often used for moving the tailstock along the bed, and they may also be arranged for turning the turret heads on heavy turret lathes.

Series motors only are used for these purposes, as they are always started under full load, and have their speed regulated by armature control. No rules can be laid down for the power of these auxiliary motors, but the requirements are comparatively small, from 2 to 5 horsepower covering all of the above cases except for the very largest tools. The time of duty is very short. The drives are invariably by means of gearing to the operating shaft, one set of reducing gears frequently being needed to reduce the speed of the motor sufficiently. These motors should never be belted, for if the load should be thrown off, by breaking the belt, they will run up to a dangerously high speed, and may be badly damaged. Another type of auxiliary motor is shown in Fig. 15, where it is used to operate the slotting attachment of a large boring mill. Such a motor should be compound wound and the data relative to slotters are applicable for such motors.

Controllers

For use with motors on machine tools the drum-type controller is most satisfactory, as it has sufficient mechanical strength to withstand the rough usage to which it is liable to be subjected, at the same time being completely enclosed so that all current-carrying parts are fully protected from dirt and chips and from external injury. Drum controllers are built for both armature and field controlled motors as well as for combined control. They may be either reversing or non-reversing, as desired. When used with motors having a 3 to 1 speed range, obtained by field control, they will ordinarily contain about twenty speed steps. In some sizes the necessary resistance is mounted on the back of the drum, while in others it is supplied as a separate unit which is connected to the drum by wiring.

The controller should be mounted on the tool at any point to best suit the convenience of the operator. The various applications illustrated by the halftones will serve as suggestions for suitable locations. In the case of long lathes a good arrangement is to mount a handle on the lathe apron, and this, by means of gears and shafts can readily be arranged to operate the controller when mounted on the end of the lathe bed. (See Fig. 8.)

The resistance, if separate, should be mounted near the controller in order to economize in wiring, but it should be so placed as to be exposed to the air and at the same time protected from dirt and cuttings from the tool. Do not cover up the resistance or place it inside of the tool frame, but select some place above the table of the tool, away from the path of the chips. In Figs. 8 and 12 the resistances, which are in the form of iron boxes with slate tops, are shown in excellent positions.

* * *

A SPIRAL GEAR CALCULATION

By GUY H. GARDNER[*]

A man in the shop was given a pair of new spiral gears with orders to ascertain all dimensions necessary to enable the shop to duplicate them in the future. He was about to find the angle of spiral in the time-honored way of rolling the gear on a piece of carbon transfer paper with white paper under it, so as to be able to measure the angle of the tooth marks with an ordinary protractor and figure what fraction of the circumference a tooth advanced in the width of the gear face. A neighbor then suggested that an easier method would be applicable, as the gear was new and of standard pitch. The gear was 8 diametral pitch, 52 teeth, 8.237 inches outside diameter; hence the pitch diameter was 7.987 inches. The pitch diameter of a spur gear of 52 teeth, 8 diametral pitch, is 6.5 inches. This divided by the pitch diameter of the spiral gear ($6.5 \div 7.987 = 0.8138$) gives the cosine of the tooth angle, which is thus found to be 35 degrees, 32 minutes. The mating gear had 106 teeth, and if the previous calculations are correct, its tooth angle must be 54 degrees, 28 minutes, as the shafts are at right angles. The pitch diameter of the large gear then is $106 \div (8 \times \cos 54$ deg. 28 min.$) = 22.799$ inches, and the outside diameter 0.250 inch more, or 23.049 inches. By actual measurement, it was found that this outside diameter was 23.044 inches, so that the calculations could be assumed to be correct. To make absolutely certain, however, the calculations could be checked in accordance with the rules on page 5 of MACHINERY'S Reference Book No. 20, second edition.

* * *

The Krupp firm in Essen, Germany, has built two new guns which are larger than anything hitherto used in marine or fortification service. The largest of these is a 15-inch gun. The total length of the bore is about 66 feet and the weight of the gun proper is about 226,000 pounds. The weight of the projectile is 1650 pounds, and the gun requires a charge of 690 pounds of powder. The muzzle velocity is slightly over 3100 feet per second, and the energy at the muzzle about 122,000 foot-tons. Close to the muzzle the projectile is capable of penetrating steel plate to a thickness of 4 feet 5 inches.

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NEW PLANT OF THE GISHOLT MACHINE CO., MADISON, WIS.

The new plant of the Gisholt Machine Co., Madison, Wis., manufacturers of Gisholt turret lathes, boring mills and tool grinders, the construction of which was started last August, has just been completed. The layout of the plant is shown in Fig. 3, where the various departments are numbered, the key to this numbering being given in the illustration. As will be seen, the new building is of the regular sawtooth roof construction—tile supported on steel T-iron purlins—with trusses provided with extension gusset plates, to which hangers or other fastenings for holding shaftings, etc., can be readily attached. The area of the wire skylight glass is equal to about one-third of the floor space, which insures a good distribution of a flood of light. The building is constructed of fireproof material and every provision is made to secure the best sanitary and hygienic conditions.

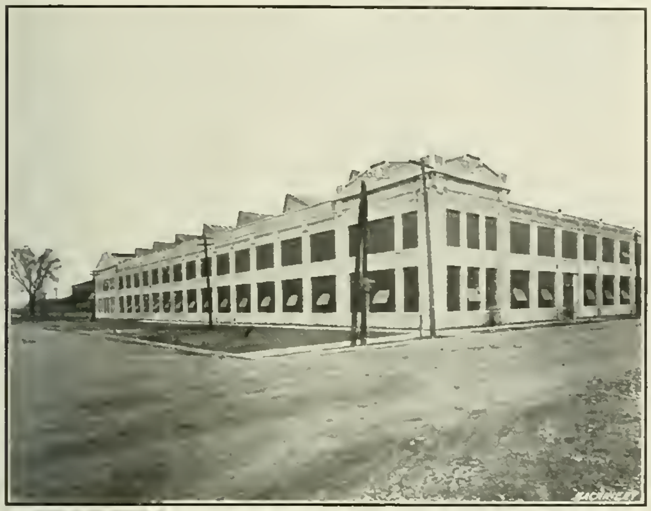
Fig. 1. General View of Gisholt Machine Co.'s New Plant in Madison, Wis.

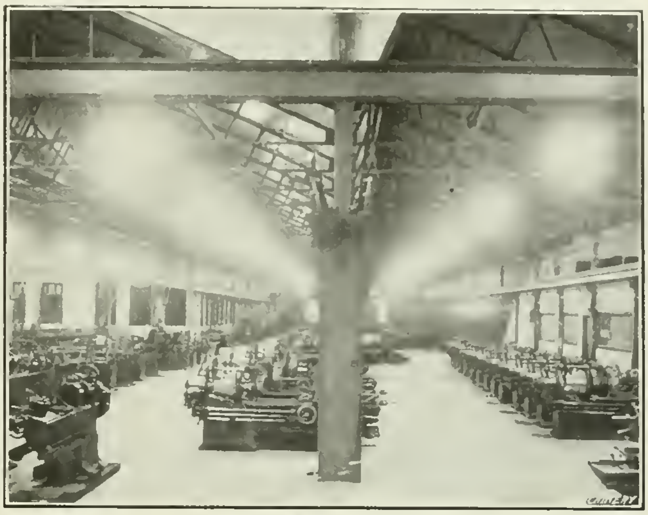
Fig. 2. View of Small Bay taken at Night, Ten Minutes Exposure, 16 Stop

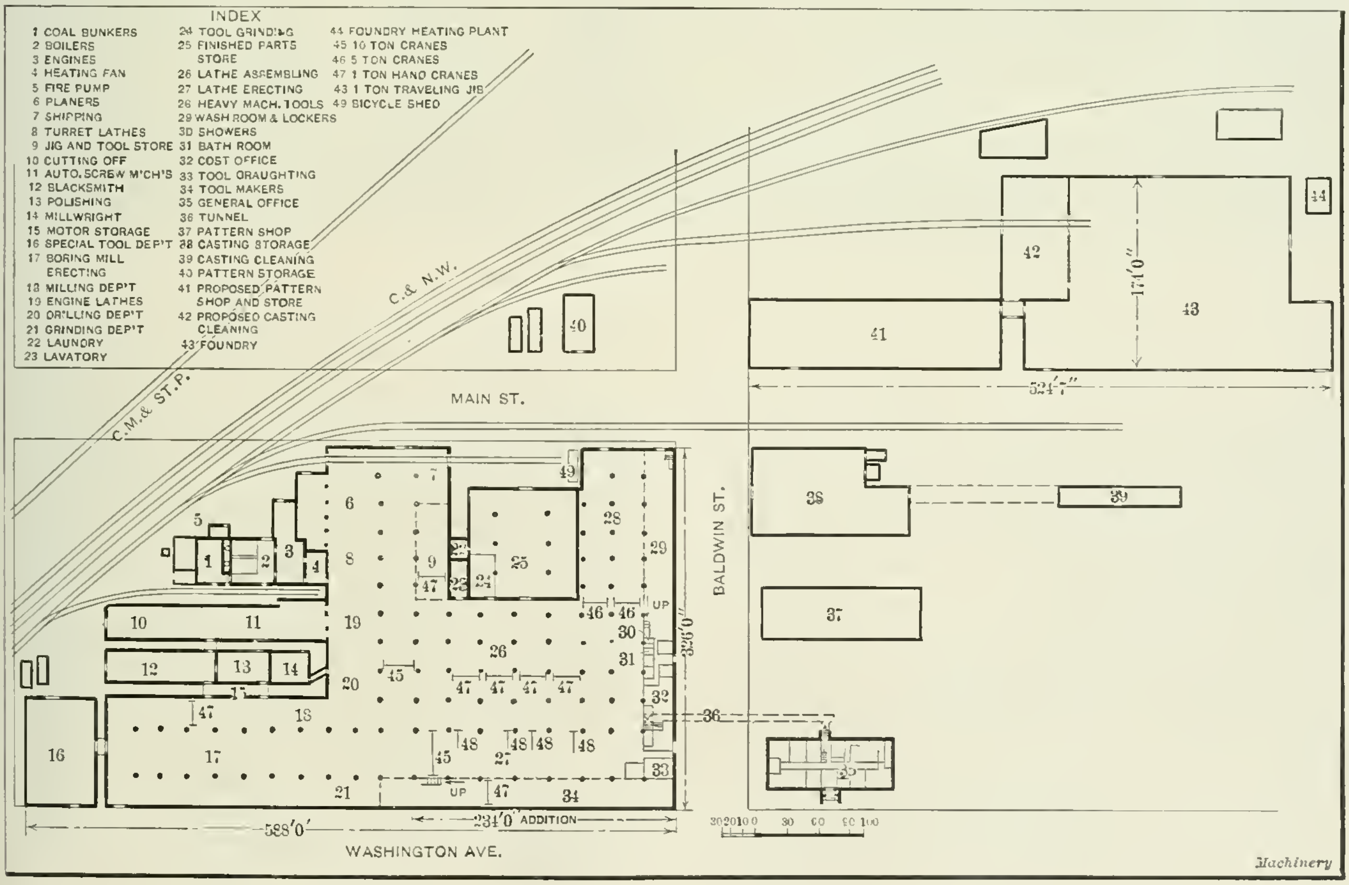

Fig. 3. Plan showing Location of the Various Departments and Buildings, Gisholt Machine Co., Madison, Wis.

Storerooms and Crane Service

The storerooms in which the finished material is held until wanted, are shown in the background in Fig. 4. The parts are brought on small trucks out to the assembling benches, shown in the foreground, where the carriages, headstocks, turrets, and feed-boxes for the turret lathes are assembled. A notable feature of the arrangement shown here, is that the trucking does not interfere with the man at the assembling bench. A good wide alley-way provides ample room for the trucks to pass through. There is also considerable space left in which to place the parts to be assembled. All the various parts of the turret lathes and boring mills made by this company are assembled on the unit plan, and are finished and tested before being attached to the machine proper.

The manner in which the traveling cranes are arranged, is commendable for a plant producing heavy machinery. The beds of the turret lathes are machined in Department 28, where the large planers are located. When a lathe bed has been machined, the small five-ton traveling crane which may be seen to the left in Fig. 5, operating in the small bay, is used to convey the finished bed to the erecting floor. As can be seen by referring to this illustration, the tracks on which this crane is mounted extend out past the posts, and are located low enough so that the crane carriage will pass under the ten-ton crane, which travels the entire length of the large bay or erecting floor. It is evident that it is a simple matter with this arrangement to transfer a bed from the small crane to the large one, and in this way avoid a second handling or resorting to trucking. The work can be carried directly from the planer or the machine used in performing the required operations to the erecting floor with comparatively little effort. The gallery, a portion of which is shown in the background in Fig. 5, extends around two sides of the building. It is 25 feet wide by about 500 feet long, and is used for erecting light machinery, such as tool grinders, countershafts, etc. In the gallery are also located the lunch room, lecture hall, and emergency hospital, which will be referred to again later. The factory is illuminated at night by overhead tungsten "Mazda" lamps, 250-watt lamps being located over all crane-ways and 100-watt lamps over the assembling benches. The heating is of the direct vacuum system, and it has been found to give very satisfactory results.

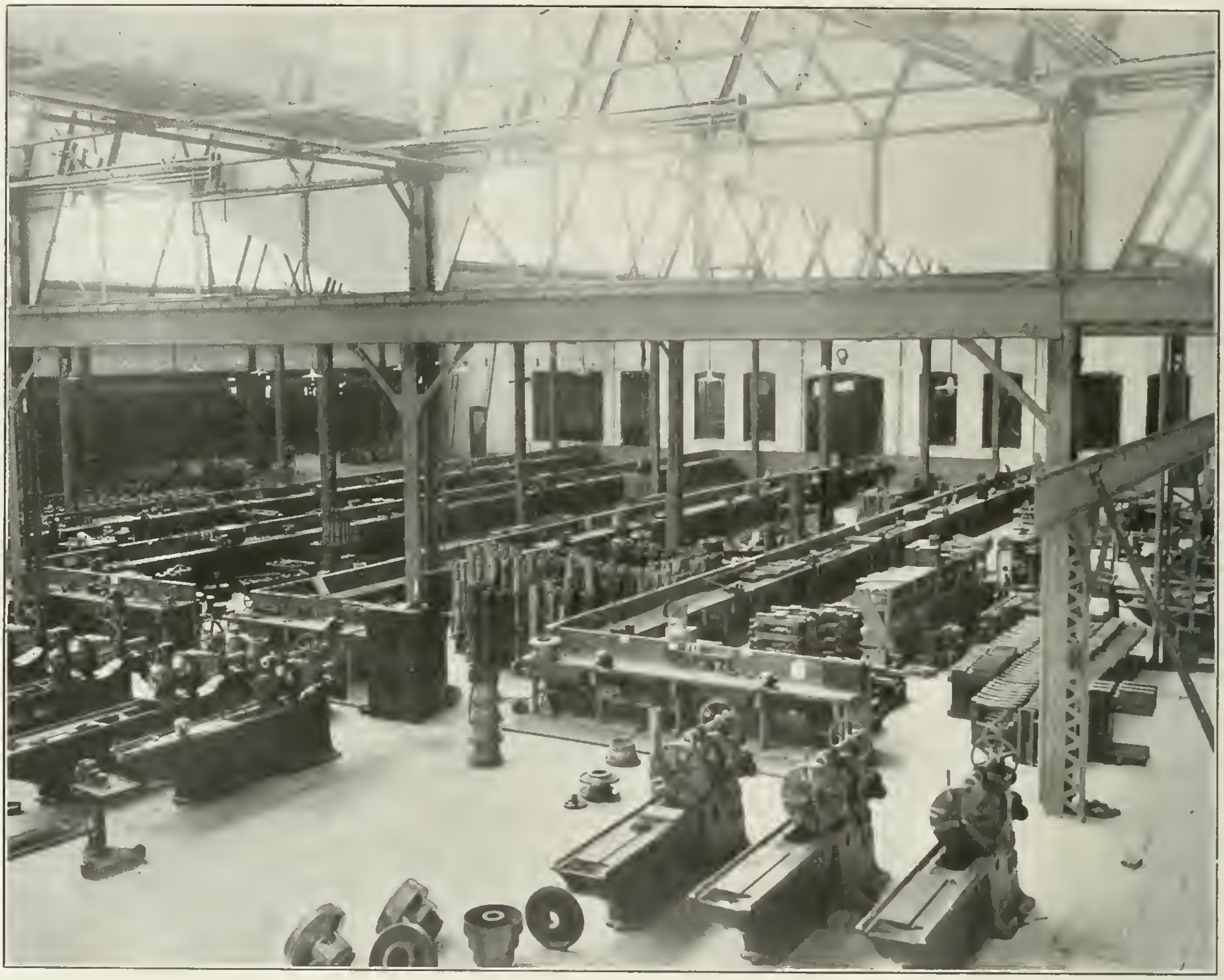

Fig. 4. Assembly Floor for Carriages, Headstocks, Turrets and Feed-boxes. Storeroom in the Background

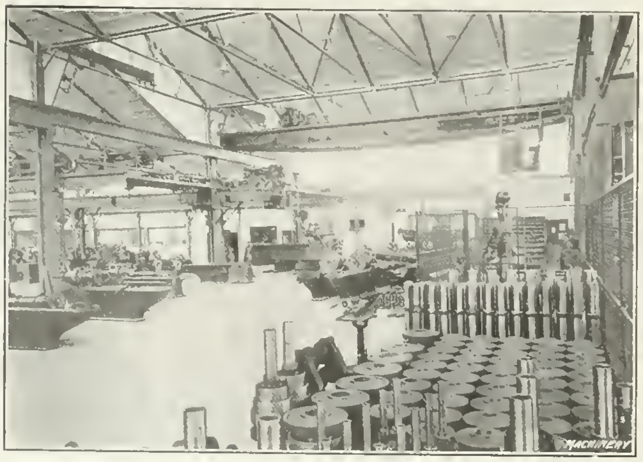

Fig. 5. Main Bay showing the Five- and Ten-ton Cranes

The Tool-room

The tool-room, a view of which is shown in Fig. 6, is located beneath the gallery shown to the right in Fig. 5, and is equipped with milling machines, boring machines, lathes, grinders, etc. In the tool-room all the jigs and fixtures used in the manufacture of both the boring machines and turret lathes are produced. This department is about 25 feet wide by 150 feet long, and is screened off from the main portion of the erecting floor.

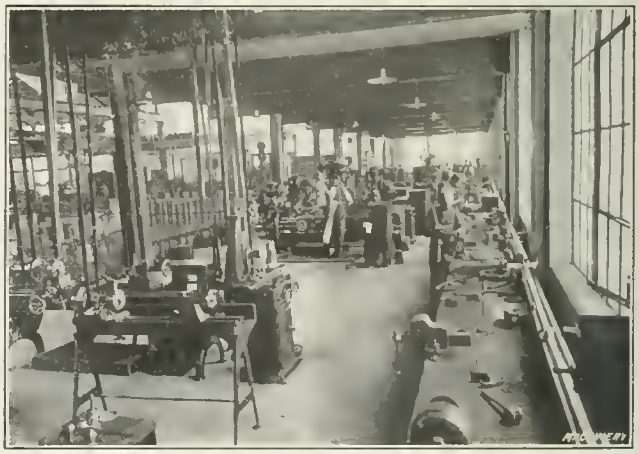

Fig. 6. A Portion of the Tool-room

General Conveniences for the Workmen

Each man is provided with a separate locker in which to keep his hat and coat, and also an individual wash bowl. Two shower baths and a bathtub are installed to be used by the workmen, and every sanitary condition possible is provided for. Above the gallery is a lecture hall where meetings and entertainments can be held when desired. This hall has a seating capacity of about 300, and can be made still larger by throwing back the folding doors, some of which are shown thrown back in Fig. 7. The seats are in sections of three and are of the folding type. The rear portion of this hall is used as a lunch room for the workmen. Provision is made for a motion-picture machine and the stage is equipped with scenery.

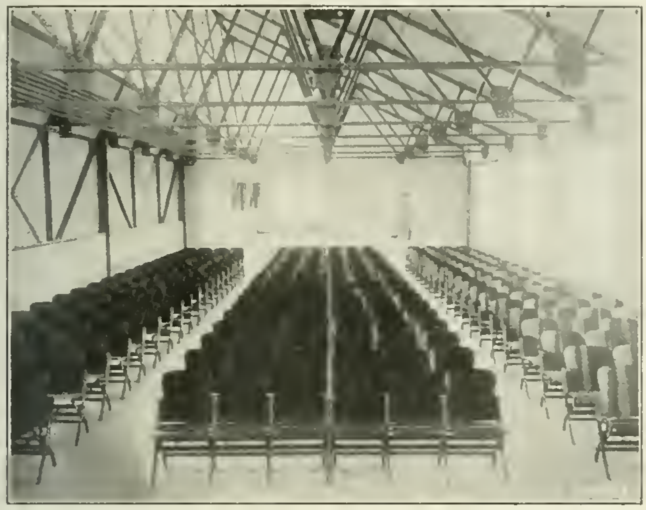

Fig. 7. Lecture Hall looking from the Stage

In this illustration the extended gusset plates of the roof construction are clearly shown.

The First Aid Room

The first aid room or emergency hospital shown in Fig. 8, is 12 feet square, and is equipped with the following: One examining table and stool, one cabinet, one instrument stand, one sterilizer, one waste receptacle, one irrigator and one hospital sink, the latter being equipped with foot pedals for opening the cold and hot water faucets. The cabinet contains a set of surgical instruments and all first aid supplies. A desk, not shown, is provided for the convenience of the surgeon in making up records of injuries. The room is painted in white throughout and is provided with a tile floor. All of the furniture is of steel construction painted white.

Offices and Engineering Departments

As shown in Fig. 3, the office building is located on the corner of Washington Ave. and Baldwin St., opposite the new main building, and is connected to the latter by an underground tunnel. The steam pipes and wiring for the electric lights in the office building are conveyed from the power house through this tunnel. The office building is of fireproof construction, with tile flooring, and is trimmed in quartered oak. It is 48 by 116 feet, and consists of two stories and a basement. In the basement is located a ventilating fan, which supplies the various offices with fresh air and forces the foul air out. The building is heated by direct and indirect radiation, the direct radiation being controlled by air-operated valves of the Johnson system. The fresh air being drawn from the outside, and the foul air being forced out through a ventilator in the roof mechanically, heating and ventilation are independent and separately controlled. On the ventilating fan is an automatic humidifier to keep the humidity in the offices constantly at a certain point, a very necessary provision for comfortable working conditions in offices.

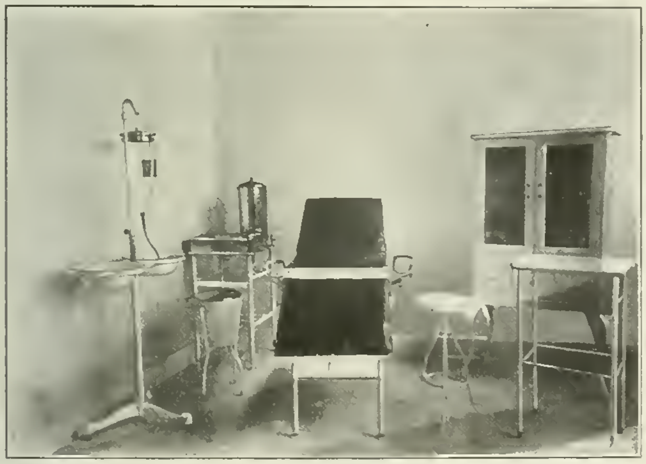

Fig. 8. The First Aid Emergency Hospital

All lighting in the office building is of the indirect type. Fig. 9, which shows a part of the engineering department, looking towards the vault and blueprint room, illustrates the effectiveness of this system of artificial lighting. This photograph was taken at night with the room illuminated only by the lamps. The negative was given eight minutes exposure, using a 32 stop. This system of lighting, as can be seen, eliminates all shadows and provides uniform distribution of light. Each unit is composed of four 150-watt lamps spaced at fourteen-foot centers. It requires seventeen kilowatts to illuminate the entire office building.

The system used by this company for keeping track of the workmen's time is a little out of the ordinary and worthy of note. A register called a "periodograph," is used throughout the factory to record the time. The system is worked out on the quarter hour basis, that is, the minimum time recorded is fifteen minutes. The time when the job is started is recorded by the instrument, as is also the time when it is finished. The difference between the two numerals stamped on the card shows the number of quarter hours the man has been on the job. The clocks in these periodographs are regulated by a master clock, located in the engineer's office. The data can be taken directly from the cards and added on an ordinary adding machine. As this system will be explained more fully in another article it will not be necessary to make further mention of it here.

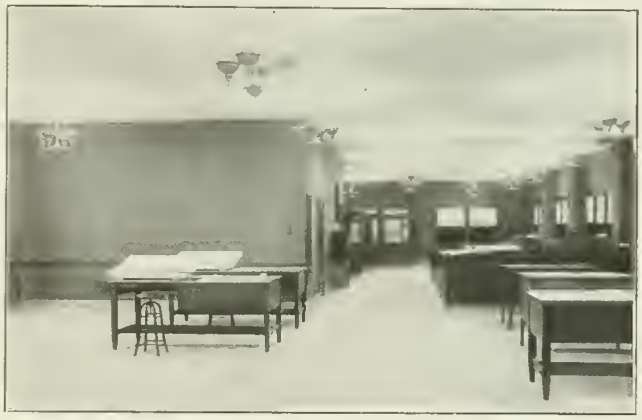

Fig. 9. A View of the Engineering Department taken at Night, Eight Minutes Exposure with a 32 Stop

The plant, the new part of which is briefly described in the foregoing, is one of the best in the United States, especially designed for manufacturing machine tools. It is an expression of the development of a business that has steadily grown in strength and prestige since it was founded about twenty-five years ago in Madison by Mr. John A. Johnson. Originality in design and efficiency in operation have been the characteristics of machine tools, known as "Gisholt"—the name of the boyhood home in Norway of the founder.

* * *

FIRST TELEGRAPHIC TRAIN ORDER

A bronze tablet was set in a monument May 21 at Harriman (formerly Turners), N. Y., as a memorial presented by the Erie Railroad Co., to commemorate the spot where, in 1851, the first telegraphic order was given directing a railroad train to move. The order was sent by Mr. Charles Minot, general superintendent of the Erie Railroad, a vignette of whose face appears at the top of the tablet, enclosed in a wreath. Prior to directing train movements by telegraph, the engineers and conductors ran their trains by the time-table and "judgment." The telegraph is now being displaced by the telephone and the probability is that in the not distant future the train despatcher will be in direct communication with all the trains on his division all the time, either by a wireless or sliding contact system.

WATCH MOVEMENT MANUFACTURE—2

METHOD, MACHINES AND SPECIAL TOOLS USED BY THE SOUTH BEND WATCH CO.

By DOUGLAS T. HAMILTON*

The special tools, gages, etc., used in watch movement manufacture compare favorably, from the standpoint of accuracy, with the tools used in any other line of manufacture. Accuracy is an absolute necessity in this class of work, if interchangeable manufacture is to be carried on successfully, and on a paying basis. In the following article a few of the representative gages and tools used by the South Bend Watch Co., South Bend, Ind., will be illustrated and described before the making of the various members of the watch movement is taken up.

The Transfer Chuck

The transfer chuck which is illustrated in Figs. 12 and 14 has been developed for making watch models and master plates, a group of the latter being shown in Fig. 13. The transfer chuck consists mainly of two dovetailed circular plates *A* and *B*, which can be adjusted at right angles to each other by screws *C* and *D*, the latter being provided with micrometer collars reading to 0.001 inch. Readings to 0.0001 inch can be easily obtained by means of the auxiliary vernier scale on the end of the slide, Fig. 14. These two adjusting circular plates *A* and *B* move in north, south, east and west directions to correspond with the geographical lines used in laying out the various holes in the watch plates, thus making it possible to drill any hole in its exact position.

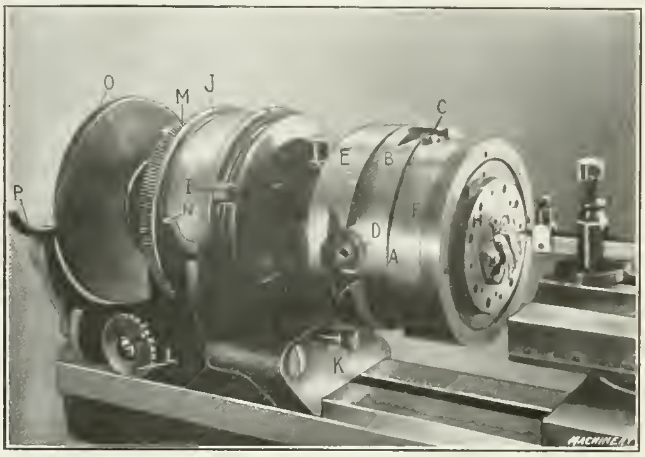

Fig. 12. Transfer Chuck used in making Master Plates and Model Watch

The circular plate *F* is provided with a circular tongue which fits in a corresponding groove in plate *A*. The circumference of plate *F* is marked off in degrees, and the vernier scale on plate *A* makes it possible to set plate *F* to an angular position reading in minutes and fractions thereof. Plate *F*, as shown in Fig. 14, is held to plate *A* by fillister-head screws and elongated washers, which fit in a tee-slot cut in plate *A*. Fastened to the swiveling plate *F* is a brass disk *H* to which the master plate, or the various parts of the model watch to be made, are clamped. The boring of the holes and the other machining operations are completed before the master plate or model watch is removed from the brass disk. In Fig. 12, a bridged-type model watch is being worked upon.

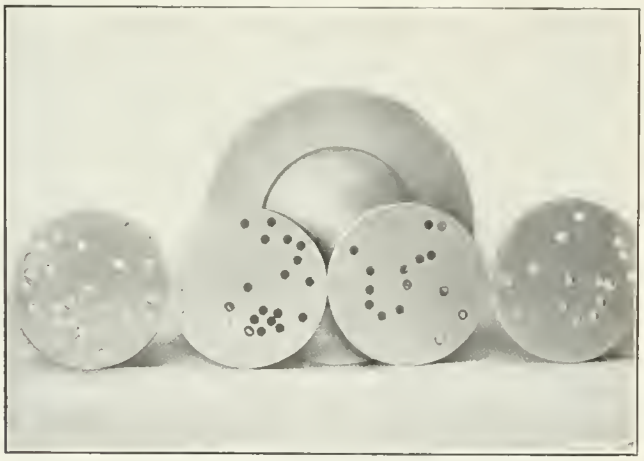

Fig. 13. A Representative Group of Master Plates

It will be evident now, upon referring to Figs. 12 and 14, and also to the preceding description, that all dimensions north or south, east or west of the center lines can be laid out very accurately by means of these adjustable calibrated circular plates or slides. Also, in addition, any angular dimensions, or parts to be machined, can be accomplished by rotating the swiveling plate *F* to any desired angle.

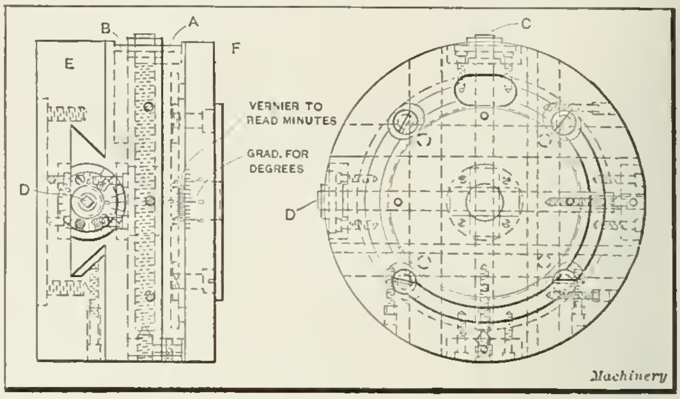

Fig. 14. Construction of the Transfer Chuck shown in Fig. 12

Arcs of any length can be milled by simply setting adjustable dogs *I* in a slot in the front face of the driving pulley *J*, Fig. 12. These dogs come in contact with a pin *K*, which when pushed in acts as a stop. When small end mills are being used, and when it would be dangerous to pull the pulley *J* around by hand, a worm attached to handwheel *L* is engaged with the worm-wheel *M*. Of course the belt must be thrown off the pulley before the head can be rotated by handwheel *L*.

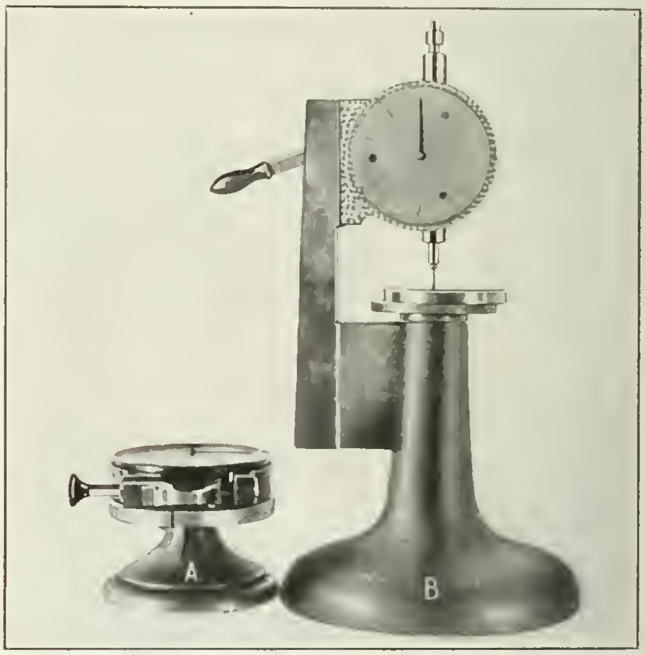

Fig. 15. Upright and "Fine" Multiplying Gages used for measuring the Various Parts of a Watch during Process of Manufacture

The head of this transfer chuck can be indexed by hand to the four positions—north, south, east and west—where it is held by a latch *N* fitting in notches cut in the front flange of the driving pulley. Other indexing disks giving a greater number of divisions are placed on the rear end of the spindle. A disk *O*, which is graduated in degrees, is located by finger *P*, as shown in Fig. 12. This transfer chuck is never taken from the model department, so that it cannot be mutilated in any way or its accuracy impaired.

Master Plates

All hole distances for the various tools are located by means of master plates, a group of which is shown in Fig. 13. These plates are all made of the same size—1.6 inches in diameter, 0.22 inch thick, while the holes are all made 0.100 inch diameter, regardless of the size of the hole required to be produced in the plate of the watch. The holes in these master plates are accurately spaced in the transfer chuck and are lapped to size. All of the holes are numbered to correspond with the chart, Fig. 6 (see the May number of MACHINERY), each hole having its own particular number regardless of how many plates it may be located in.

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* Associate Editor of MACHINERY.

Measuring Gages

Two types of multiplying gages are shown at *A* and *B* in Fig. 15. These are used for measuring the various parts of a watch during the process of manufacture. The gage shown at *A* is called a "fine" gage, and that shown at *B* is called an "upright" gage. The fine gage is used for measuring such parts as balance staffs, pinion staffs, and most of the circular work; the upright gage is used largely for measuring flat work.

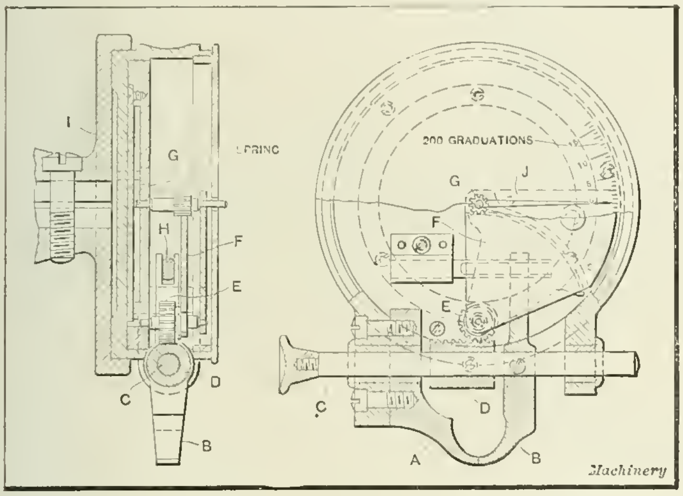


Fig. 16. Construction of "Fine" Gage shown at A in Fig. 15

The construction of the fine gage is shown in Fig. 16, to which reference should now be made. This gage is provided with a dial having 200 graduations laid off on its face. The work to be measured is placed between the jaws *A* and *B*, these jaws being separated by forcing in the rod *C*, to which jaw *B* is attached. Held on this rod by a screw, is a rack *D* which meshes with a pinion *E* having 40 teeth. Pinion *E* is connected to fan gear *F*, (the whole number of teeth in which should be 225) which meshes with pinion *G* attached to needle *J*. Jaw *B* which is held by a screw to rod *C* has a slot cut in its rear end, which fits a flattened stud *H*, thus preventing the jaw from tilting. One complete revolution of needle *J* around the dial gives a corresponding opening between the jaws *A* and *B* of 0.080 inch, so that the space between each graduation on the dial represents a movement of the jaw of 0.0004 inch. The working mechanism of the gage is enclosed in a case, which is supported on the stand *I* as shown.

The working mechanism of the upright gage is illustrated in Fig. 17. This gage is furnished with a dial having 100 graduations. The measuring spindle *A* is moved up and down by a handle *B*, which is connected to the spindle by a link *C* and a collar *D*. As spindle *A* is raised, the rack teeth cut in it mesh with a pinion *E*, which transmits motion to gear *F*, pinion *G* and needle *H*. Gear *I* is interposed to eliminate back lash in the gearing. The dial, as already mentioned, is divided into 100 equal spaces and each graduation corresponds to a movement of the measuring spindle of 0.001 inch. The capacity of this gage is ½ inch.

The table *J* is adjustable, and a plate *K* for holding the work to be measured is attached to it by screws. The stud on which table *J* is held, is screwed into a babbitt bushing *L*, the latter being clamped on the stud by the screw *M*. The babbitt was poured in through the screw hole, after the stud was put in place. The spindle *A* works in hardened and lapped bushings inserted in the case holding the measuring mechanism.

Master Thickness Gages

All measuring gages throughout the factory are kept in repair and tested from time to time by means of standard thickness gages. A remarkable illustration showing twenty-seven of these thickness gages wrung together is presented in Fig. 18. These gages are made from ½ inch diameter Sanderson drill rod, and vary in thickness from 0.025 up to and including ½ inch. The gages presented in the illustration were made twelve years ago by Mr. William R. Zessinger, foreman of the tool-room. For the benefit of those who would be interested to know how these gages are made and lapped, the following description is given.

Making and Lapping Master Gages

A piece of ½-inch diameter Sanderson drill rod is held in a chuck and is cut off, leaving sufficient material for facing, grinding and lapping. After hardening, the temper is drawn slightly—just enough to remove the strains set up in hardening. Then the block is ground, leaving 0.0002 inch on a side to be removed by lapping. The next thing to do is to prepare the cast-iron lapping block. This is planed as true as possible, using a flat tool for finishing. After the cast-iron block is planed, a hardened and ground steel block is used to rub No. 6 diamond dust into it.

Before describing the lapping of these gages it might be well to describe briefly how the No. 6 diamond dust is obtained. Splint and broken pieces of pure water diamonds are put in a mortar, and the plunger which is made of hardened steel is struck repeated blows until the broken diamond chips are crushed to powder. The powder is now removed and placed in a receptacle partly filled with watch oil. The receptacle holding the diamond dust and oil is allowed to stand for ten minutes; then the oil is poured off and the sediment which is left, is removed and labeled No. 1. The oil with the finer dust in it is then allowed to remain in the receptacle thirty minutes, after which the sediment is removed and called No. 2. The diamond dust still remaining in the oil is now allowed to settle from 4 to 6 hours, then the dregs are removed and labeled No. 3. This process is again repeated and the oil is allowed to stand for 24 hours, the sediment removed being called No. 4. The diamond dust that has not sifted through the oil is very fine, but it is still there, so that the receptacle is put away and left for two weeks. The sediment is then removed and labeled No. 5. This is the diamond dust which is used for lapping these fine thickness gages.

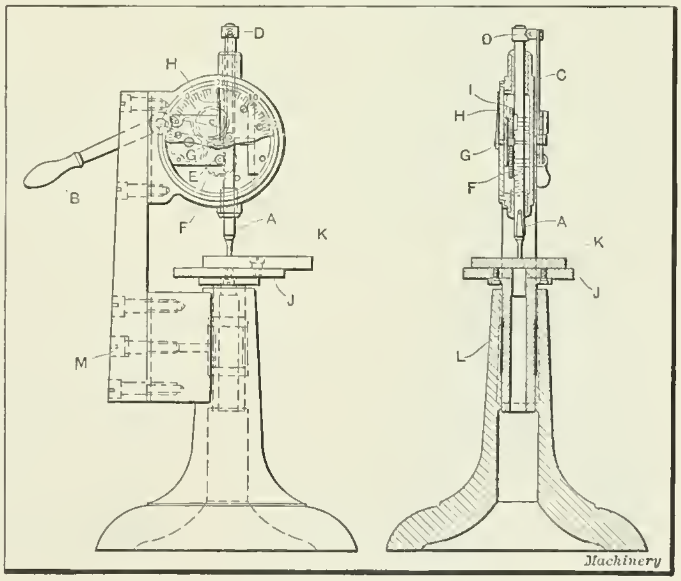


Fig. 17. Construction of Upright Gage shown at B in Fig. 15

To proceed with the lapping operation; the gages in this case have a hole in them and are held in contact with the lapping block by means of a piece of steel pointed like a lathe center, and fitting in the hole, but not passing completely through the piece. The gage to be lapped is held down firmly on the diamond charged block, and is given a rotary motion. The pressure on the gage should not be released before the lapping is stopped. After rotating the gage a few times on the block, remove all foreign matter with benzine, and repeat the lapping process until the gage is reduced to the desired thickness. Here is a point about lapping with diamond dust to be observed—never apply any more dust after the lap has once been charged, but remove the material ground from the work with benzine when the block commences to glaze. When a lapping block commences to glaze some toolmakers apply more dust; this is wrong. The reason for the glazing, is that the material removed fills the pores of the iron and prevents the diamond dust getting at the work.

These gages, if properly lapped, can be wrung together and can be held without dropping apart as shown in Fig. 18. To wring the gages together, they should be slid back and forth on each other, and not brought together with their faces in a parallel plane, as the dust particles in the air adhere to their surfaces and prevent them coming together. It has been demonstrated that the reason that these gages adhere is because there is an extremely thin oil film on them which acts as a binding medium. Of course the more closely the surfaces approach true planes, the greater will be the power required to separate them. This work is not as difficult as it appears, but there is a slight "knack" in lapping which can only be acquired by experience. However, even a novice by following the foregoing method will be surprised at the results he will achieve.

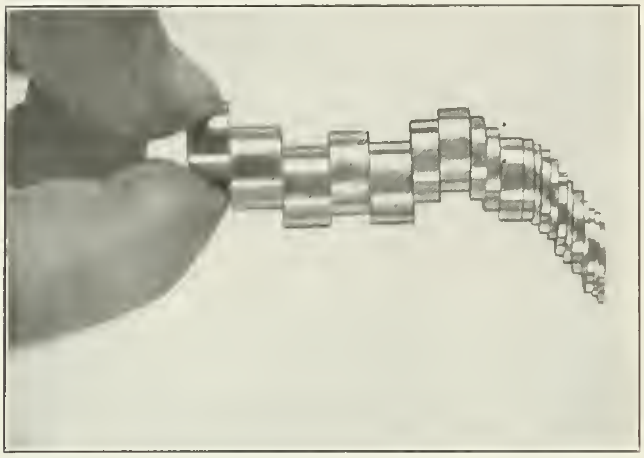


Fig. 18. A Remarkable Illustration showing Twenty-seven Standard Thickness Gages wrung together

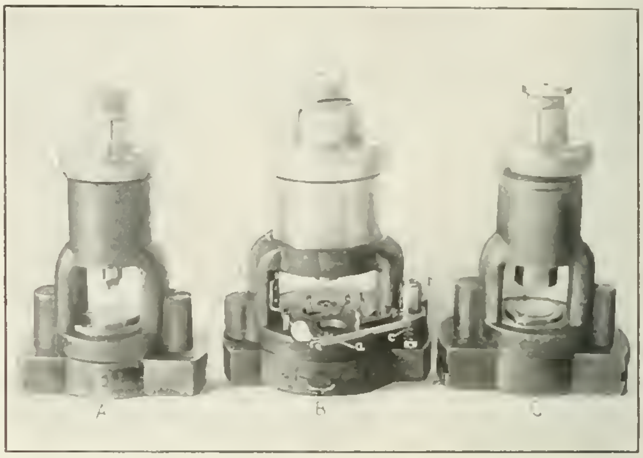


Fig. 19. Standard Sub-press Dies of the Blanking, Shaving and Burnishing Types

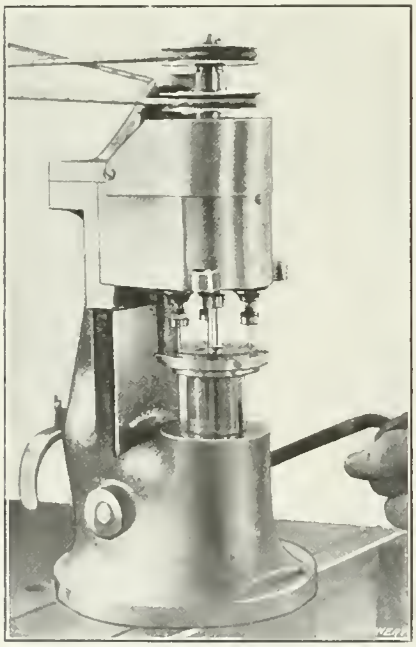


Fig. 20. Three-spindle Drill Press for Drilling Dial Foot Holes in Watch Plates

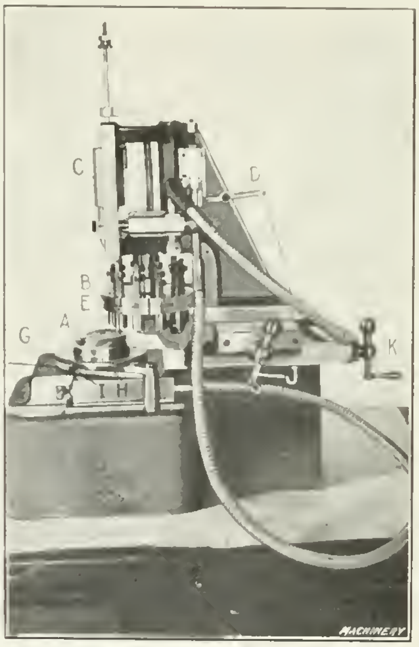


Fig. 21. Numbering Machine for Watch Plates, etc.

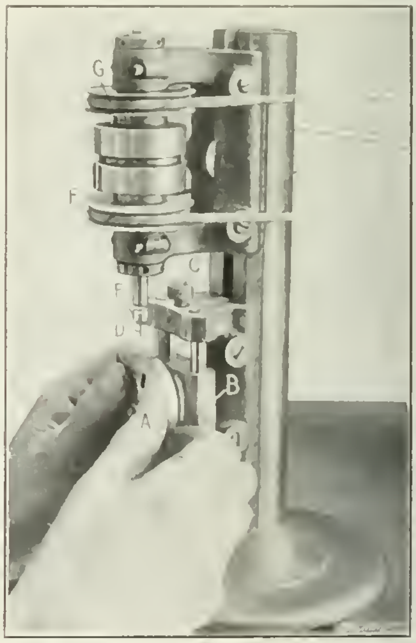


Fig. 22. Friction Tapping Machine for Dial Foot Screw Holes

Sub-press Dies

The sub-press type of punch and die is used almost exclusively in watch movement manufacture, because of the accuracy which can be obtained by its use. Three types of sub-press dies are shown in Fig. 19 where *A* is a blanking die, *B* a shaving die, and *C* a burnishing die. The general construction of these sub-press dies has previously been described in MACHINERY. The device shown attached to the shaving die at *B* in the illustration, however, is novel and worthy of description.

The particular sub-press die shown at *B*, Fig. 19, is used for shaving wheels, after they have been blanked, and is provided with a shaving locator. This consists of a nest *a*, hinged at *b*, and kept out by a coil spring *c*. The blank is placed in the nest, and the latter forced in by the thumb piece until the set-screw touches stop *d*. In this position, the blank is located over the ejector *e*.

Now supposing a wheel has just been shaved, the nest is pulled back until the front hole is in line with the ejector; then the lever *f* is depressed, which operates the ejector and places the blank in the nest. A blank is now placed in the hole *g*, in the nest, the latter being pushed in to the stop and latch *h* operated. This series of actions puts a blank in position to be shaved, and at the same time locates a blank in the "chuck" of the ejector ready for the next operation. This eliminates the necessity of the operator putting his fingers near the punch, and also allows the press to run continuously.

The burnishing die shown at *C* is a type of die which is used to a large extent in the manufacture of the steel parts of a watch movement. The use of this die obviates the necessity of polishing, as a nicely finished and accurate surface can be obtained with very little trouble. Of course it requires good work on the part of the toolmaker who must produce the die without scratches or other imperfections. The work is forced by the punch entirely through the die, which is made with straight and polished sides.

Making Watch Plates

The mechanism of a watch is retained between plates and bridges, holes being drilled and jewels inserted to act as bearings for the shafts on which the various pinions and wheels are mounted. In the South Bend watches, all plates and bridges are made from nickel alloy and are blanked out in the punch press. The lower plate is then drilled, reamed, faced, tapped, and recessed for the various wheels, barrels, etc. The bridges are punched, shaved, faced, stoned, drilled, counterbored, recessed and pinned. After all the machine work is completed, these parts are nickel-plated.

Drilling Dial Foot Holes

The three holes in the lower plate of a watch are used for holding the dial by the pins riveted into the latter, and they also serve as locating points in all the subsequent turning and counterboring operations. It is evident, therefore, that these holes must be accurately located, drilled and reamed.

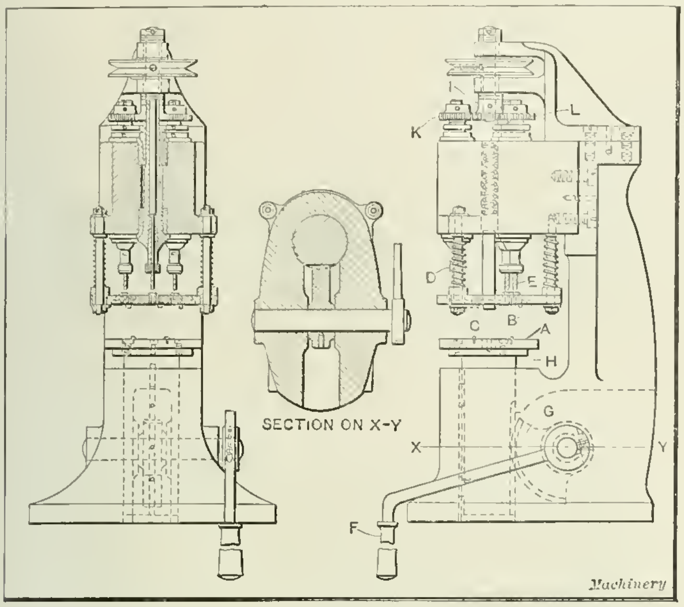


Fig. 23. Construction of Three-spindle Drilling Machine shown in Fig. 20

The three-spindle drilling machine used for this purpose, is shown in Figs. 20 and 23. The watch plate, when being drilled, is held between two circular plates *A* and *B*; the work, however, does not come in contact with the plates, but rests on small contact points in them, thus making it impossible for dirt to get between the plates and prevent the holes in the plates from being dead in line. The work is also held down tightly by a spring plunger *C*. The upper plate *B*, which is held down by coil springs *D*, carries the drill bushings. The lower plate with the work on it is raised to the drills *E* by means of a handle *F* fastened to a shaft on which a fan gear *G* is retained. This fan gear meshes with a rack in stud *H*, on which the table is held. The top plate acts as a shedder for the drills, and at the same time by means of bushings guides the drills. The three drilling spindles are driven from the overhead works by grooved pulleys and spur gears. Intermediate gear *I* is held on the same shaft as the grooved pulley, and meshes with spur gears *K* and *L* which are fastened to the other two drilling spindles. The drills are 0.052 inch in diameter.

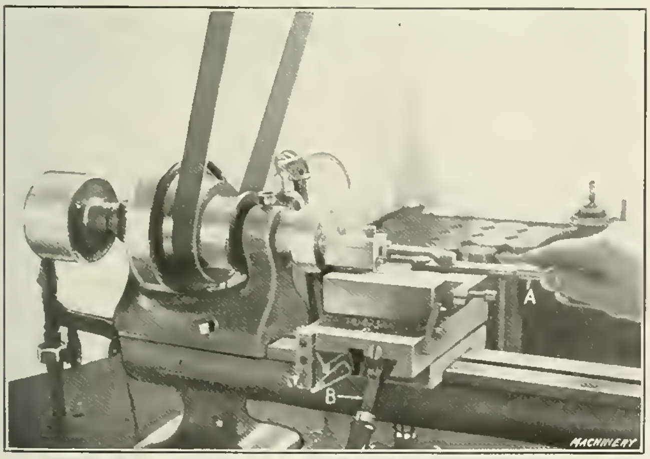


Fig. 24. Lathe equipped with Air-chuck for facing Plates

It is of vital importance that the dial foot holes are accurately located as to relative position and absolutely uniform as to size. This is secured by a subsequent operation performed in the same machine which does the drilling. This operation is done by means of accurately sized reamers.

Lathe for Facing Watch Plates

The lower plate after the dial foot holes and some of the other smaller holes have been drilled and reamed is faced off in the lathe shown in Fig. 24, which is provided with an automatic air chuck for holding the work. This air chuck is operated by a foot treadle which, when pressed, opens a valve, admitting air behind the piston connected to the outer sleeve of the chuck; this action holds the plate tightly against the hardened and ground stationary points in the chuck. The chuck is split and is provided with six bearing points so that the plate is always made the same thickness. The facing is accomplished by a turning tool held on the slide-rest. This tool is brought into contact with the work and fed to the desired depth by handle *A*, while handle *B*, having a gear that meshes in a rack under the slide, traverses the tool across the work.

Numbering Machine for Watch Plates

The bridges of a watch are numbered and lettering is stamped on the various parts of the watch, such as the number of jewels and other information of similar character. The numbering is accomplished in the machine shown in Figs. 21 and 25. The part to be numbered is held in a form on table *A* by a spring finger, and the head *B* carrying the letters or stamps, is indexed by hand, indexing slots and a latch being provided for this purpose. The hammer *C*, which gives a blow to the stamp to sink it into the work, is released by a compressed air device which is operated by tripping lever *D*, connected by a string to a foot-treadle. By a system of valves and air pipe connections, the hammer is returned to its "up" position after the blow has been delivered. The spindles *E* carrying the stamps, are forced down by the hammer against the tension of open wound springs. These springs are made of various tensions, so that the stamps will receive just sufficient pressure to force them in to the required depth. It is

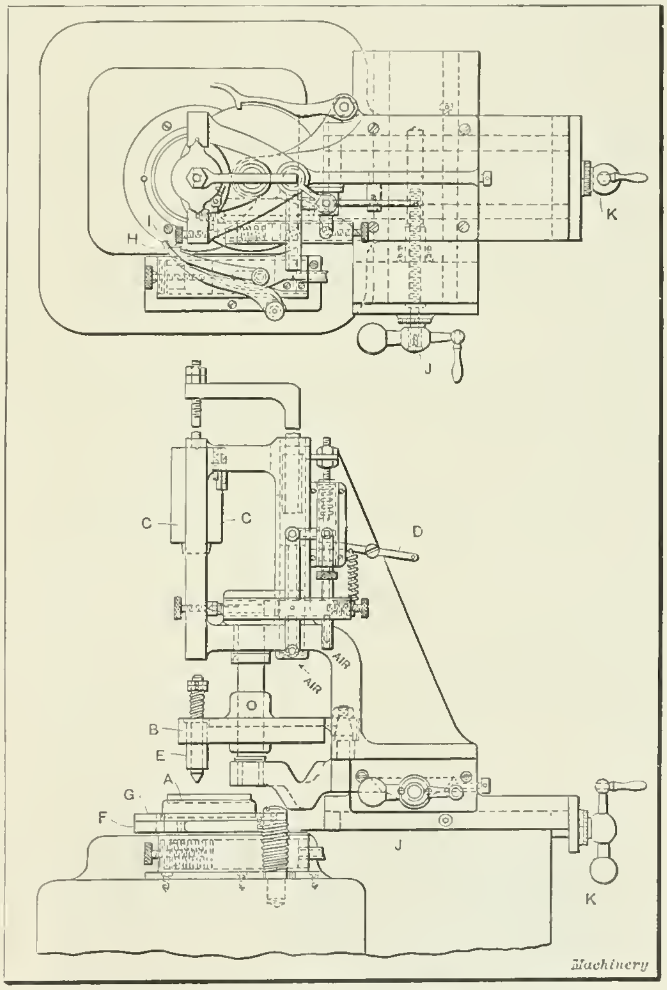


Fig. 25. Construction of the Numbering Machine shown in Fig. 21

evident that figure "8" will require a considerably greater blow than figure "1".

The table *A* is indexed by means of two ratchet dials *F* and *G*, operated by compressed air, one of which is used for indexing, and the order for locking, or holding the table when the stamping is being done. Finger *H* does the indexing, while finger *I* retains the table in position. Stops on top of the indexing dial are used as locating points, so that the stamp can be started in any desired position. The number of teeth that the dial is indexed can be changed to compensate for the diameter of the circle on which the letters are to be stamped. Of course a small circle will require a larger spacing than a large circle. The head carrying the letters is provided with adjustable slides which are operated by handles *J* and *K*, so that the stamping can be done in any desired position on the work.

Friction Tapping Machine

The pins which hold the dial to the lower plate, and which pass through the dial foot holes, are held in place by screws. Clearance holes are drilled in the pins that are fastened to the dial, so that the screws instead of being tapped into the pins, are threaded into the plate. The tapping size holes are drilled in an index drilling fixture. The tapping is accomplished in the machine shown in Fig. 22. The plate *A* to be tapped is held in a small fixture *B*, recessed to fit it, which is pushed up and down by the operator. The depth to which the tap extends into the work is governed by stop-screw *C*, which retards the fixture at any desired point in its travel. The tap *D* is not fluted, but is filed three cornered with flat sides and is held in a split chuck *E*. The spindle carrying the tap is provided with two cone clutches tapered to an angle of 8 degrees. These cones fit in corresponding cones which form integral parts of the two pulleys *F* and *G*, driven in opposite directions.

In operation, when the fixture holding the work is pushed up, the tap travels in to the correct depth. Stop-screw *C* then comes in contact with the fixture holding the work, and in so doing withdraws the cone from pulley *G*. Now as the fixture is pulled down, the cone comes in contact with pulley *F*, running in the opposite direction, and backs the tap out of the work. The tap is 0.047 inch in diameter and 110 pitch, and the fixture works so successfully that no taps are broken, or threads stripped in the work.

* * *

BORING LATHE PARTS IN RADIAL DRILLING MACHINE

The jigs and tool equipment used in the shops of the American Tool Works Co., for machining quick-change gear boxes and aprons of lathes, are shown in Figs. 1 and 2. These two views also illustrate how a radial drill is now used for machining these parts, instead of a horizontal boring machine, which was the type of tool formerly employed.

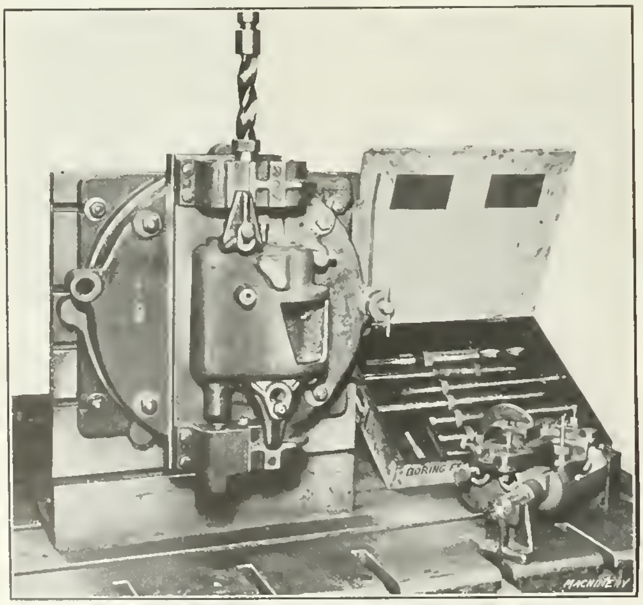


Fig. 1. Jig and Tools for Machining Change-gear Boxes with Radial Drill

Fig. 1 shows the jig used for the quick-change gear-boxes and also the tool equipment required for this particular job. All of the necessary tools are kept in the box seen to the right, so that no time is lost while hunting for boring tools or drills. The convenience of a radial machine and the rigidity and power of a modern design, makes it possible to perform operations of this class very efficiently. When a horizontal machine was used for this work, 216 hours was required for machining thirty-six castings. The same number of parts are now done in a 6-foot radial drill (by means of a suitable jig) in 45 hours, thus effecting a saving of 171 hours for every thirty-six parts machined.

Fig. 2 shows the jig and tool equipment for machining a 24-inch lathe apron on the radial drill. These aprons were formerly bored on a horizontal machine in lots of twelve, each lot requiring 72 hours. A similar number of aprons of the same design are now being done on the radial machine (by means of a jig), in 24 hours, thus effecting a saving in time of 48 hours. All of the tools required for the aprons are also kept in a wooden box which is marked with the name of the part, the size of the lathe, and the number of the jig, as the illustration shows.

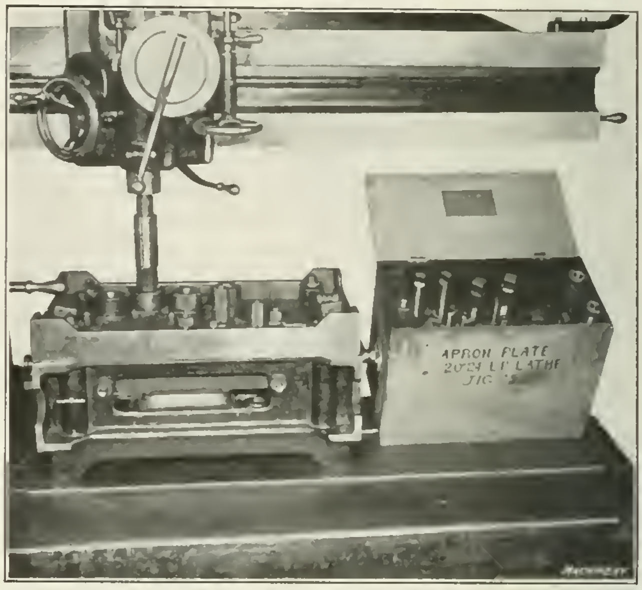


Fig. 2. Tool Equipment for Drilling and Boring Lathe Aprons

* * *

SPECIFIC GRAVITY OF SOLIDS SUBMERGED TO GREAT DEPTHS IN WATER

Some "scientific" contributors to the daily papers have worried about the fact that "scientists have failed to agree" as to whether the *Titanic* actually sank to the bottom of the sea, the estimated depth at the part of the ocean where she foundered being some 10,000 feet. They have argued as a reason for this uncertainty that the great pressure of the water at these immense depths would prevent the vessel from sinking. The fallacy of this reasoning is, of course, obvious to anyone who has the least idea of the meaning of specific gravity; in fact, the deeper the vessel sank the more certain did it become that it would sink to the bottom; for while the specific gravity of water is practically the same at all depths, increasing only one per cent under a pressure of 3000 pounds per square inch, that of solid substances immersed in water may be greater the deeper they are immersed, on account of the fact that these substances can be compressed. In many cases the specific gravity is apparently raised because the water, on account of its pressure, fills minute cavities between the fibers of various substances. Wood offers a familiar example of this. Some woods can absorb water until their specific gravity becomes almost as great or even greater than water. Cork offers another interesting example. Cork is one of the most buoyant of substances, but if it is sunk to a depth of 200 feet in water it will not rise to the surface, being compressed to such an extent by the pressure of the water at this depth that it sinks instead of rising.

THE BALOPTICON—AN INSTRUMENT FOR PROJECTING LARGE OPAQUE OBJECTS

A new field for optical projection has been opened up by the "balopticon," an instrument by means of which pictures and objects can be reflected in their natural colors on a large screen. The accompanying illustrations show a large instrument of this type recently constructed by the Bausch & Lomb Optical Co., Rochester, N. Y., the special feature of which is that it projects an image of objects much larger than has ever before been attempted, and, hence, presents new possibilities for this method of showing, before a large audience, illustrations of objects which otherwise could not be properly exhibited.

The original model of the device shown was designed as an experiment in response to a request from the National Cash Register Co. for an instrument of sufficient size to project an entire section of a cash register on the screen. The instrument made proved entirely satisfactory. The general features of its design are indicated in Figs. 1 and 2. The device has an opening for objects measuring 20 inches square, having any thickness up to 9 inches. In order to cover this wide area with sufficient illumination to the very edges, it was necessary to use two large 90-degree arc lamps in the light-tight houses at *A*, as shown in Fig. 2. These lamps are placed at a suitable angle so that the object on the table is covered with the light. The lamps are also placed near enough to the object being projected to avoid the use of condensers, thus avoiding the loss due to absorption of light. Two adjustable rheostats regulating the electric current are mounted one on each side of the base. Good results are obtained with a current of 25 amperes to each lamp.

The next problem to be met after having obtained the maximum amount of illumination for the area to be covered was to utilize this light so as to obtain an effective image. For this purpose a high-grade photographic anastigmat lens—a Bausch & Lomb-Zeiss Tessar Ic of 19 3/4-inch focus, 4 7/16 inches in diameter—was employed. A mirror *B* is used above the projection lens to direct the image toward the screen, this being necessary because the objects to be projected are held in a horizontal position on account of their size and weight. This mirror also serves the important purpose of reversing the view so that objects and printed matter are shown on the screen in their true positions. The mirror is silvered on the front surface, thus reducing the amount of light absorption practically to a negligible quantity.

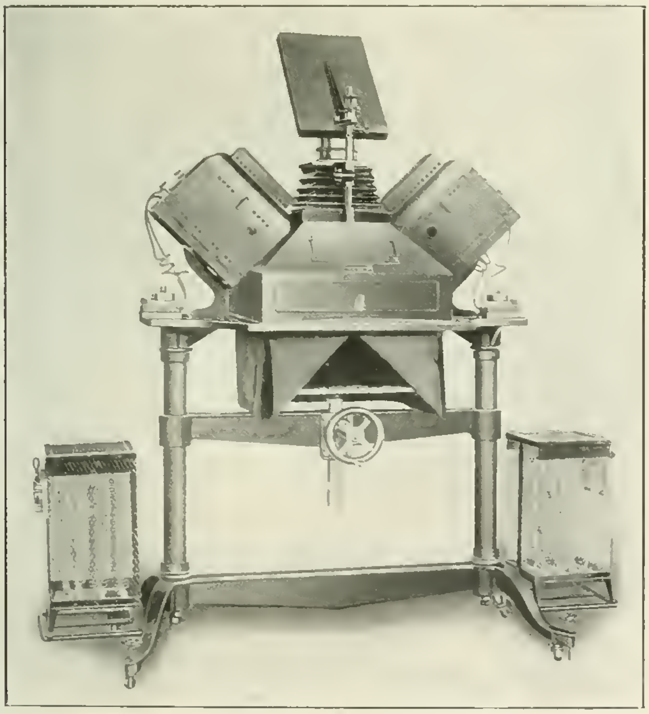


Fig. 1. The Balopticon for the Projection of Large Opaque Objects, made by Bausch & Lomb Optical Co., Rochester, N. Y.

The focusing is accomplished by bringing the object into the range of the lens by adjusting the large object table *C* vertically by means of handwheel *D*. A dark velvet curtain surrounds the table and prevents the light from escaping when the carrier is lowered. The corners of the curtain are draped up in Fig. 1 to show the table.

The instrument is of unusually large proportions for a projection lantern, the base being 54 by 24 inches, and the height of the stand to the top of the mirror being approximately 80 inches. The dark chamber is 23 inches square and is provided with a large door and an observation window of smoked glass, covered by light-tight doors, so that the object can be placed in position without lowering the carrying table.

An instrument of this kind, in addition to its commercial uses, can be used to advantage in projecting large illustrations and photographs of any size up to 20 inches square. This instrument, like a moving picture machine, undoubtedly would have considerable value in educational work, as small specimens and pictures could be shown to a large class simultaneously, and on such an enlarged scale as to make explanation of details easy and interesting.

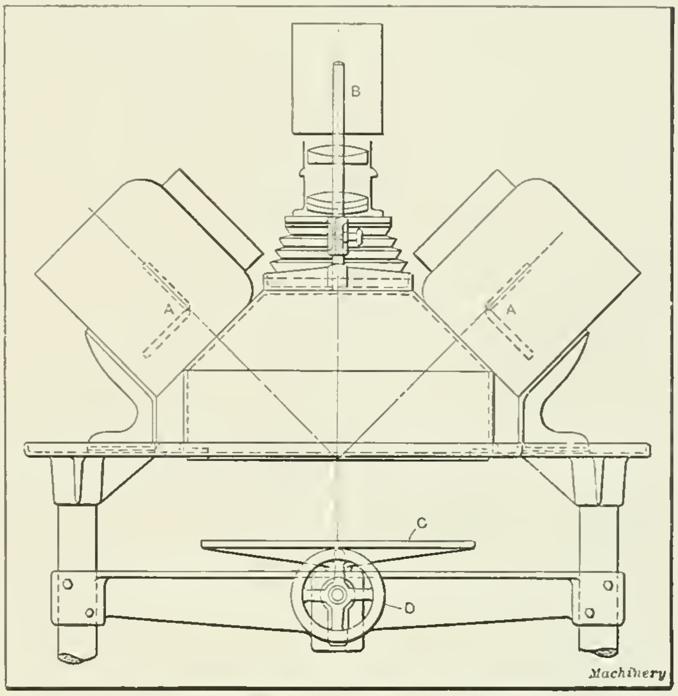


Fig. 2. General Design of the Balopticon

* * *

Thomas A. Edison is an enthusiast on the value of moving pictures as an educational means. He proposes to revolutionize the present school system by teaching children through their eyes in the natural manner rather than by making them learn to read, and from reading gain knowledge of the world and its ways. He proposes to make 4000 films, costing $3,000,000, and requiring years to prepare, which will cover the subjects of the greatest importance in a general educational scheme. These films will be supplied to public and other schools to be used by the teachers as an easy and agreeable means of inculcating knowledge at an early age of sciences many of which are ordinarily taught only when pupils are approaching maturity. Take, for example, a course in physics. This can be presented by moving pictures so clearly and simply that children five or six years old will comprehend principles clearly. The pumping of water, for example, is shown, glass pumps having been constructed in which the action of water, lifting and closing of the valves, movement of the plunger, etc., can be clearly seen. Geography, botany, history, discovery, agriculture, industrial pursuits, the army, the navy and hundreds of other sciences and activities can be graphically, rapidly and effectively presented to all classes at low cost.

* * *

The designs of the two new White Star liners, now being built at Belfast, are being changed with regard to the arrangement of the bulkheads. The change provides for lateral bulkheads in addition to the transverse watertight compartments, so as to minimize the risk of disaster in case several compartments are torn open, as in the case of the *Titanic*.

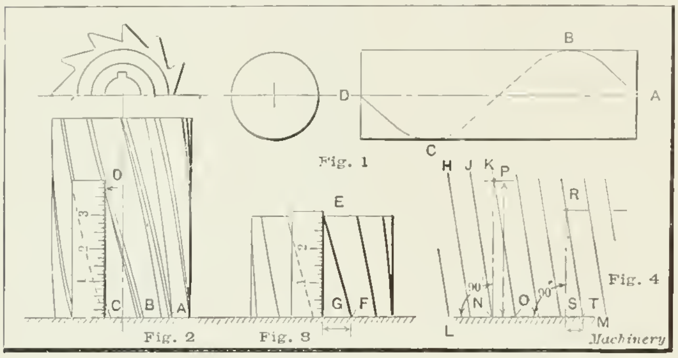
LETTERS ON PRACTICAL SUBJECTS

We pay only for articles published exclusively in MACHINERY

DETERMINATION OF MILLING-CUTTER SPIRALS FOR RECUTTING

Frequently a toolmaker is called upon to recut a spiral-toothed milling cutter. One of the first things he has to determine is the pitch of the spiral. If it is not stamped on the cutter this pitch must be calculated by methods such as those given in the following, or else guessed at; and guessing is very apt to involve several settings of the change-gears.

In order to understand the methods of calculation given herein it is necessary first to have a clear conception of what is meant by the *pitch* of a spiral. Referring to Fig. 1, the spiral *ABCD* has a pitch equal in length to the axial distance *AD*, because this is the distance measured along an element of the cylinder from the point where a spiral crosses it, to the point where the same spiral crosses it again. Hence when cutting the spiral-tooth, the table will be fed forward a distance equal to the pitch, while the cutter-blank makes exactly one turn about its axis.



Figs. 1 to 4. Different Methods of Obtaining Spirals of Milling Cutter Teeth for Recutting

Cutters are seldom or never so long that one tooth makes a complete spiral. If such were the case, however, the spiral could be measured directly. Usually the cutter will conform to either Fig. 2 or 3.

First Method.—Set the cutter on end on a flat plate as shown in Fig. 2. The points *A*, *B*, and *C* represent the corners of the cutting edges. Now, set a square ended scale, as shown, so that its corner coincides with the cutting corner *C*. Measure the distance *CD* along the scale to where the next cutting edge crosses the edge of the scale. The pitch will be as many times this distance *CD*, as there are teeth in the cutter.

Second Method.—When the cutter is so short that the first method cannot be employed, set the cutter up on a flat plate as shown in Fig. 3. Lay the scale up against it so that its edge touches the cutting corner *E*. Now, measure the distances *EG* and *FG*, the latter being the distance from the lower cutting corner *F* of the same cutting edge to the base of the scale. Find the circumference of the cutter-blank by multiplying its diameter by 3.1416. Divide this by the distance *FG*, and then multiply this result by the distance *EG*. This final result will be the pitch of the spiral.

Third Method.—Roll the cutter on a piece of paper or wrap a piece of paper about it and rub the paper so as to get an impression of the teeth including the same ends of several teeth, as shown in Fig. 4. Here the inclined lines *H*, *J* and *K* represent the cutting edges. Draw the line *LM* through the ends of the inclined lines. From the end *N* of the line *JN* erect *NP* perpendicular to *LM*. If it cuts the next inclined line *OK* at some point *P*, the distance *NP* multiplied by the number of teeth in the cutter, gives the required pitch. If, however, the point *P* lies outside of the line *OK* it may be found by producing *OK* until it crosses *NP*.

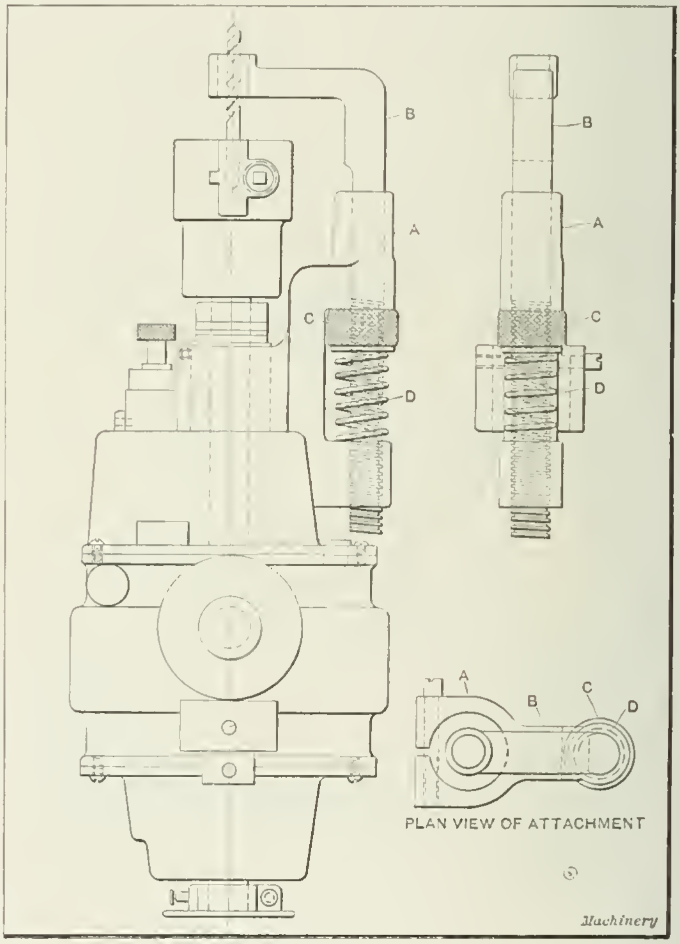
An alternative, when the cutter is narrow as shown by *SR*, is to draw from the upper edge and corner *R* a line *RS* perpendicular to *LM*. Measure the distance *ST* from the base of this perpendicular to the lower corner *T* of the cutting edge *RT*. Then the pitch will be found by multiplying the distance *RS* by the number of times that *ST* goes into the circumference of the cutter. Precaution should be taken when rolling a narrow cutter to be sure that it tracks straight, so that the points *N*, *O*, *T*, etc., will lie on a straight line.

South Bethlehem, Pa. H. A. S. HOWARTH

SAFETY STOP FOR ELECTRIC OR PNEUMATIC DRILLS

The accompanying illustration shows a safety stop for an electric or pneumatic drill. The breakage of drills used in these devices, especially in the electric drills, is very high. There are two main causes for this. In the first place, the device cannot be held very steadily, thus causing cramping of the drill in the hole. The second cause, and the more important of the two, is due to the drill's "breaking through" too suddenly after having passed through the work. This causes by far the greatest damage to drills. If the drill is large the driving device will come to a dead stop, causing damage to the mechanism itself.

Having the above difficulties in mind, the writer designed a stop which is shown applied to an electric drill in the accompanying engraving. At *A* is shown a stop bracket fastened to the frame of the drill; *B* is the stop proper fitted into *A* and bent so as to come in front of the drill chuck at the end. The hole in the end of *B* is made large enough so that the largest drill used can pass through it. The shank of the stop is threaded to receive knurled nut *C*, and spring *D* is inserted between nut *C* and the lower part of bracket *A*. The shank of stop *B* is milled flat on one side and the hole in *A* made to suit it, so that the shank of *B* cannot revolve. When using this stop the end or eye through which the drill passes is so adjusted by means of knurled nut *C* that the length of drill projecting outside of stop *B* is equal to the thickness of the work to be drilled. Then when the drill begins to break through, the stop will come against the work and a slight extra pressure



Safety Stop Device for Portable Drills

on the drill will be required to force it through the work, this extra pressure compressing the spring *D*. In this way, all danger of breaking through too suddenly and causing injury to the drill or tool is avoided. The writer has used this stop for over a year and it has given good results. T. C.

A GRINDING OR LATHE DOG WITH A CAM GRIP

The accompanying illustrations show a grinding or lathe dog made by the apprentice department of the West Lynn works of the General Electric Co. Fig. 1 shows the way in which the work is inserted. The lever is pushed back, putting under tension a spring which returns the lever as soon as it is released. The lever is provided with a cam face which comes in contact with the work holding it securely. Fig. 3 shows more clearly the construction of this dog.

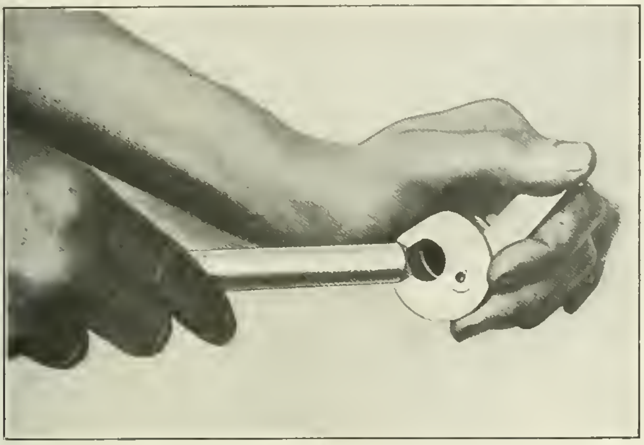


Fig. 1. Inserting the Work in the Dog

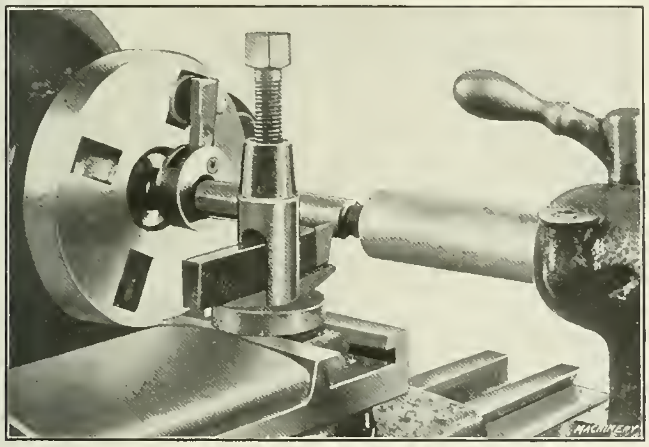


Fig. 2. Dog in use driving Work in the Lathe

In Fig. 2 the dog is shown in use holding a piece in the lathe. It has been found that in the lathe, the lever will break before the work will slip in the dog. The ¼-inch dog will take a variation in stock of 1/16 inch, and the 1-inch dog, a variation of 1/8 inch—this is the capacity of the cam. One advantage of this dog is that there are no set-screws or clamps to tighten, and it does not mark the shaft as a set-screw or clamp does, which is usually tightened more than is necessary.

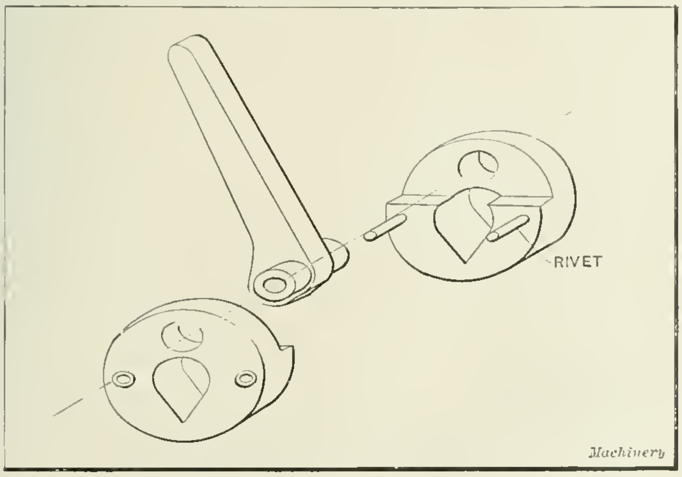
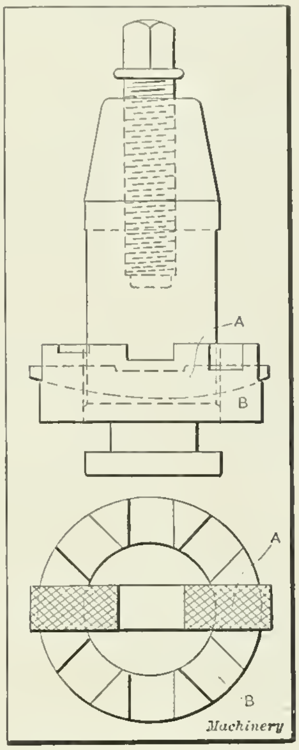


Fig. 3. Construction of Lathe Dog with Cam Grip

West Lynn, Mass. CHARLES K. TRIPP

IMPROVED LATHE TOOLPOST

The accompanying illustration shows a lathe toolpost which the writer believes will prove of interest to the readers of MACHINERY. This design of toolpost was made long ago, but to the writer's knowledge it has never been published in the technical press.



Type of Toolpost permitting of Great Range of Adjustment

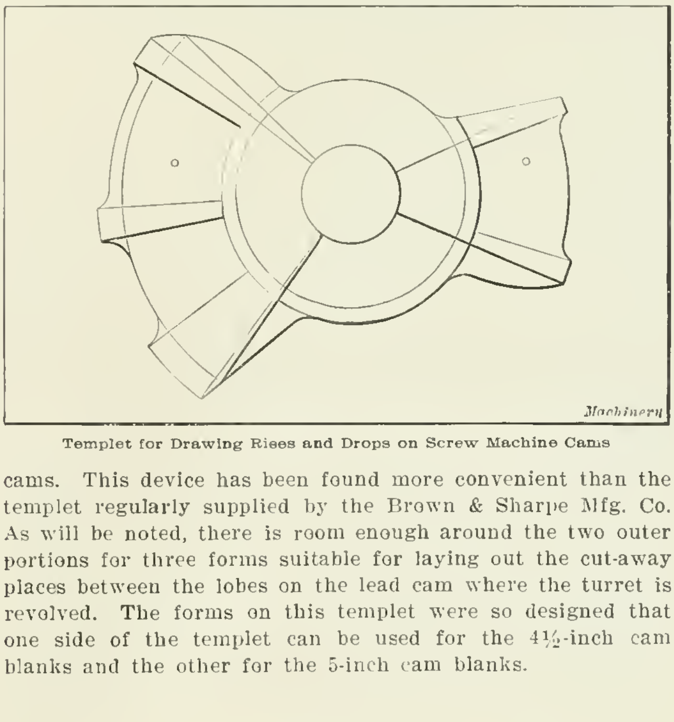
It will be seen in the illustration that this toolpost has decided advantages over the ordinary types, in that a greater variation in adjustment is possible. This will be appreciated by lathe operators who know what a difficult thing it is to pack properly under a boring tool, for instance, in order to bring the tool to the center so that there may be plenty of clearance when boring small holes.

One of the great advantages of this design is that it is comparatively easy to convert the toolposts now in use to this new type. In this way, toolposts with small adjustments can be changed into devices permitting a great range of adjustment and providing a simple method of setting the tool to the proper height. The only thing necessary is to cut four slots or grooves through the collar *B*. These grooves should fit the wedge *A*, as indicated.

Wickatunk, N. J. O. G. SIMMONS

TEMPLET FOR DRAWING RISES AND DROPS ON B. & S. SCREW MACHINE CAMS

The accompanying illustration shows a templet made by the writer, both in steel and celluloid, for drawing the rises and drops on No. 00 Brown & Sharpe automatic screw machine cams. This device has been found more convenient than the templet regularly supplied by the Brown & Sharpe Mfg. Co. As will be noted, there is room enough around the two outer portions for three forms suitable for laying out the cut-away places between the lobes on the lead cam where the turret is revolved. The forms on this templet were so designed that one side of the templet can be used for the 4½-inch cam blanks and the other for the 5-inch cam blanks.



Templet for Drawing Rises and Drops on Screw Machine Cams

The writer finds it convenient to have the radial lines where the rises and drops meet the outside circumference of the cam, scratched on the templet. For the celluloid templet, the 1-inch center circle is simply scratched on it, but for the steel templet, the hole is machined and made to fit a 1-inch plug; this plug serves to locate the templet in the proper position on the cam blank.

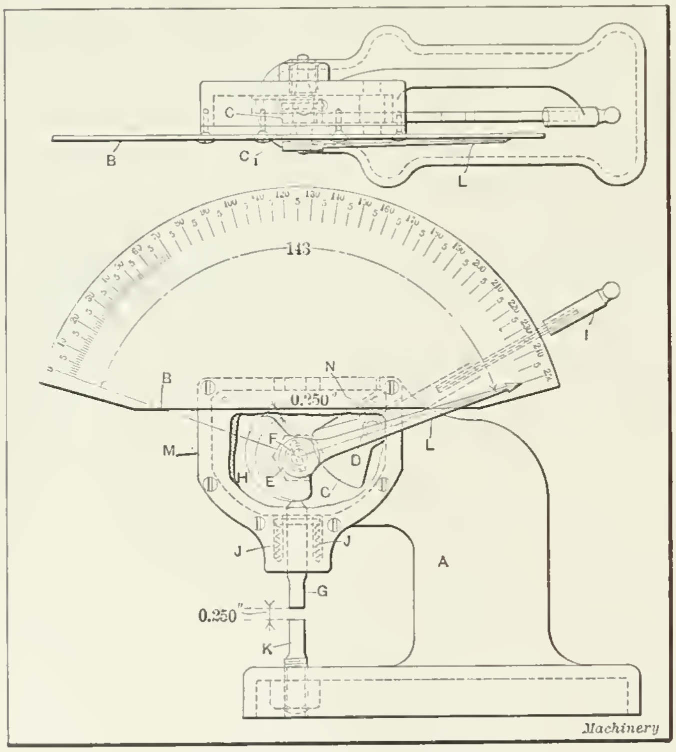
J. T. George

Providence, R. I.

[Templets can be used for laying out the rises and drops on the cross-slide and lead cams for the No. 00 Brown & Sharpe automatic screw machine with satisfaction, as the rise from the lowest to the highest point on the circumference of the cam is slight. However, the use of templets, constructed on this principle—drawing a line tangent to a circle for the drop or laying a line off from a circle for the rise—is not advisable on cams for the Nos. 0 and 2 machines. The reason for this is, especially on the lead cam, that the lobes are not all of the same height; consequently, when a rise for example, is laid out from a circle, it requires the same amount of cam circumference to rise a short distance as it does to rise to the full height of the cam. This adds to the time required for idle movements aand consequently reduces the production. The correct method of laying out the rises and drops for Brown & Sharpe automatic screw machine cams was described in the August, 1910, number of Machinery, engineering edition, in an article entitled, "Designing Screw Machine Tools and Cams."—Editor.]

A MEASURING DEVICE

The accompanying illustration shows a measuring device which has been used satisfactorily for measuring the thickness of mica for a number of years in our factory. For this class of work the regular micrometer is too slow, and would also show wear in a very short time. Of course, this device can be used for measuring paper, cardboard, sheet brass, sheet steel, etc. It consists of a cast-iron stand *A* to which a dial *B* is attached by screws as shown. The graduations on this dial are laid off to read to 0.001 of an inch in a space of 143 degrees.



A Measuring Device for Mica, Sheet Steel, etc.

The working mechanism of this device consists of a segment gear *C*, 20 pitch (50 teeth) which is held on a shaft *D*, and is in mesh with a pinion *E* having 15 teeth, and keyed on shaft *F*. The measuring spindle *G* is operated by a cam *H* having a uniform rise of 0.250 inch in 143 degrees. This cam is fastened to the shaft *F*, and is rotated by means of the handle *I* through the segment gear *C* and pinion *E*.

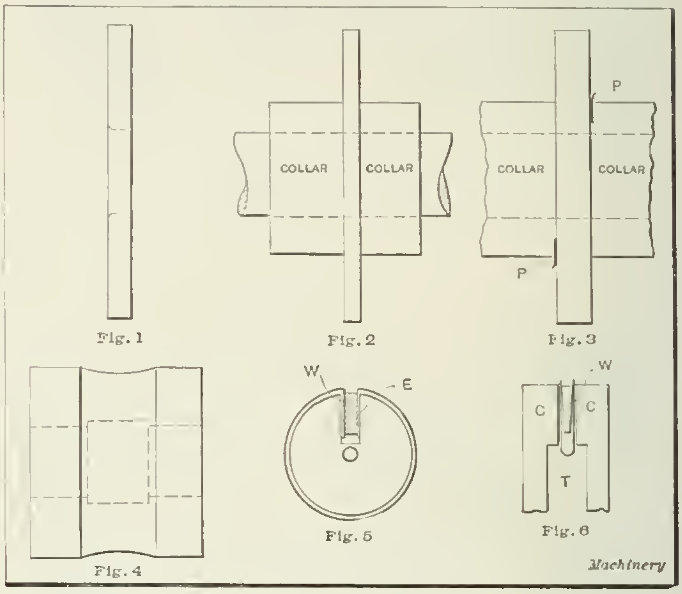
The measuring spindle *G* is kept in contact with the cam *H* by two springs *J* which bear against a pin driven into the spindle. The anvil *K* is adjustable, and is held when set in the desired position by means of a nut as shown. The needle or pointer *L*, which indicates the movement of the spindle *G* is also pinned to the shaft *F*. The steel plate *M*, which is fastened to the casting *A* by screws acts as a cover for the mechanism, and also as a bearing for shafts *D* and *F*. The shaft *F* has hardened tapered journals and bearings, the rear bearing being adjustable in this case to provide for lost motion, this being accomplished by means of a lock-nut. The flat steel spring *N* keeps the spindle *G* as well as the handle *I* in the upward position.

J. E. U.

SOME MILLING CUTTER SUGGESTIONS

Though improved management has greatly perfected manufacturing methods, set rules for odd jobs can hardly be formulated. This is true of jobbing and experimental work, some tool- and die-making, and of work in the smaller shops.

Milling cutters play an important part in shop practice. Saws and most other thin cutters frequently fit too tight on the arbors. By rounding the edges of the hole as in Fig. 1, much of this trouble will disappear. Another way of making a thin cutter work smoothly on the arbor is to use a collar of some width on each side of it when sliding the cutter on or off, as in Fig. 2, where the collars keep the cutter square with the arbor. In slotting, a cutter of the right width is not always to be found, nor is it always profitable to reduce the width of a wider one for the purpose. Lack of truth in arbor and collars will make a cutter leave a slot wider than itself, and it can be made to do likewise by inserting slips of paper between collars and cutter, on opposite sides, as shown at *P*, Fig. 3. It is not to be understood that this will produce an absolutely perfect job, but nine times out of ten it will do well enough.



Figs. 1 to 6. Various Suggestions relating to the Use of Milling Cutters

A cutter used on a special milling machine for a certain manufacturing operation is shown in Fig. 4. A dozen were purchased for the machine, and in due time were ground to the limit. The shop undertook to re-cut them and put them back in service. The job was done, and, in hardening, the cutters contracted most decidedly. As no internal grinder was at hand, nor any lap of that particular size one had to be made. A piece of a shaft, 1/16 inch smaller in diameter than the hole, was procured, and a slot 2 inches long was milled in one end, as shown in Fig. 5, after which a strip of No. 0 emery cloth was wound about the shaft and the lap brought into the slot and held by a wedge; *E* is the cloth and *W* the wedge. Placed on the centers of the speed lathe, it made a cheap lap for the purpose, and was easily and quickly renewed.

To lap out the cutters, they were slipped on the shaft and the lathe started. Then by grasping a stick of soft wood in the hands and using it in the same manner as a file, the cutters were revolved two or three times for every stroke, and with the pressure exerted, the revolving lap within soon corrected them to size. Kerosene was used as a lubricant.

Taking off a gang of cutters to put in a paper washer at the far end is expensive and uncertain. Expansion collars have done much to remedy this, but there are a few cases where an expansion collar cannot be used—between the halves of an interlocking cutter, for example. There is a way of making the cut larger without dismantling a gang. This way is shown in Fig. 6, which represents the halves of an interlocking side milling cutter. The little steel wedge W is driven between the parts C, spreading them the required amount; T is a strip of tin, the soft metal layers increasing the "staying-in" properties of the wedge. Donald A. Hampson

Middletown, N. Y.

A SUGGESTION FOR THE DESIGN OF CHAIN BLOCKS

The writer believes that inventors and designers of chain blocks have overlooked an opportunity in not having designed a type especially for the use of erectors and small shops or power plants not provided with cranes. For such uses, it is necessary to frequently shift a chain block from one point to another in order to place it over the piece to be lifted. In doing this, the principal difficulty lies in getting the block down from one place and up in another. Much time is lost, because it is the heaviest part of the block which must be lifted and placed at the top, while the light part, the hook end, stays on the floor. It would seem that it would be possible to change this so that the light part, which one man could easily carry, would be placed at the top, and the heavy part of the block would be at the lower end. The only objection seems to be that in handling a load where there would not be sufficient head room to hang it far enough below the block, and where it extended too far horizontally, one might not be able to work the hand chain, but such cases would occur so rarely that they would hardly need to be considered.

It is also frequently a great convenience to be able to use a chain block for horizontal pulling, but the chain guides on the blocks generally made are not adapted for this purpose. It would be easy, however, to shape some hand chain guides so that they would take care of that chain, and a lug to peel the load chain from the slack side of its sheave would be sufficient for that chain.

A new device for chain blocks in such a building as a power house is to stretch a wire rope permanently as high under the roof trusses as possible and across the building. On this wire is put a light trolley with a grooved wheel about 6 inches in diameter, and from the bottom of the trolley is hung a chain block. The small wheel rolls freely enough so that the trolley can be moved on the rope, but not so freely that it will run away on a down grade. Some sag, of course, is required in the rope; otherwise, it woud be placed under too high a stress initially, and there would be nothing left for the handling of the load. The installation the writer has in mind is in a building 40 by 105 feet, having a height of 22 feet under the trusses. Three ¾-inch ropes are stretched lengthwise so as to have four feet of sag. With them, one man handles anything in the building weighing less than a ton. Four or five men were often required for the same pieces, before the ropes were put up. F. D. Buffum

Ellsworth, Pa.

CHAIN CASES FOR AUTOMOBILE TRUCKS

The remarks made by Mr. W. F. Schaphorst and C. P. W., in the April issue of Machinery lead me to further defend the practice of uncovered chains. I would not dispute that, theoretically, cases are an advantage, but there are some things which are theoretically correct that are not adopted commercially, because the advantages gained do not outweigh the disadvantages. I believe this to be true of chain cases.

The recent exhibitions of commercial cars seem to bear out this statement. Only a small number of models exhibited were equipped with chain cases. The *Power Wagon*, a Chicago automobile periodical, recently published a review of the mechanical features of 381 models. Of this number, only twenty-three had chain cases and seventy-seven were shaft-driven, which means that only about fifteen per cent of chain-driven cars are equipped with chain cases. Mr. Chester S. Ricker says in the *Horseless Age* in an article entitled "A Review of the Recent Automobile Shows": "On most trucks the chains are exposed, but upon several they are enclosed, as on the Sampson and on the Lozier." Mr. A. C. Woodbury, in the same journal of January 31, states: "A year ago one of the things that looked most promising was what seemed to be a general movement toward enclosed chains for the rear wheels of the larger trucks. The movement seems to have fallen flat, for although the Lozier is fitted with a sheet steel case and the Sampson has retained it, there is, on the whole, a smaller proportion of chain cases than last year."

An instance where chain cases would have proved a disadvantage was forcibly called to my attention after my first article was written. I was sent out to supervise the replacing of a rear axle that after years of service had broken on the road. The truck was jacked up, the axle replaced, and all the adjustments made on the road. If the truck had been provided with chain cases they would have had to be strong enough to support a seven-ton load or they would have been crushed.

In regard to the skill of drivers, it may not be out of the way to refer to the transcontinental trip made by the Saurer and Packard trucks. In this case the drivers were competent to negotiate roads of every description, without any appreciable injury to their chains. Yet, how many chain cases would have been broken on this trip if the trucks had been provided with them? I do not think it logical to compare sprocket chains and gears. A small obstruction will prevent a gear from turning, whereas, a sprocket will turn even with rather severe obstacles in the way.

I believe that a campaign of advertising the proper methods of mounting chains would lead to a more general use of chain cases. It is apparent that, at the present time, the campaign for chain cases is not being carried on by the chain manufacturers so much as by the salesmen of internal gear drives, worm drives, and other enclosed forms of drives, who are calling the attention of the public to the theoretical advantage of chain cases.

Brooklyn, N. Y. John F. Winchester

ESTIMATED COST OF MAKING MECHANICAL DRAWINGS

The following method may be used for determining the average cost of producing mechanical drawings. Assume that

A = average number of drawings of a given size produced in one year by one man,

B = number of square inches per drawing,

C = number of working days in the year,

D = draftsmen's rate of wage per hour,

E = working hours per day.

Then the labor cost per square inch of drawing equals $\frac{CDE}{AB}$.

In the same way the average cost per square inch of tracing and checking is determined. The cost of drawing paper and tracing cloth per square inch is also calculated. The total cost of the completed tracing per square inch equals the sum of the unit drafting, tracing, checking and paper costs. From this the average cost of any tracing of a given size can easily be determined.

In a drafting-room where the work consisted of assembly and detail drawings of punches and dies, jigs and fixtures, and tools in general, it was found that one draftsman could complete 262 drawings in 306 eight-hour working days. The draftsman's rate was fifty cents an hour. The size of the drawings was 16 by 23 inches. Hence the cost per square inch of the drawings was found as follows:

$$\frac{306 \times 8 \times 0.50}{262 \times 16 \times 23} = 0.0127 \text{ dollar.}$$

The cost per square inch of the tracing work was found in the same way to be $0.0054, and for checking $0.004. The cost per square inch of drawing paper and tracing cloth was found to be \$0.0005. Hence the total cost per square inch of the completed tracing will be:

$$0.0127 + 0.0054 + 0.004 + 0.0005 = 0.0226 \text{ dollar,}$$

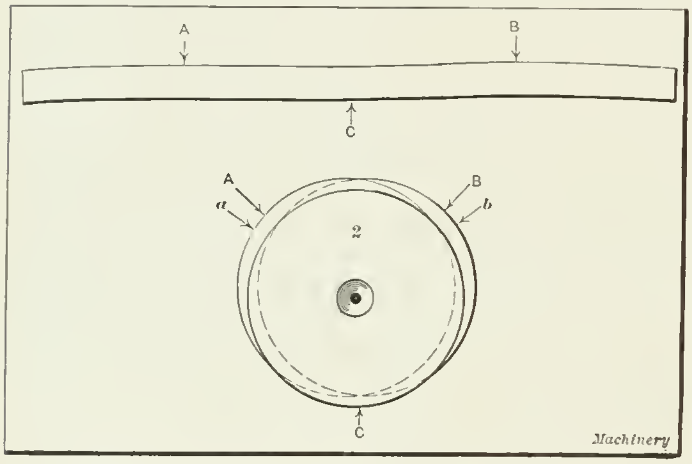
or the total cost of producing a drawing 16 by 23 inches within its borders would be: $16 \times 23 \times 0.0226 = 8.32$ dollars.

The cost of blueprints can, of course, be easily determined, and is quite independent of the cost of drawing, depending upon the number of blueprints required from each drawing. To all of these costs must be added a certain percentage for "overhead expense," if the absolute cost of the drawing is to be determined.

Cicero, Ill. E. A. Peterson

STRAIGHTENING SHAFTING

In the March, 1912, number of Machinery, an interesting article on straightening shafting, by Mr. J. W. Brandle, was published. Having had some fifty years' experience, the writer would like to say a few words on this subject. The accompanying engraving shows a two-inch rough shaft, 10 feet long, which is bent at two places about 2 feet 6 inches from each end. There is also a bend in the middle. After having "chalked" the shaft, it is found that the chalk marks are located as at *A*, *B*, and *C*. The beginner usually has trouble in straightening a shaft of this kind. He applies pressure at the points indicated by the chalk marks, the result being that the shaft is bent too much toward the opposite side. The proper method is to shift the marks a trifle as to *a* and *b* as indicated in the engraving, the shifting being perhaps about ten degrees. Pressure is then applied first at *a* and then at *b*. This throws the three bends into one direction, so to speak—that of the bend at *C*. Pressure is then applied at this place and the shaft will soon be found straight enough to clean up.



Indicating Method of Straightening Shafting bent in Three Places

Birmingham, Ala. W. B. Odell

METHOD OF DIMENSIONING DRAWINGS

The Taft-Peirce Mfg. Co., of Woonsocket, R. I., issues the following rules for its draftsmen.

> "If a limit can be permitted above and below the dimension, specify the limit thus: ±, giving the amount of limit tolerated. If a limit can be permitted below the dimension only, specify it thus: —, giving the amount of limit tolerated. If a limit can be permitted above the dimension only, specify it thus: +, giving the amount of limit tolerated.
>
> "Fractions: Unless limits are specified, common fractions are capable, in the main, of a wide variation of limitation. For the purpose of fixing a standard, however, it shall always be understood that if a fraction is not accompanied by a limit, a minimum limit of ± 0.010 inch is permissible.
>
> "Fractions that must be held closer than this must be accompanied by a specified amount of limit."

In order to make it unnecessary to give limits in all instances on the drawings, it is understood that two-place decimals have no limits added in case a tolerance of ± 0.005 inch is permissible. A three- or four-place decimal should be used only when absolutely necessary. If the tolerance is not added, a limit of ± 0.0015 inch is permissible. Dimensions to be accurate to three or four decimal places should be marked "exact."

Worcester, Mass. H. P. Fairfield

A MULTIPLYING ATTACHMENT FOR AN INDICATOR

In Fig. 1 is shown a multiplying attachment which the writer has used with an indicator of the type shown in Fig. 2. The principles employed might be interesting to the readers of Machinery. The device needs very little explanation. It will be sufficient to say that the area of the large plunger *A*, which is applied to the work, is ten times the area of the small plunger *B*, which, when the instrument is attached to the indicator proper, bears against the working anvil of the indicator. The cavity between these plungers is filled with heavy oil or grease of the best quality. The movements of the plungers are in inverse proportion to their displacement areas, and, therefore, any movement of the large plunger is transmitted to the indicator proper, multiplied ten times.

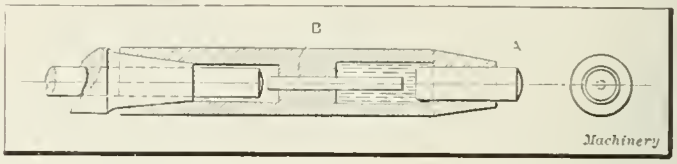


Fig. 1. A Multiplying Attachment for the Indicator shown in Fig. 2

It was the writer's practice to true up work such as buttons, etc., as accurately as possible with the indicator minus the attachment, which would be within 0.001 inch. Then by attaching the multiplier this error would read on the dial of the indicator as 0.01 inch. Thus when this error was again corrected to read 0.001 or 0.002 inch, the writer knew the work to be accurate within 0.0001 or 0.0002 inch. Needless to say such accuracy can only be obtained with the use of a machine having very true bearings, and set on a very solid foundation.

The writer cannot forebear mentioning that he has had considerable amusement owing to the fact that he did not at once disclose the secret of the innermost mechanism of the device. The unique and learned explanations of the complicated mechanism it was supposed to contain, and the compliments to a mechanic capable of arranging so much mechanism of a complicated, delicate nature in so small a space, were very entertaining indeed.

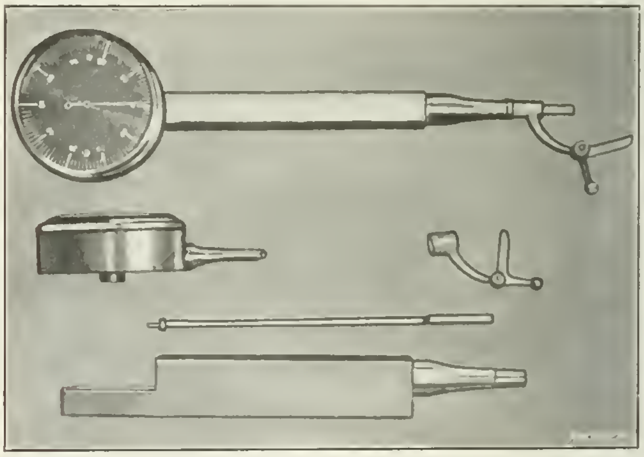


Fig. 2. Indicator to which the Device in Fig. 1 was attached

In making one of these attachments, considerable care should be taken to have the plungers fit properly. If they are too loose, the oil leaks out and destroys the accuracy, and if too tight, they will not work properly. T. Covey

LEAD HAMMERS FOR SHOP USE

The lead hammer is an indispensable tool in the modern machine shop. Before the advent of finely finished jigs and fixtures, when the tools for interchangeable manufacturing consisted of some old straps and boiler plate taken from the scrap heap, the machinist generally pounded the work on and pounded it off again. This process became a habit, and even yet, we frequently see some drill press hand raising the lid of a nice jig with a machinist's hammer. Some shops still build jigs without any regard to looks or finish, but the majority of them recognize the fact that a nice looking tool will be more carefully handled and last longer than one that is not given a good finish.

Fig. 1 shows the detail of a lead hammer we make for our own use, which has saved our jigs from being all battered up, besides giving the men something to hammer with when a steel hammer would not do. The handle is made of ¾-inch steel tubing, flattened at the end as shown at *A* to keep the mallet part from slipping off. The mallet part is made of 60 parts lead, 30 parts tin and 10 parts antimony. This makes a good general-purpose hammer, but should a softer one be required, add a little more lead. The molds for producing the mallet part of the hammer are illustrated in Fig. 2, where some completed hammers are also shown. G. W. Linn

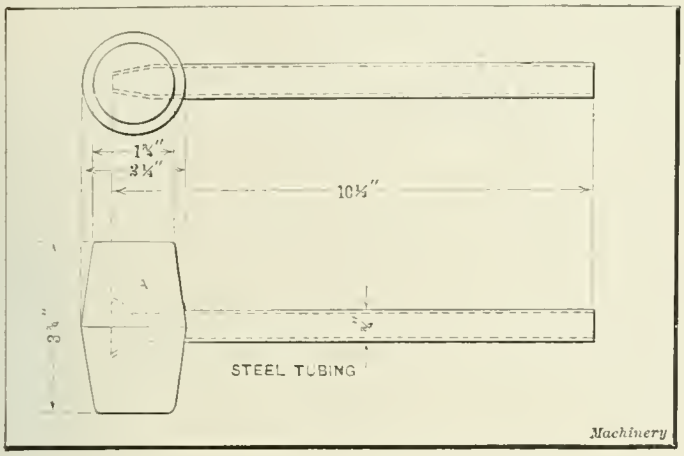


Fig. 1. Details and Proportions of Lead Hammers

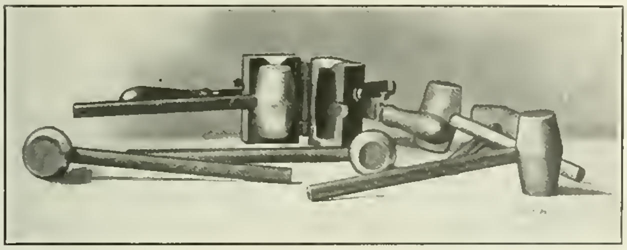
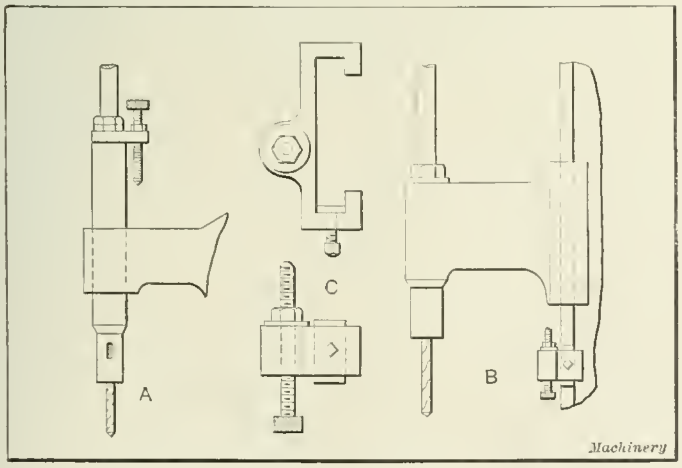


Fig. 2. The Molds for Casting the Mallet Part of the Hammers—Some Mallets fitted with Handles

Indianapolis, Ind.

STOPS FOR DRILLING MACHINE SPINDLES AND HEADS

It seems strange that none of the new drilling machines possesses a drilling stop. I have noticed in a large machine shop from 10 to 20 drilling machines in daily use and not one of them has even a respectable stop. The accompanying illustration shows stops for the spindle and also for the head. At *A* is shown a stop which can be applied to the spindle of a sensitive drill, while at *B* is a stop for a movable head, located on the column. An enlarged view of the stop at *B* is shown at *C*. To gage a hole for depth, set the point of the set-screw to a sizing block when the point of the drill is in the same plane as the top face of the work.



Adjustable Stops for Drilling Machine Spindles and Heads

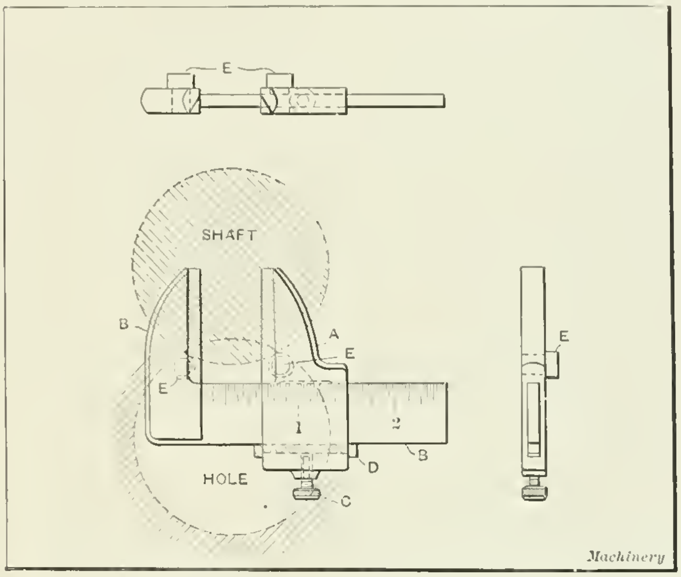
Brighton, Mass. F. Rattek

MARKING-OFF GAGE FOR KEYWAYS

The accompanying illustration shows a handy gage for marking off keyways in hubs of pulleys, gears, etc., and at the ends of shafts. The illustration shows the gage applied to both a hub and a shaft.

The jaw *A* which moves along the bar *B* is set to the required width of keyway by means of the graduated scale on the bar, and locked by tightening the screw *C* on the gib *D*. The gage is then applied to the hub or shaft as shown, the hardened pins *E* being held against the sides of the hole, or shaft, while the keyway is being marked off. The gage has a capacity for shafts up to 6 inches in diameter.

J. M. L.



A Marking-off Gage for Keyways in Hubs and Shafts

MAKING PISTON RINGS—A CRITICISM

The writer takes exception to some of the methods described in the article: "Making Piston Rings" in the April, 1912, number of Machinery. It is stated that the rings are turned eccentric, and then a parting or cut-off tool is used and the first ring is cut off within 1/64 inch. This must mean that 1/64 inch thickness of metal is left at the thin side, but how much stock would then be left at the other side? Again, does it produce good results to use a cut-off which generally chatters and take a finishing cut at the same time? Do not the rings give trouble by breaking off before they are cut way through?

Some firms scrap their rings if they are 0.0015 inch out of parallel. Do the rings made by the method described come as close as that? The writer does not like the milling practice mentioned. It is said that clamps are not required because of the snug fit. In that case it seems that it would be difficult to put them on quickly. It is also mentioned that they can be held with the fingers, but that seems to be a rather dangerous practice. The question of safety is being agitated at the present time so much that one can not indorse any practice that tends to lead away from the safest possible methods.

Milwaukee, Wis. W. Butzlaff

STATING PROPORTIONS

In a contemporary I see recommended a mixture of "55 parts tin, 45 parts zinc and 1 ounce of bismuth." Does the author mean 55 ounces of tin, or 55 pounds?

Very often we see mixtures or alloys recommended, in which every figure given is a factor of 5 or some other prime number. Why say "25 to 35" when "5 to 7" is more simple? Everyone speaks of an "8 to 1 gun-metal"; that is much more readily kept in the head than "16 to 2" or "40 to 5." Why not in all other cases use the most simple factors?

Dresden, Germany. Robert Grimshaw

HOW AND WHY

DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST

Give details in full and name and address. The name and address will not be published with the answer.

MIXING BEESWAX WITH ALUMINUM SOLDER

C. E. L.—A formula for aluminum solder was published in the January, 1912, number which I have tried with very unsatisfactory results. In attempting to mix the beeswax with molten tin and zinc I came near causing a bad fire. The beeswax was apparently entirely consumed, and just what benefit it is to the mixture, I cannot understand.

A.—The contributor of the receipt assures us that the formula is quite correct, being exactly as given to him by the originator, and as such has been used for a number of years. Care must, of course, be taken to prevent the beeswax from taking fire by keeping the heat of the mixture as low as possible, consistent with its remaining in the molten state. Should the heat become too great, the ladle can be lifted from the fire, and in fact it is advisable to remove it from the fire when adding the beeswax, which should be inserted in small pieces, one at a time. If, however, the mixture does take fire it is an easy matter to put a cover over the pot and smother out the flame. It might be thought that the pine stick mentioned would catch on fire, but if the metal is kept at the proper heat, neither the stick nor the wax will be fired. The originator of the formula particularly recommended the use of the pine stick.

FROSTED OR CORRUGATED GLASS FOR FACTORIES

E. H. B.—I am a constant and appreciative reader of Machinery and admire the way it handles mechanical topics. I would be glad to see a discussion of the merits of frosted glass in the windows of factories employing skilled labor.

A.—The advisability of the use of frosted glass in the windows of factories employing skilled labor is a question of general interest. We are not in favor of frosted or corrugated glass for small floors. The effect is depressing, having a tendency, we believe, to cause eye strain. In large factories, however, the conditions are different. The dimensions of floors are great enough to allow the workers to change the focus of their eyes by looking at distant objects and the mental stimulus of the outside world is not required so much in the large shops, as there is a variety of action within to be seen. Corrugated or frosted glass can be used advantageously with clear glass in small shops, placing the corrugated glass on the sunny sides and the clear glass on the shady sides. The light from the sunny side is diffused by the glass and that coming from the shady side is diffused by reflection. To obtain a large flood of diffused light should be the object of the plant designer. The use of frosted glass to prevent men from looking out, does not appeal to us. If the shop conditions are right little time should be wasted by men staring out of the windows. Discussion is invited.

SEASONING CAST IRON FOR MACHINES

R. L. S.—Is there any practicable method or process for "seasoning" cast iron which does not require taking roughing cuts and then allowing the castings to stand for several weeks or months to prevent warping after finishing? Our system is to bore or plane castings in the rough and let them stand for some time to take whatever shape they will. They are then put back on the machines and finished. This method is costly, and during the busy season is too slow, and besides it is not entirely satisfactory as we often find that the parts change shape after finishing even though seasoned several weeks.

A.—The change of shape of castings after machining is due to readjustment of internal stresses thrown out of balance by the removal of the surfaces. These forces set up by irregular cooling of the metal in the foundry may be partially eliminated by reheating. Tumbling, rapping and repeated dippings in hot water have an accelerating tendency, but so far as we know the cheapest and most effective method is that commonly pursued by the machine tool builders, *i. e.*, taking roughing cuts off the parts to be finished and then letting the castings stand for several weeks or months to season. Then little change takes place, as the internal stresses have been largely neutralized by the effect of alternate heating and cooling due to variations in temperature. Any suggestions from readers as to ways and means of cheaply accelerating the seasoning process will be appreciated.

CONDUCTIVITY OF WROUGHT-IRON PIPE

F. C. P.—In connection with the design of a cooling apparatus for oil, in which the oil is cooled from a temperature of 100 degrees F. to 60 degrees F. by circulating through a coil placed in a water bath, it is required to find the approximate number of British thermal units (B. T. U.) that will pass through the walls of a 1¼-inch iron pipe, per hour, per square inch of radiating surface, for each degree difference of temperature of the liquid inside and outside of the pipe.

A.—The coefficient of conductivity of iron, that is, the quantity of heat in therms (252 therms = 1 B. T. U.) that will pass through one square centimeter of surface, one centimeter thick, in one second, per each centigrade degree difference in temperature, is (for temperatures here dealt with) on an average 0.165. Transforming this to English units, the quantity of heat in B. T. U. that will pass through one square inch of surface, one inch thick, in one second, for each degree F. difference in temperature is

$$\frac{0.165 \times 2.54 \times 2.54 \times 5}{252 \times 2.54 \times 9} = 0.00092 \text{ B.T.U.}$$

As 1¼-inch wrought-iron pipe has a thickness of 0.140 inch, the quantity of heat that will pass through its walls per square inch of surface per hour for each degree F. difference in temperature equals:

$$\frac{0.00092 \times 60 \times 60}{0.14} = 23.6 \text{ B.T.U.}$$

LOCATION OF VALVES IN PIPES

R. J.—Should valves be placed with the pressure on top or underneath the valve in main steam lines or in boiler feed pipes? What practice is followed in the United States Navy? The writer was somewhat surprised upon consulting two engineers engaged in power plant construction to hear directly conflicting opinions on the positioning of valves in these pipes

A.—The engineer-in-chief of the Bureau of Steam Engineering, Navy Department, states that the requirements of the machinery specifications on locating valves in main steam and boiler feed pipes with reference to whether the pressure is above or below the valve are as follows: "All high-pressure steam valves over six inches diameter, except boiler stop valve, will have flat faced seats, with the pressure on the back of the valves, and will be so designed that the stuffing-box may be packed while under pressure. High-pressure steam valves six inches diameter, and below are installed to close against the pressure, in order that the valve stem may be packed when the valve is closed. In the feed system there is a feed check valve and stop valve on each boiler. These two valves are in the same casing, the stop valve being between the check valve and the boiler, opening against the boiler pressure and so fitted that the stuffing-box may be packed when pressure is on the boiler. The remaining valves in the feed system are gate valves, except the suction and discharge valves at pumps, which are stop valves, except where the connections are such that water may run to the bilge in case valves are left open, under which conditions stop lift check valves, so arranged that they may be kept off their seats when desired, are fitted."

METAL PAINT TO WITHSTAND ALCOHOL

Replying to the question by S. J. B., in the April number of Machinery, for a paint for brass vessels which will successfully withstand the action of diluted alcohol, the writer wishes to say that years ago, during his apprenticeship as a nautical instrument maker, a paint made of white zinc and pure turpentine was used, two coats of which was applied. White japan was also used, the objects afterward being baked in an oven. This, however, was more expensive. The instruments so painted were liquid ship compasses, and the liquid consisted of rectified spirits of wine reduced 50 per cent with distilled water.

Denver, Colo. Robert Neill

NEW MACHINERY AND TOOLS

THE COMPLETE MONTHLY RECORD OF NEW DESIGNS AND IMPROVEMENTS IN AMERICAN METAL-WORKING MACHINERY AND TOOLS

THE MELLING-NORTHRUP DIE-SINKING MACHINE*

The superiority of drop forging over casting for certain classes of work is well known, but the cost of making dies of intricate shape has impeded the progress of this art to a considerable extent. It has been necessary in connection with a great deal of die work, to rough out certain impressions with a chisel by hand, and then scrape and "type" the impression to a finish. When the impression is deep and narrow, this work of chipping, scraping and typing will be found to be slow and difficult. Many devices and attachments for both the milling machine and the ordinary die-sinking machine, have been devised to eliminate chipping and the difficult hand work. Some of these attachments are very ingenious and have been of inestimable value to the die-sinker. When not more than two types have to be sunk in a die, it is the usual practice for the die-sinker to use a chisel and type, because the work can be accomplished much cheaper and quicker in this manner, as it takes considerable time to set up a cherrying attachment. Having worked as a die-sinker for about ten years and experienced the need of an improved device for this work, Mr. Herman Melling of Melling-Northrup Co., Jackson, Mich., set about to design a machine which would meet all the existing requirements of drop-forge die-sinking. After considerable experimenting with different attachments and devices for this work, he conceived the idea of building a machine which would be suitable both for routing and cherrying.

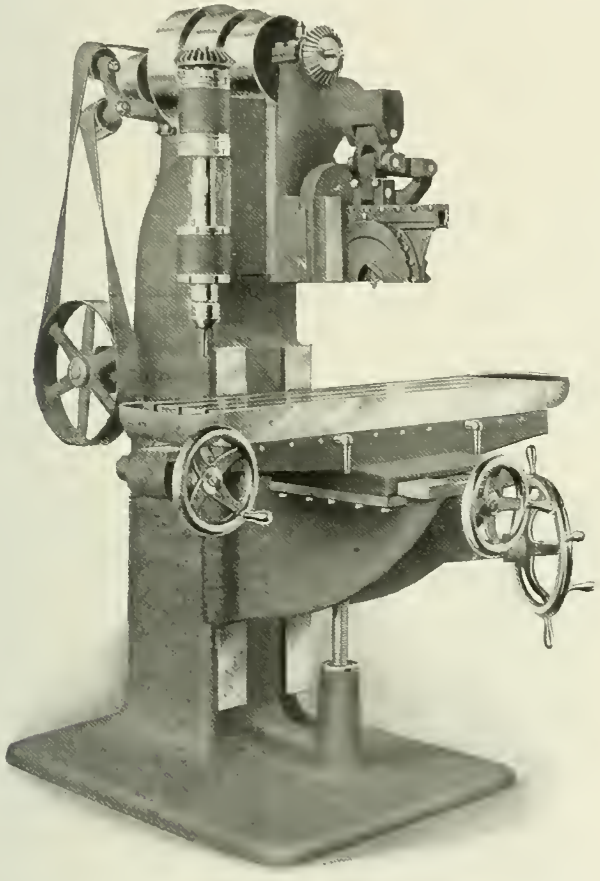


Fig. 1. Die-sinking Machine manufactured by Melling-Northrup Co.

The machine, which is shown in Figs. 1 and 2, does away with the necessity of typing most dies, so that the impression can be completed without resorting to any chipping or typing. The machine is of the column-and-knee construction, and the aim has been to make it heavy and rigid enough to eliminate chatter. The knee has a vertical adjustment on the column, which is effected by hand-wheel *A*. The table is long and wide, and is traversed by hand-wheel *B*. Lateral adjustment of the table on the knee is obtained by hand-wheel *C*. All movements of the saddle and table are effected by hand, no automatic feeds being employed to confuse the workman and make the machine more difficult to operate. These hand-wheels are all in convenient reach of the operator, and the table, saddle and knee are equipped with lock levers.

This machine is so arranged that it can be used for cherrying out an impression in a die, and also as a vertical milling or routing attachment, and both devices can be brought into operation without resetting the work. The vertical milling head *D* carrying the routing cutter *E*, is hinged at *F*, and is held to the column, when in the working position, by two bolts *G*. This vertical milling head can be swung out of the way by simply removing the bolts *G*, when it is necessary to use the cherrying cutter. The vertical milling spindle is driven from the cone pulley *H* through miter gears *I*, and it runs in solid, taper, phosphor-bronze bearings. The thrust, instead of being taken on the lower journal, is transferred to the upper journal, in order to equalize the friction on both bearings and, consequently, prevent them from heating excessively under heavy cutting action. The spindle can be locked by a spring-actuated wrench, which fits over a flattened portion of the spindle, when it is desired to hold the latter rigidly to remove the routing cutter.

Construction and Operation of the Cherrying Head

We now come to the most interesting part of this machine, namely, the cherrying device. This consists essentially of a segment head *K*, which carries a cherrying cutter *L* having teeth on half of its periphery and sides, the latter being beveled at an angle of 7 degrees, which takes care of the draft necessary in the dies. The axis of the die-sinking cutter *L*, is located in line with the axis of the segment head *K*, the latter being oscillated by a rack *M* which, in turn, is operated by a lever *N* and crank arm *O* (see also Fig. 3). This arm is free to slide in a bronze box *P*, which is fastened to the cam-wheel *Q*. The cam-wheel *Q* is rotated by a pulley *R* (Fig. 3), which, when it is desired to use the cherrying attachment, is pinned to a collar fastened on the main driving shaft by a spring-plunger *S*. The belt runs over idler pulleys *T* and onto a lower pulley *U* which drives the cam-shaft and cam-wheel.

The cherrying cutter *L* cuts into the impression when the rack *M* (see Fig. 5) is on the return stroke. Owing to the eccentric location of bronze box *P* on cam-wheel *Q*, a quick-return movement for the cutter is obtained, the cutting being done on the slow movement of the eccentric, or, in other words, when box *P* is at the bottom and farthest from the rockshaft *V*, Fig. 3. As shown in Fig. 1, the cherrying head slides in another slide which, in turn, is mounted on the face of the column and can be moved in a lateral direction. Connected with the cherrying head by a toggle joint, is a link *Y* (Fig. 4), which, in turn, is fastened to a bellcrank A_1, shaft B_1 and cam-lever C_1. Located on the lower end of cam lever C_1, is a roll which runs in a groove cut in cam-wheel *Q*. This cam transmits an oscillating movement to the cam lever, which operates the toggle, thus raising and lowering the cherrying head. This action, as can be seen, will remove the cherrying cutter from the impression on the back stroke, owing to the relative positions of the eccentric crank *P* and the operating portion of the groove in the cam-wheel.

When the cherrying cutter is to be sunk down into the die to produce an impression the exact duplicate of its own shape, it is not necessary that it be relieved on the sides, but when it is necessary to make an impression much longer than the width of the cherrying cutter, the cutter on being returned for the next stroke must be relieved or else it would be dulled very quickly and would not produce a good finish. This relief is accomplished in a very interesting manner. As can be seen in Fig. 4, bell-crank A_1 is formed into a yoke in which a stud D is held. Sliding on this stud and also on a second stud E_1, held in lugs cast integral with the slide in which the cherrying head is mounted, is a yoke F_1. This yoke is provided with a lug in which a spring plunger is held, the latter fitting in a series of drilled holes in the cherrying head slide. Now by changing the position of this yoke relative to the center of the cam-shaft B_1, the desired movement of the cherrying head slide can be obtained. When the plunger is in direct line with the center of the shaft B_1 no movement at all will be transmitted to the slide, and when the plunger is shifted to a position above or below the center, a corresponding movement is given to the slide, so that the cutter is relieved to allow it to return free and without roughing up the work.

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* For information previously published in MACHINERY on drop-forge die-sinking, see "Drop-Forge Die-Sinking," July, August and September, 1911, and articles there referred to; "Making Duplicate Drop Forging Dies" and "Compound Trimming Die," July, 1911, engineering edition; "Tempering Drop Forging Dies," January, 1908, engineering edition. See also MACHINERY'S Reference Series, No. 45.

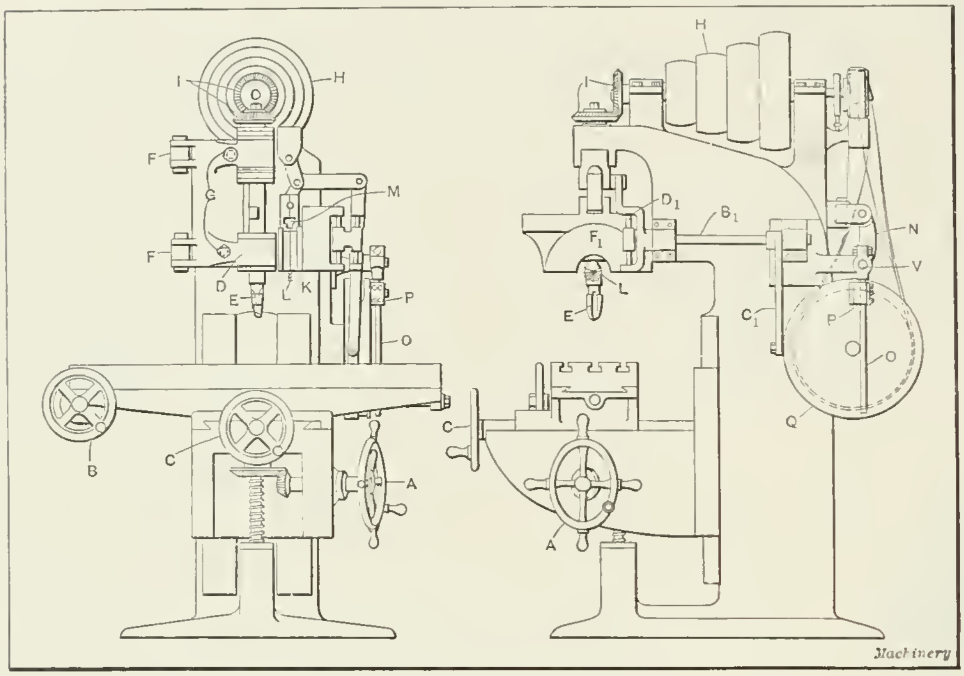


Fig. 2. Front and Side Elevations of the Melling-Northrup Die-sinking Machine

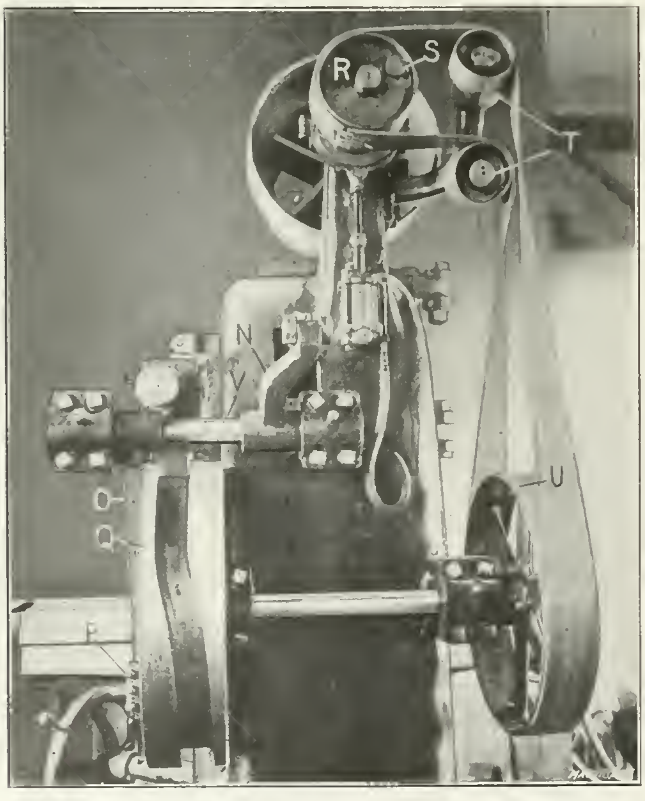


Fig. 3. Rear View showing Drive for Cam-wheel and Compressed Air Pump

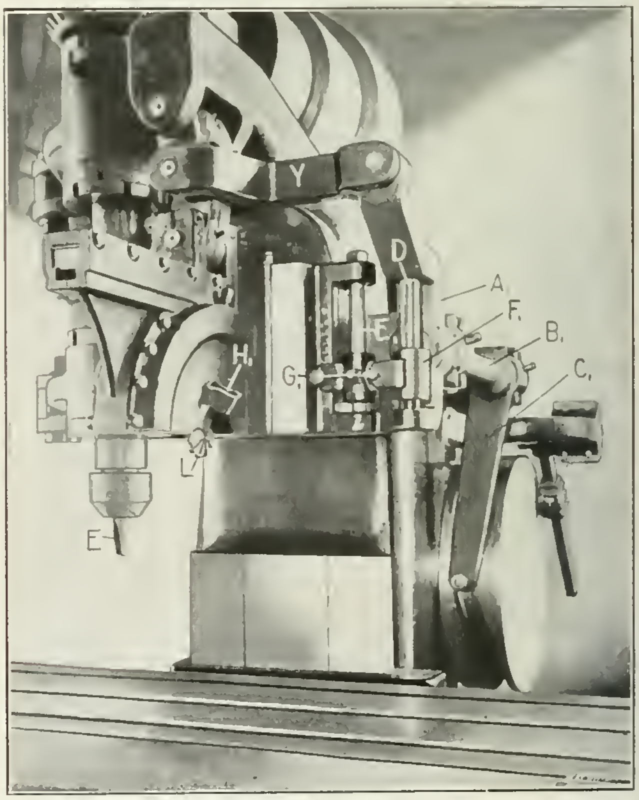


Fig. 4. Front View showing Relieving Mechanism for the Die-sinking Cutter

The action transmitted to the cherrying head by means of this toggle-joint motion and sliding yoke, is clearly indicated in Figs. 6 and 7. In Fig. 6 the toggle joint is shown in the position it occupies after being operated by cam Q; hence the cutter L has been raised and relieved from the bottom of the impression. The spring plunger G_1, as can be seen, is located above the center of the cam-shaft, and, consequently, has relieved or drawn the cutter away from that portion of the die in which it was working. In Fig. 7 the toggle joint is shown straightened out, in which position the cutter would be at work. Of course, while the toggle joint is straight, no side relieving movement is given to the cherrying cutter L.

A little device that will be appreciated by most die-sinkers is a small air pump which is operated from the cone-pulley driving shaft by an eccentric, as shown in Fig. 3. The compressed air is carried to the front of the machine through flexible tubing. This tube passes through holes drilled in the frame of the machine and is held, when not in use, in a spring socket H_1 as shown in Fig. 4. With this simple little device, it is possible for the die-sinker to always keep his work free from chips and dirt.

The Cherrying Cutters

In Fig. 8 is shown a representative group of die-sinking and routing cutters. The routing cutters A, as is the usual practice, are made with but two cutting edges. They are relieved on the sides, ground on the ends, and are somewhat similar in shape to twist drills. Of course, this type of cutter would only be used for roughing purposes. When any special shape is to be reproduced, a cutter would be made to that shape. The cherrying cutter shown at B has six teeth and cutting edges on the sides that extend to the center or axis. The teeth, as has been previously mentioned, are backed off on the periphery and sides, and are also tapered on each side to an angle of 7 degrees, this being the angle of draft usually allowed in drop-forge dies.

It has been found from actual experience that, irrespective of the diameter, six teeth will give the best satisfaction. These cutters are made from drop forgings, and are milled on a special fixture, which is an exact duplicate, as far as the radius is concerned, of the segment head in the cherrying attachment. Owing to the construction of this die-sinking tool, and the attachment in which it is used, it is possible to cut in to the center and completely mill an impression without doing any chipping or typing. Cutters have been made ranging in diameter from ¼ inch to 3 inches.

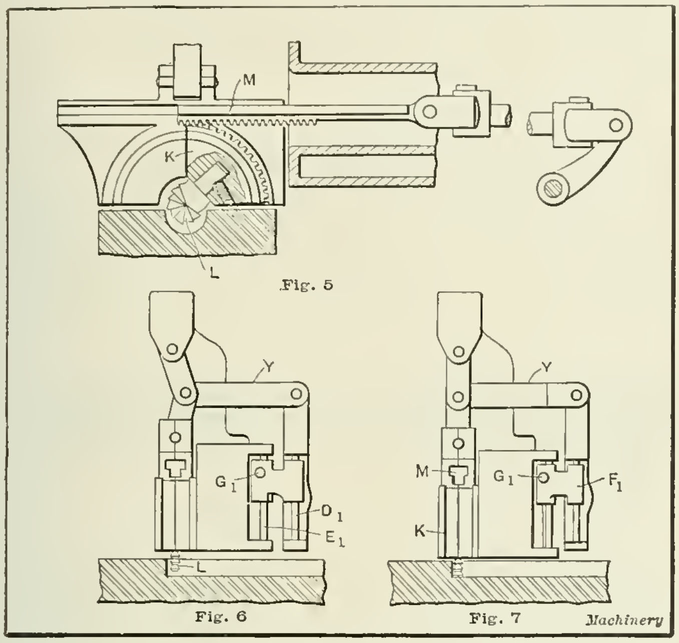


Fig. 5. Section of Cherrying Head showing how it is operated. Fig. 6. The Cutter in the Relieved Position. Fig. 7. The Cutter at Work

Work Done by Melling-Northrup Die-sinking Machine

In Fig. 9 is shown a die block which has been used for testing the machine. The rapidity with which the majority of these impressions have been sunk is marvelous, considering the time that it takes a man to do this work by hand. The impression *A* is 1½ inch in diameter and ¾ inch deep, and the width of the impression is 5/16 inch. This impression was sunk in 7½ minutes, without previous roughing operations. The smaller hole *B*, which is 1 inch in diameter, was formed in 3 minutes. This test block is made of the regular crucible steel used for drop-forge dies and contains from 0.40 to 0.50 carbon.

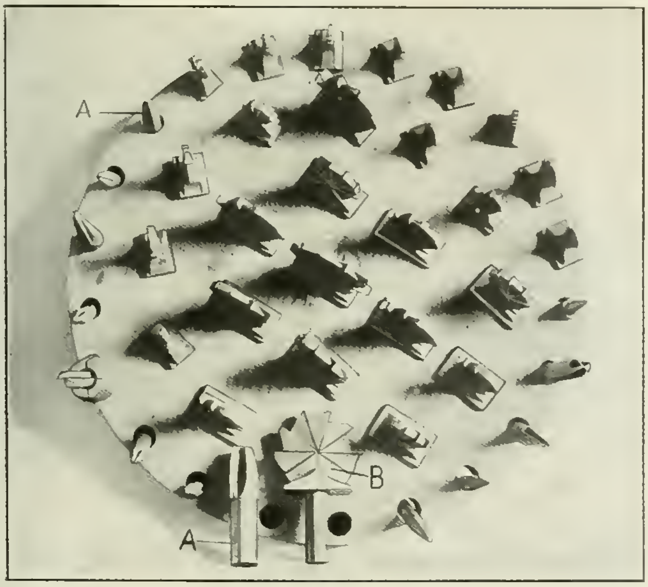


Fig. 6. A Representative Group of Routing and Cherrying Cutters

The small block shown to the right, has an impression *C* sunk in it which is 3 inches in diameter, and the width of the narrowest part is only 5/16 inch. This impression was made in 45 minutes, which includes roughing with the routing attachment. A die-sinker would certainly have difficulty in producing a similar impression with a chisel or by any other means, on account of the great depth and small space in which he would have to work. If this hole had been sunk with an ordinary cherrying cutter, it would still be necessary to do a little hand work, as the ordinary cherrying cutter does not cut clear to the center, and, consequently, does not finish the impression. On holes much larger than 1½ inch in diameter, it is always best to rough out the impression with the routing cutter, as this will relieve the cherrying cutter of considerable hard work.

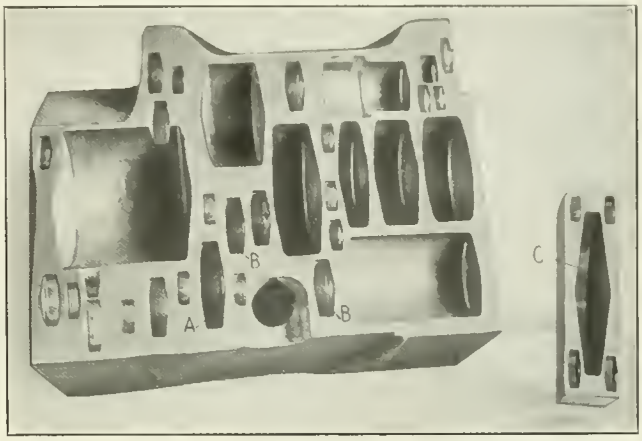
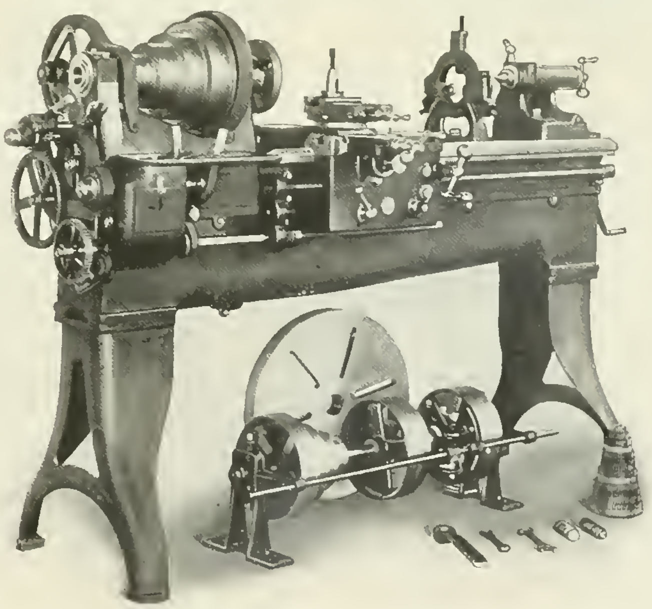


Fig. 9. A Drop-forge Die-block used in Testing the Capacity of the Machine for Sinking Holes quickly

The first machine built by the Melling-Northrup Co. was sold to the Baker Drop-Forge Co., Jackson, Mich. Other machines with some changes are now in process of manufacture.

BARNES EXTENSION-BED GAP-LATHE

The Barnes Drill Co., 814 Chestnut St., Rockford, Ill., is now building a 14–24-inch gap-lathe which embodies a number of improved features. The feed changes are effected by quick change gear boxes giving six variations ranging from 0.007 to 0.049 inch. The bed is of a broad, deep pattern and well braced. The top and main beds are fitted together by a dovetailed construction which permits the top section to be firmly held in any position by means of clamp bolts which extend transversely through the main bed. The top part is adjusted for varying the width of the gap by a screw and crank at the tailstock end.



Barnes 14-24-inch Extension-bed Gap-lathe

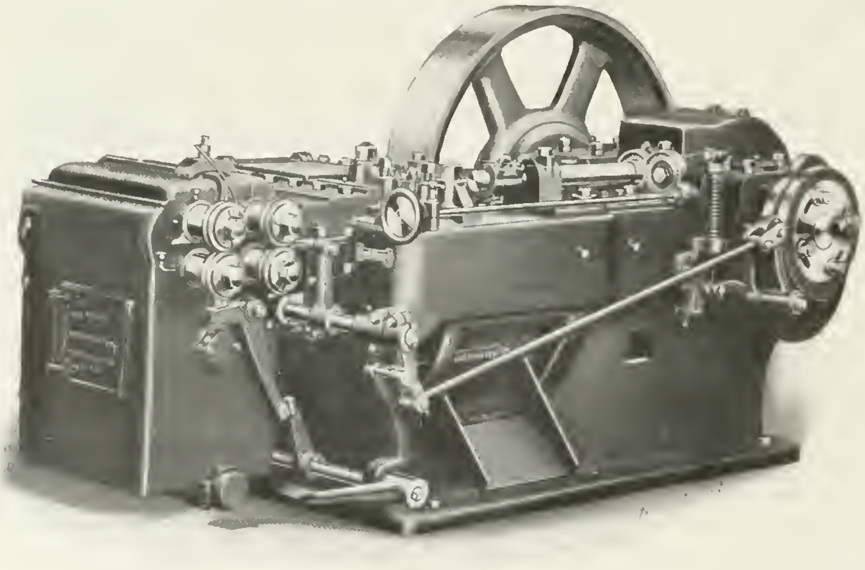
The headstock is of a heavy design, and the spindle has a diameter of 2 15/16 inches in the front bearing. A 1 9/16 inch hole extends through the spindle so that 1½ inch stock can be inserted. The spindle runs in split bronze bearings which are carefully scraped and fitted. The cone pulley has four steps, the diameters of which are 4, 6, 8 and 10 inches, and the width 2⅛ inches. By means of the back-gears which have a ratio of 11 to 1, eight spindle speeds are obtained. The cone can be quickly locked and unlocked for direct or indirect driving, by means of a push-pin and without the use of a wrench. The tailstock is of the offset type.

The carriage is extended in front to provide a firm support for the tool when turning large diameters. The carriage has a long bearing on the front V and a flat bearing at the rear. It is fed by a splined screw and can quickly be clamped to the bed for cross-feed work. A taper attachment is secured to the back of the carriage and turns any taper up to 2¾ inches per foot.

This lathe has a swing over the bed of 14½ inches, a swing over the carriage of 10 inches, and a swing through the gap of 24 inches. The sizes of the front and rear bearings are 2 15/16 by 3 7/16 inches and 2 1/4 by 2 3/4 inches, respectively. The diameter of the tailstock spindle is 1 13/16 inch. The feed-screw is one inch in diameter and has eight threads per inch, Acme standard. The maximum distances between the centers with 5½ and 7½ foot beds, when the gap is closed, are 36 and 60 inches, respectively. When the bed is extended the maximum distances between the centers are 54 and 96 inches, respectively. This lathe can be equipped with a motor-drive, if desired.

NATIONAL RIVET-HEADER WITH AUTOMATIC FEED

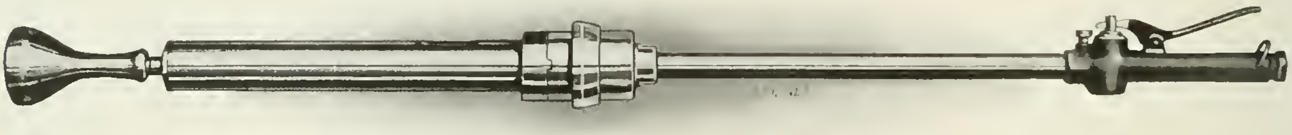
The National Machinery Co., Tiffin, Ohio, is manufacturing a wedge-grip, rivet-header equipped with a new design of automatic feed. In the operation of this machine, long rods in mill lengths are taken from the finishing rolls while on the initial heat (or they are re-heated in special long furnaces) and when the rod is started into the feed rolls by the workman, it advances automatically and a blank is sheared and headed, and a finished bolt or rivet is ejected for each revolution of the machine. Single-blow bolts, track bolts or any kind of "single-blow" work can be made in this machine, and the wedge-gripping mechanism insures a product free from swollen shanks or objectionable fins along the body, as the dies cannot spring or give during the upsetting operation.


National Wedge-grip Rivet-header with Automatic Feed

The feed rolls are made of chilled castings and they are water-jacketed, in order to maintain an even temperature and insure a minimum wear on the feeding surfaces, so that a positive and uniform feeding movement is obtained. A new type of stock gage is employed which is designed not only to allow rapid and minute adjustments while the machine is in operation, but also to eliminate "spring" and thus secure uniformity in the work produced. The output of this type of header is said to be from 50 to 100 per cent larger than is obtainable on the hand-feed machine, and, owing to the accuracy and uniformity in feeding, a better quality of work is secured on the automatic-feed header. This machine is built in 1-, 1¼- and 1½-inch sizes.

CLEVELAND SAND RAMMER

The Cleveland Pneumatic Tool Co., Cleveland, O., has brought out a new molders' sand rammer. This rammer, which is illustrated herewith, is pneumatically operated and is made in different styles and sizes, adapted for general foundry work or for bench or core ramming. All sizes are equipped with either a round or grooved rod, as preferred, and with a butt and pein. The use of the groove is to prevent the rod from turning when the rammer is in operation, except at the will of the operator.


Pneumatically operated Sand Rammer manufactured by the Cleveland Pneumatic Tool Co.

These rammers are light in weight, operate at high speed and with practically no vibration. The piston-rods are packed with a special design of packing which prevents dirt from getting into the piston chamber and cutting the working parts. The floor rammer, which is the type shown in the illustration, has an exhaust deflector which prevents the exhaust air from blowing onto the operator, as well as on others who might be working with him.

THE BADGER TOOL RACK

The tool rack illustrated herewith is designed for machine shops and manufacturing plants. The trays are made of cast iron, and the legs, which are of 1-inch round steel, are threaded into the top tray and pass through the lower trays. Swiveling casters with 4-inch wheels are fastened to the legs in such a way that they will not become detached. The lower tray acts as a stiffener for the legs and, when the rack is assembled, it is strong and serviceable. Any number of trays

Tool Rack for Machine Shops and Manufacturing Plants

can be furnished, and drawers can be supplied if desired. The standard racks are made with 20- by 25-inch trays and have a total height of 36 inches. If a stationary rack is wanted, ¾-inch pipe legs with floor flanges are furnished.

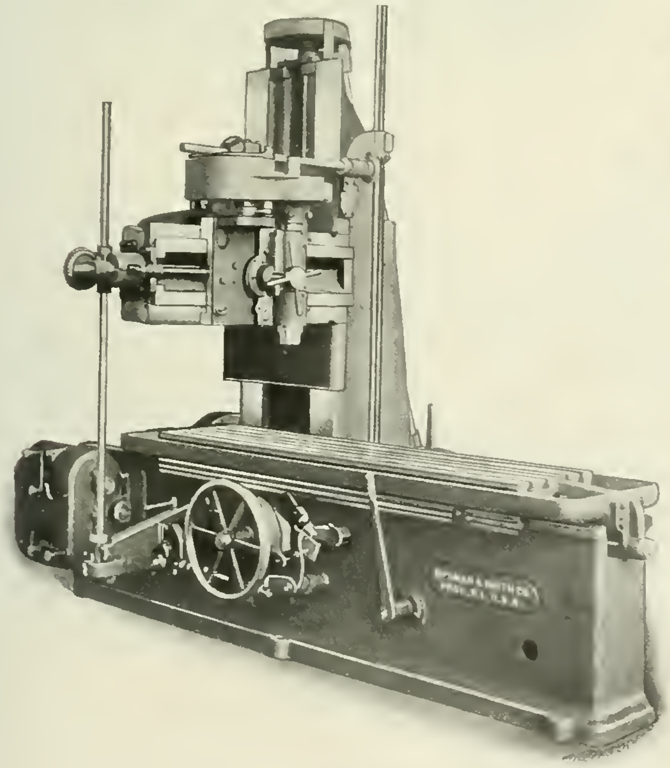
These racks are especially adapted for use in connection with machine tools, as they can readily be moved about. They can also be used in place of "tote" trucks for conveying products from one tool to another and from one department to another. The weight of a crated rack is approximately two hundred pounds. These racks are manufactured by the Wisconsin Foundry & Machine Co., 623 E. Main St., Madison, Wis.

BEAMAN & SMITH MILLING MACHINE

The vertical-spindle milling machine shown in the accompanying engraving is a recent design built by the Beaman & Smith Co., Providence, R. I. This machine is of the open-side construction, and is capable of handling a large variety of work. The horizontal bed of the machine has attached to it an upright that carries an overhanging arm or cross-rail. The spindle is carried by a saddle which, in turn, is mounted on the overhanging arm and has a horizontal feeding movement. The work table is provided with a rapid power movement, available in either direction and varying from 9 to 26½ feet per minute. The table is operated by a screw which engages a revolving bronze nut, and the thrust is taken by ball bearings.

The feed for the table is positive and operates in either direction. The required changes are obtained by a geared feed-box which is conveniently located at the left end of the bed, as the illustration shows. There are nine changes of feed, ranging from 1 inch to 8½ inches per minute, and the arrangement is such that the feed can be varied independently of the spindle speed. The table is equipped with an automatic stop for disengaging the feed at any predetermined point.

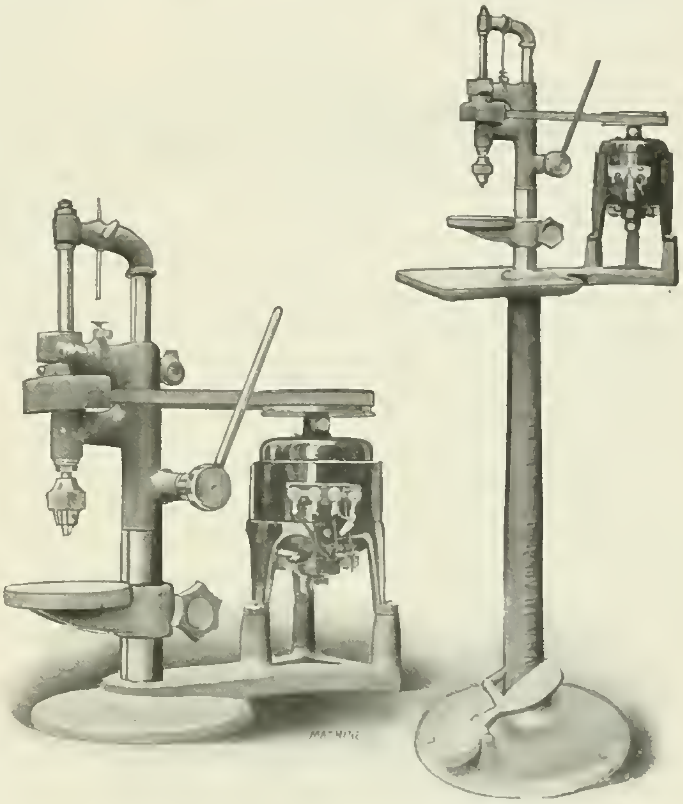
This machine is driven by a 4-inch belt which operates on a four-step cone pulley. Eight spindle speeds are available, varying from 14½ to 140 revolutions per minute. The spindle is of crucible steel and runs in boxes of hard bronze. It has a tapered end 3 inches in diameter, for attaching face milling cutters, and also a No. 11 Brown & Sharpe taper hole for receiving cutter shanks and arbors. The spindle has a 6-inch independent vertical adjustment and a horizontal movement of 22 inches on the overhanging arm. There is a hole through the center of the spindle for a retaining bolt. The respective diameters of the two spindle bearings are 3 1/4 and 2 9/16 inches, and the length, in each case, is 4½ inches.


Beaman & Smith Open-side Vertical-spindle Milling Machine

The cross-rail or overhanging arm is very substantial and proportioned to best resist the strains to which it is subjected. It has a vertical power movement for adjustment on the upright, varying from 11 to 32 inches per minute. The work table is 18 inches wide, 6 feet long, and has a feed and rapid power movement of 6 feet 9 inches. The distance from the end of the spindle to the top of the table can be varied from 0 to 36 inches. The weight of the machine is approximately 13,000 pounds.

LANGELIER MOTOR-DRIVEN SENSITIVE DRILLS

The Langelier Mfg. Co. of Providence, R. I., has recently designed a new line of motor-driven drilling machines of the sensitive type. These are made in two sizes and for either bench or floor use, as shown by the accompanying illustration.


Langelier Sensitive Drilling Machines of Bench and Floor Types

The smaller size has a capacity for drills up to 7/32 inch, and the capacity of the larger size is for drills up to ⅜ inch in diameter. The machine shown to the left in the illustration is the No. 1 bench type, and the machine to the right is the No. 1 stand or floor drill. These machines are driven by ⅛ horsepower motors, and they can be obtained either with or without the motor.

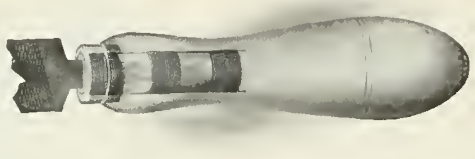
The motor drives the drill spindle by an endless belt at a speed of about 2000 revolutions per minute. The spindle "floats" inside of a sleeve which is continuous through the two spindle bearings, and the driving pulley is keyed to this sleeve and not to the spindle. This feature gives great sensitiveness and adapts the machine for precision work. This form of drive also obviates any jerking of the spindle, no matter how tight the driving belt may be, and spindle wear is practically eliminated. A belt guard is placed over the spindle pulley to prevent the belt from hitting the operator in case of breakage.

The feeding of the spindle of either a bench or stand drill can be effected by a hand-lever at the side of the column or by a foot-treadle connecting with a rod passing inside of the column. The drill table has a vertical adjustment of 4⅝ inches and it can be swung to one side, if desired. Each of these machines is equipped with a depth gage, which is a valuable feature when drilling duplicate parts, especially if the holes must be drilled accurately to a given depth. This gage consists of a vertical rod which passes through the spindle frame and can be locked in any position by a winged nut. The lower end of the rod strikes a hardened, fine-pitch knurled screw, by means of which very minute adjustments can be made. A binding screw at the side locks the vertical screw after it is set to the required height.

All of the running parts of these machines are designed for taking up wear and for replacement, if necessary. The weight of the No. 1 bench drill with a motor attached is 50 pounds, and the bench space is 20 by 12 inches. The weight of the No. 1 stand drill with a motor is 100 pounds, and the floor space 20 by 16 inches.

OSGOOD FILE AND TOOL HANDLES

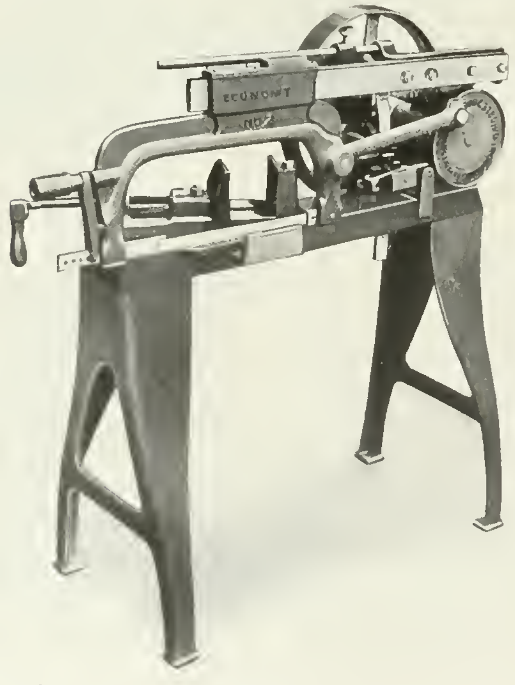
The J. L. Osgood Tool Co., 121 Erie County Bank Bldg., Buffalo, N. Y., has added to its line of indestructible file and tool handles, the type shown herewith. This handle has a steel-bound inner core to prevent splitting, and it is made in six different sizes, having lengths varying from 4 to 5⅝ inches. The smallest size is intended for files from 2 to 4 inches in length, and the largest size, for files from 14 to 20 inches in length. This company has also brought out a line of screw-driver and toolmakers' handles. The latter have a a tough wood core reinforced by a steel tube, and the grip is made of soft, flexible cork.



Osgood File Handle with Steel-bound Center Core

ROBERTSON POWER HACK SAW

The power hack-saw machine shown herewith, is a recent design being manufactured by the W. Robertson Machine & Foundry Co., 32 Greenwood Pl., Buffalo, N. Y. The general construction of this saw is clearly shown by the illustration. The surfaces of the bed are milled true, and the base of the head is machined to fit into housings formed on the bed, which gives a solid construction. The frame is supported on a finished steel arm and has a long bearing provided with ample lubrication.



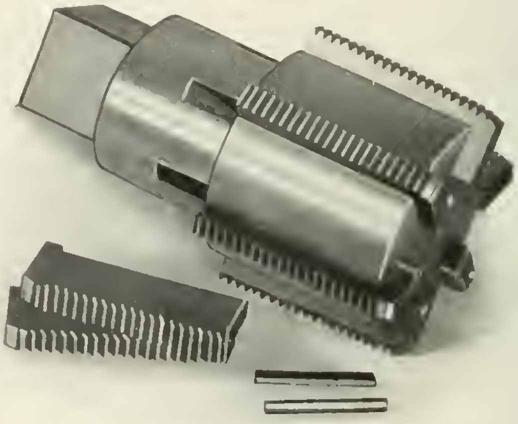
Power Hack-saw made by W. Robertson Machine & Foundry Co.

The frame is mounted and driven so as to insure a true cut and it takes either 10-, 12- or 14-inch blades. The saw cuts on the draw stroke, and there is a mechanical release on the return stroke. The machine is equipped with an automatic stop. The vise is strongly constructed and all surfaces are milled true. It is secured to the bed by two bolts and can be swiveled to 45 degrees. The position of the vise is indicated by degree graduations. This machine has a capacity of 6 by 6 inches, and the net weight is 250 pounds.

WINTER BROS. INSERTED-CHASER TAPS

Winter Bros. Co., of Wrentham, Mass., in developing a line of high-speed taps, found, that for sizes above 2 inches diameter, the cost of the steel increased to such a point that it more than offset the increased production obtained as the result of the superior qualities of high-speed steel. The inserted-chaser style of tap was developed to solve the cost problem. After numerous trials in different shops, the simple style of inserted-chaser tap which was first designed proved both economical and satisfactory.

This tap, one size of which is shown herewith, has a body made of machinery steel, or, in the case of very large sizes, of cast iron, and the chasers are held in slots, the sides of which are parallel. Before these slots are milled in the body, holes (which ordinarily have a diameter of 3/16 inch) are drilled in such a location that the inner sides are flush with the bottom of the slots, and the centers are 1/32 inch ahead of the sides of the slots. When the latter are milled, two-thirds of each hole is left, and into these holes the chaser binding pins are inserted.



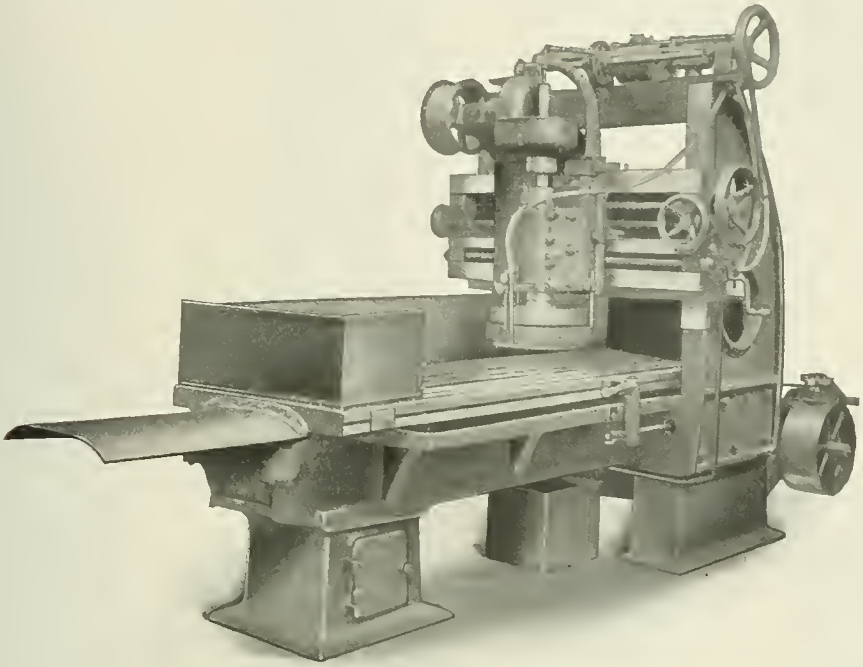
Tap having Inserted Chasers or Blades

The chasers are made of flat stock with parallel sides, and the bottom is milled off, thus leaving a shoulder about ⅛ inch high near the front end, as shown in the illustration. In assembling the tap, this shoulder is set against the end, thus locating each chaser accurately. Near the bottom of the front or cutting side of each chaser, a surface is milled, having an angle of 16 degrees to the rest of the face. The binding pins have one side flattened, and when they are driven in place, this flat side bears against the angular surface, which holds the chasers firmly against the ends and bottoms of the slots. The pins are made of straight pieces of drill rod or screw stock and they are an easy fit in the round hole, but a driving fit when the chasers are in place. It is not necessary to drive the pins very hard or insert them for any great distance. The chasers are removed by driving them out endwise, which also removes the pins.

The cost of a new set of high-speed steel chasers is less than that of a carbon steel tap for sizes above 2 inches diameter. For sizes as large as 4 inches diameter the cost of a complete inserted-chaser tap with high-speed steel blades is less than that of a carbon steel tap, and a new set of chasers costs only about one-third as much as a solid tap of carbon steel. When the same number of threads per inch is used for different diameters, the chasers are said to be interchangeable for diameters varying as much as 6 inches. Special pipe taps have also been made which work satisfactorily with duplicate chasers, for all sizes from 2½ inches up to 12 inches.

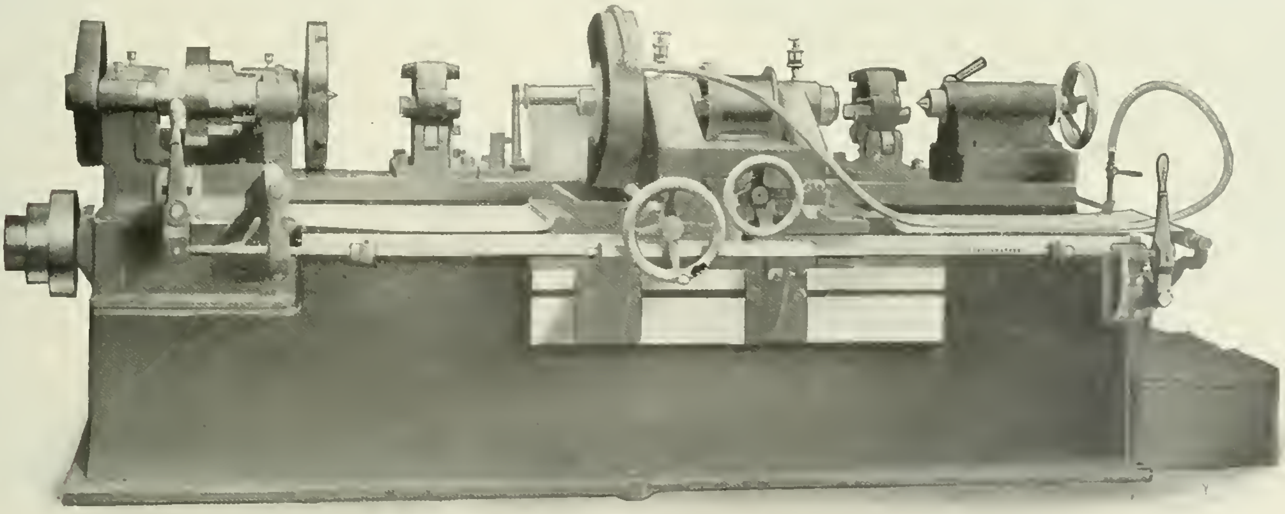
VERTICAL GRINDING PLANER WITH MOVABLE HEAD

The vertical planer-type grinder illustrated herewith is designed for grinding a large variety of work. The wheel-head on this machine is mounted on a heavy and substantial cross-rail, and has a cross movement of 36 inches. It is traversed back and forth by a screw and the crank handle seen at the right-hand end of the cross-rail. The wheel spindle has a quick hand motion, vertically by means of the large handwheel shown, and a slow or feeding motion is effected by the smaller handwheel at the front of the cross-rail, which operates through a worm and worm-gear that can easily be disengaged.



Vertical Grinder of the Planer Type

The wheel-head travels on the modern narrow guides, and has bearings of generous proportions. The wheel-head proper is of the same general design and size as that used on the Springfield-Brandes vertical grinding planer, which was illustrated in the department of New Machinery and Tools for December, 1910. The wheel is 16 inches in diameter and is driven by an accurately planed pair of bevel gears, one being of cast iron and the other of rawhide. All the high-speed bearings are either of the self-oiling or sight-feed type. The end thrust bearings are all provided with ball bearings.



Special Machine designed for Grinding Concave Rolls

The drive for traversing the table is something like a planer drive, except that the motion is transmitted through a worm and worm-gear and a large coarse-pitch screw operating in a nut 15 inches long. The machine is equipped with a pump and all necessary attachments, and lubricant can be applied either through the spindle or from the outside of the wheel. It is also equipped with a large water guard which surrounds the table to confine the spray. This guard is made in two sections. The front section is shown removed, and it can readily be taken out and put back, by sliding it in from the top and clamping with thumb-nuts.

This machine has a capacity for grinding widths up to 30 inches and lengths up to 7 feet. The weight is 13,450 pounds. It is built by the Springfield Mfg. Co., Bridgeport, Conn.

SPRINGFIELD SPECIAL ROLL GRINDER

The Springfield Mfg. Co., Bridgeport, Conn., has designed a special grinder for grinding concave rolls by means of a former. This former is located directly under the handwheels at the front of the machine, as will be seen by referring to the accompanying illustration. It is somewhat similar in construction to a lathe taper attachment and is provided with an adjustment.

In operation, the intermediate slide on which the wheel-head is mounted is forced against the former by a heavy spring. The operation of grinding is practically automatic, although the grinding wheel is fed by means of a small handwheel. The wheel face is curved slightly, as this is necessary in order to reproduce the curve of the former. The two rests seen on each side of the wheel-head are to permit revolving the rolls on their own journals. These rests are adjustable.

The machine is also designed to do internal grinding. The internal attachment is shown in place, directly beyond the wheel. It is driven by a belt which runs over a pulley that forms part of the main driving pulley for the grinding wheel. This internal attachment is removed when the machine is to be used for either straight or curved grinding.

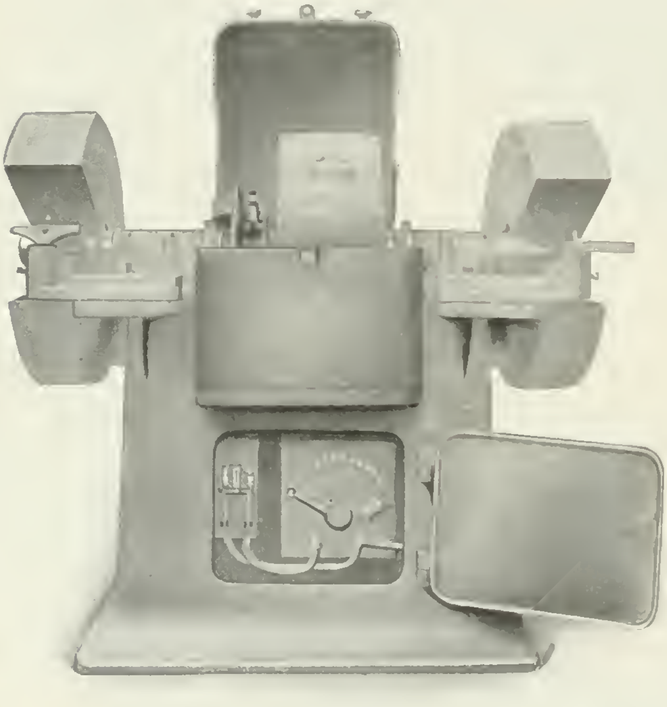
The wheel carriage is reversed automatically by ordinary trip-dogs, which are mounted on a rod at the front, as shown. This rod connects with the reversing lever seen attached to the speed-box at the left. When this lever is in a neutral position and the smaller lever seen to the right is set against the retaining drum, the mechanism remains idle and the wheel-head can be traversed by hand, the movement being transmitted by a revolving nut operating on a stationary screw.

This machine has a capacity for grinding rolls 12 inches in diameter and 4½ feet long. It is equipped with a pump and water attachment for wet grinding, and the matter of lubrication and protection of exposed parts has received careful attention. The wheel-head ways, as will be seen, have covers which are attached to automatic rollers that wind and unwind as the wheel-head traverses back and forth. The weight of this machine is 7250 pounds.

SPRINGFIELD MOTOR-DRIVEN GRINDER

The direct-connected motor-driven dry grinder shown in the illustration has been designed by the Springfield Mfg. Co., Bridgeport, Conn., as a standard for direct-current motors. The aim has been to adapt it, as far as possible, to standard motors, and the only thing that is special, as far as the motor is concerned, is the shaft. The motor is mounted on a rigid base and it is enclosed with a dust-tight case. The upper half of this case is hinged so that it can easily be thrown back to the position shown, either for inspection, adjustment or cleaning, and it is held in the closed position by a bolt. The case is bored out to fit finished projections on each of the boxes, and, as the joint is ground, the case is practically dust-proof.

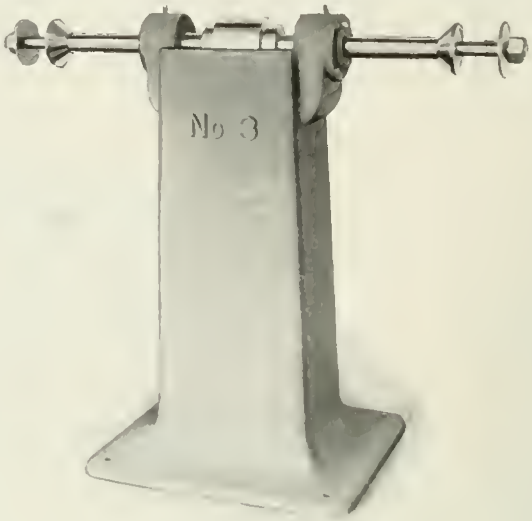
The grinder is designed to take two hoods, as shown. These are made so as to enclose practically the entire wheel, with the exception of the portion which must be left exposed at the front. The hoods have an outer plate which can readily be removed when it is desired to change the wheels. These hoods can also be connected with an exhaust system, which is desirable where such a system is installed. The starting controller is mounted on a slab inside of the base and is as close to the front as possible, for convenience in operating. The spindle bearings are of generous proportions and are of the self-oiling type. At present, these machines are made in three sizes suitable for wheels having diameters and widths of 12 by 2 inches; 18 by 2 or 3 inches and 24 by 3 or 4 inches.



Direct-connected Motor-driven Dry Grinder

GARDNER POLISHING STAND

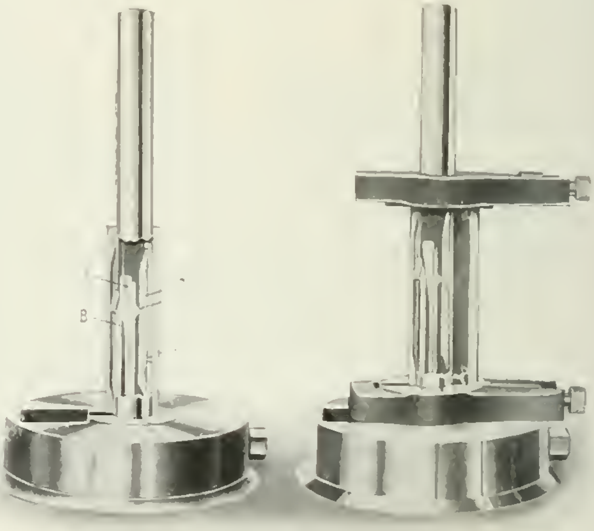
A ball-bearing polishing stand has been put on the market by the Gardner Machine Co., Beloit, Wis. This machine, which is shown herewith, is fitted throughout with ball bearings. The diameter of the spindle at the bearings is 2 inches and it tapers down to a diameter of 1¾ inch. The arbor is 1¼ inch in diameter and forms a shoulder for the 4½-inch wheel collars. The spindle extends 15 inches on each side of the base and is 39 inches from the floor. The spindle pulley is 5 inches in diameter and has a 4½-inch face. The two radial ball bearings are encased so as to be completely protected from dust or grit, and they are lubricated by a light grease contained in compression grease cups. Spacing collars are furnished when wheels of various widths are required. The countershaft hangers have ball bearings. The tight-and-loose pulleys are 8 inches in diameter and have 5½-inch faces. The loose pulley is fitted with two radial ball bearings. The driving pulley is 18 inches in diameter, and when it runs at 750 revolutions per minute, the machine is driven at a speed of 2700 revolutions per minute. This polishing stand is known as the No. 3 size. Its weight, complete with the countershaft, is 600 pounds.



Gardner Ball-bearing Polishing Stand

KEYSEATER ATTACHMENT FOR CUTTING OIL GROOVES

Mitts & Merrill, 843 Water St., Saginaw, Mich., have brought out an attachment for cutting oil grooves, which can be applied to the keyseaters built by this company. The accompanying sectional views show the working parts of this device and how it is operated. Referring to the left-hand view, part *A* is the feed wedge, *B* is the cutter, and *C* is the pattern of the oil groove to be cut. This pattern is fastened to the back of the groove in the post which forms a support for the work. Part *D* is a follower-bar having a knob or projection on the rear side, which follows the pattern and guides the cutter, thus forming an oil groove corresponding in shape and length to the pattern. The bushing *E* represents the work, and the form of the completed oil groove, as well as the way it is reproduced from the pattern, is clearly shown.



Sectional Views of Mitts & Merrill Keyseater Attachment for Cutting Oil Grooves

When the attachment is in operation, the cutter *B* and the follower-bar *D* travel together in a line parallel to the pattern.

The feed wedge *A* is operated in the usual manner for feeding the cutter into the work. The cutter has an automatic relief on the return stroke. The work is chucked by means of bushings similar to those used for keyseating. The view to the right shows the attachment equipped with expansion bushings for chucking work that varies in diameter.

With this device, as regularly furnished, oil grooves up to 3/16 inch deep can be cut. A groove 4 inches long and ⅛ inch deep can be cut in one minute, which includes the time required for chucking and removing the work. The No. 1 size will cut grooves ⅛ inch deep in holes 1 inch in diameter and larger. The No. 2 size is adapted for grooves 3/16 inch and holes 1 1/2 inch in diameter and larger.

BRYANT HOLE- AND FACE-GRINDERS

The Bryant Chucking Grinder Co., of Springfield, Vt., has designed two new chucking grinders, one of which has a single spindle and the other two spindles. These machines are being built in addition to the three-wheeled chucking grinder which was illustrated in the November, 1909, number of MACHINERY, and they are intended for chuck work which requires only one or two grinding operations at a single setting. A front view of the two-spindle type is shown in Fig. 1, and Fig. 2 is a rear view of the single-spindle machine. The former is especially adapted to that class of work which has to be ground internally and faced, as both operations can be performed successively and rapidly.

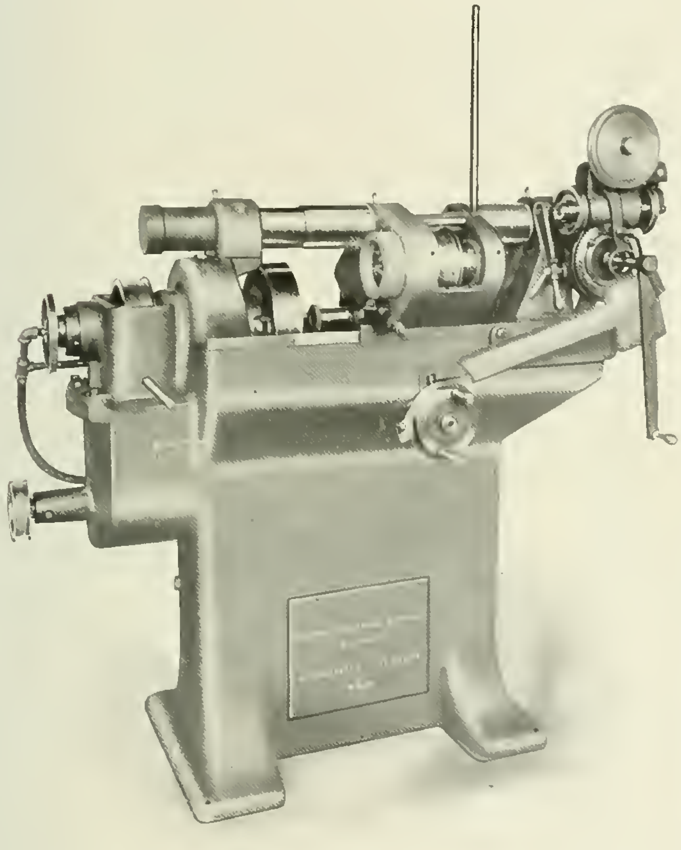


Fig. 1. Two-spindle Face- and Hole-grinder built by Bryant Chucking Grinder Co.

The design of these machines has been simplified as far as possible, in order to give a maximum output for the grinding of duplicate parts within a limited range. Provision is made only for those adjustments which are actually needed in general practice. The average machine tool is ordinarily provided with an assortment of speeds, feeds, and adjustments which are necessary to meet the conditions for work within its range, but when such machines are used on duplicate work in manufacturing, usually only one or two of the many feeds, speeds, and adjustments are needed.

These new hole- and face-grinders, as the illustrations show, are a decided departure from conventional designs, particularly in regard to the method of mounting the wheel-slide. Instead of the usual flat or V-shaped ways, the wheel-slide is held in position and traversed in hardened and ground cylindrical bearings which are located above the grinding wheels, and are further protected by brass telescoping sleeves which make them grit- and dust-proof. These bearings, the general arrangement of which is clearly shown by the longitudinal section Fig. 4, give a smooth even traverse to the wheel-slide and insure its permanent control and alignment. These bearings are not only used for the longitudinal traverse, but they enable the wheel-slide to be given a radial swinging motion, which furnishes the cross-feed for diameter control. This radial motion, when a grinder is equipped with two wheels (one for hole and the other for face grinding), is used for locating either spindle in the operating position; whereas, with the single-spindle grinder, this motion is employed to swing the wheel out of the working position when necessary.

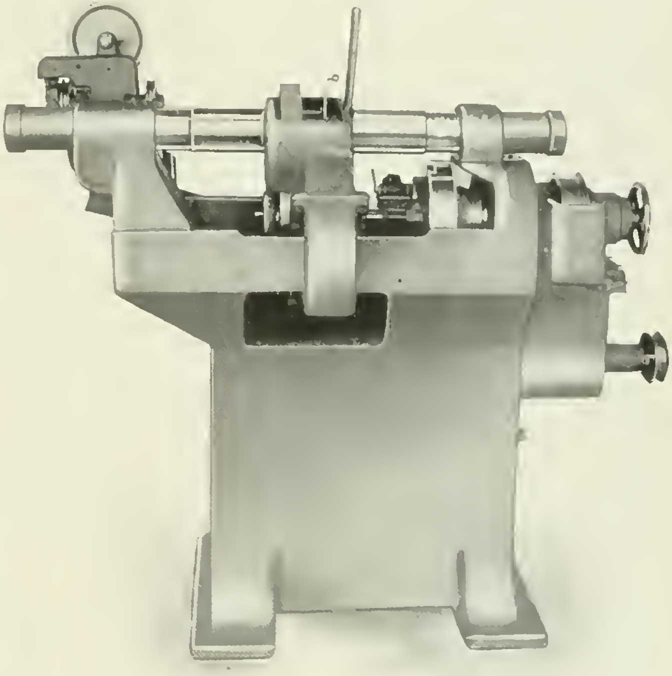


Fig. 2. Rear View of Single-spindle Internal Grinder

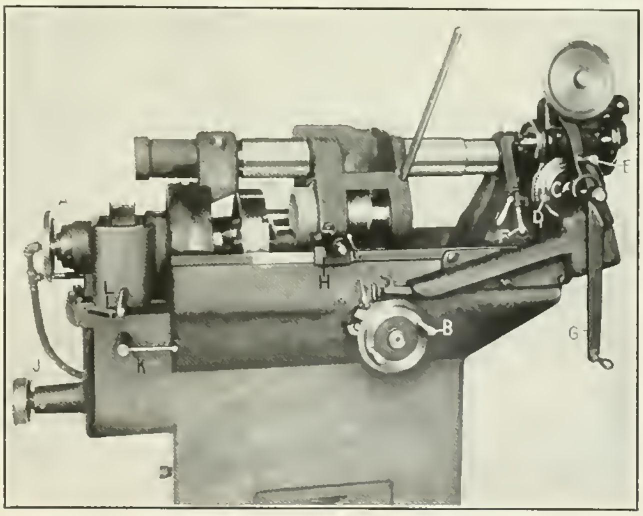


Fig. 3. Two-spindle Machine with Wheel-slide set for Face-grinding

The wheel-slide, in either case, can be moved easily and quickly.

The hand lever seen attached to the wheel-slide, is used for moving the facing wheel into position. Fig. 1 shows the wheel-slide set for hole grinding, and Fig. 3 shows the cup-wheel set for end facing. The work-holding chuck is operated by handwheel *A* (Fig. 3) at the left end of the spindle, which is connected with the chuck as shown in the sectional view Fig. 4. The handwheel *B* (Fig. 3) seen at the front of the machine, is for the diameter control, and the way this wheel imparts a radial swinging movement to the grinding wheel slide, is shown by the cross-section, Fig. 5. A circular arm *E* is bolted to wheel-slide *S* and projects into a pocket under the water pan. The lower or inner end of this arm rests against feed-screw *F* and is held in this position simply by the arm's weight and the pull of the driving belts. There is no vibration of this arm, as it simply pushes against the feed-screw.

The wheel-slide is traversed longitudinally by a belt which passes over the three grooved pulleys seen at the right-hand end of the machine. The two smaller pulleys rotate in reverse directions and are alternately connected through a clutch mechanism with a worm engaging with worm-wheel *C*. This worm-wheel, in turn, rotates a pinion shaft and pinion meshing with a circular rack on the wheel-slide, as shown to the right in Fig. 4. On the side or front face of worm-wheel *C*, are mounted the reversing stops *D* for controlling the wheel travel. The reversal of the wheel-slide can also be effected by the hand lever *E*. Lever *F* is used for disengaging the power traverse, and the long lever *G* is for moving the slide back and forth by hand.

The cross-feed is equipped with an automatic trip mechanism having suitable adjustment. A diamond holder is located at *H* for truing the grinding wheels. The cooling water is supplied by a pump driven by pulley *J*, and the piping is so arranged that the water can be conveyed to the work either through the spindle or by a flexible pipe attached to the wheel carriage. The flow of water is controlled by lever *K*, which is within convenient reach. The work-head of this machine has an angular adjustment for grinding tapers up to 30 degrees included angle. The position of the head is shown by graduations on the segment-shaped base *L*, and the method of clamping the head is clearly shown by the illustration.

This machine has a capacity for grinding holes up to 10 inches in diameter and 6 inches in length, and the chuck will hold parts having a maximum diameter of 12 inches. There are three work speeds of 150, 225 and 300 revolutions per minute, and variations of wheel traverse of 20, 30, and 40 inches per minute. The wheel-spindle driving shafts are mounted in ball bearings of the enclosed type and require only occasional oiling. Either the single- or double-spindle machines are furnished for power or hand operation.

The equipment of the two-spindle grinder consists of a 12-inch chuck; a facing spindle with a 6-inch cupwheel; an assortment of grinding wheels to cover internal and face grinding on both hard and soft metals; a diamond holder and diamond; water pump and connections; a countershaft and suitable wrenches. The floor space occupied by the machine is 3 by 6 feet, and its approximate weight, 2000 pounds.

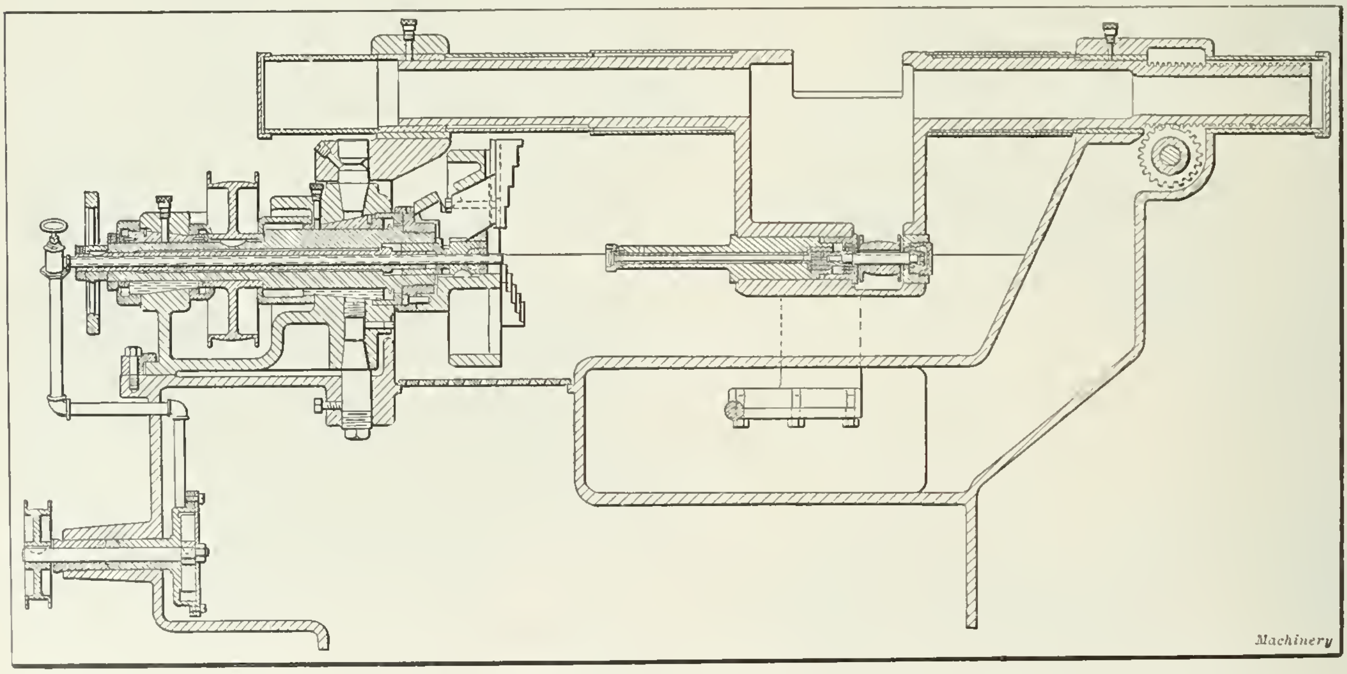


Fig. 4. Longitudinal Section of Bryant Chucking Grinder

The principal features claimed for a grinder of this type are as follows: Better control and greater rigidity for the wheel-slide; hardened and ground wheel-slide bearings, which are grit- and dust-proof; quick and accurate operation; elimination of any vibration or error such as might result from faulty fitting and adjustment of the cross-slide; a housing that partly confines the water and spray; and uniform lubrication due to the cylindrical wheel-slide bearings.

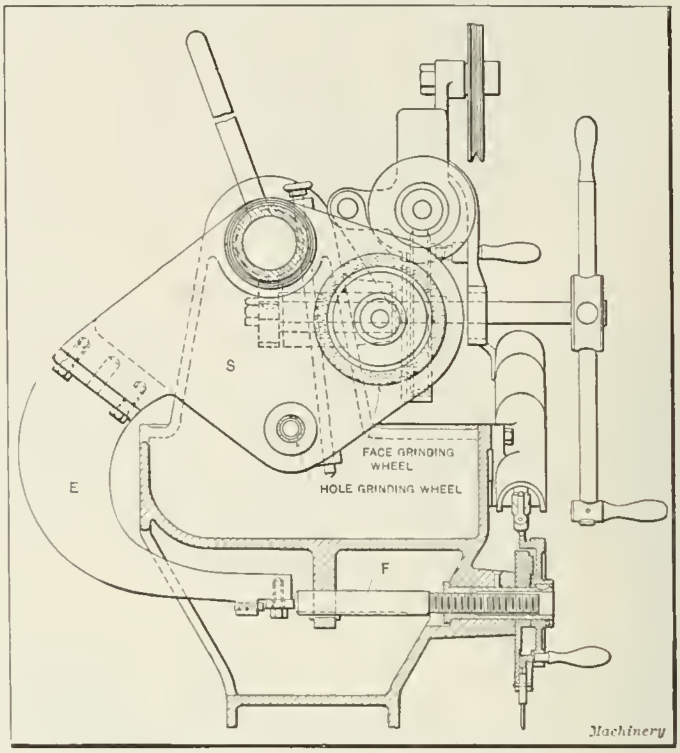
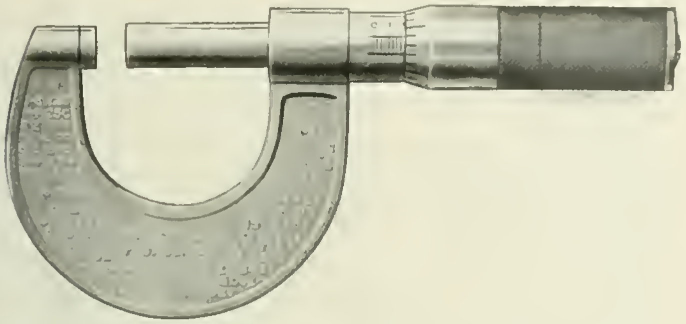


Fig. 5. Cross-section showing Cross-feed Control for Wheel-slide

FRICTION THIMBLE FOR SLOCOMB MICROMETER

Most mechanics are familiar with the friction or ratchet stop which is applied to some micrometers for the purpose of securing the same degree of pressure when measuring. Some machinists have what is called a "heavy feel" and others a "light feel," and when a micrometer without a ratchet or friction stop is used, variations in diameter are sometimes the result, when duplicate parts are measured by different men. This is overcome by the ratchet or friction, which slips when more than a certain amount of pressure is applied, thus preventing the measuring screw from turning farther.

The J. T. Slocomb Co., Providence, R. I., is applying a friction thimble or stop to the Slocomb micrometers (when so ordered) which is so arranged that it can be operated by the same hand which holds the micrometer. By referring to the accompanying illustration, it will be seen that this friction thimble is the same size as the regular knurled thimble, and it extends forward to about the center of the micrometer handle. This device consists chiefly of a coiled, flat, German silver spring the inner end of which is attached to a washer clamped to the end of the thimble by a shoulder on the central screw. The outer end of the spring slides around inside of a large bore in the outer revolving part, the arrangement being such that when the thimble is turned to the right, the device slides over the spring, but when turned to the left, the friction uncoils the spring, thus causing it to drive positively in this direction.


Slocomb Micrometer equipped with Friction Thimble

There are no parts liable to get out of order, and the spring will not wear and thus lose its tension. This stop gives a smooth forward action and a movement that is fully as positive in a reverse direction. The friction thimble can be used when the micrometer is opened to its full capacity, and the screw can, of course, be operated without using the stop, when desired.

NEW MACHINERY AND TOOLS NOTES

Knurling Tool: Edgar T. Ward & Sons Co., Boston, Mass. Knurling tool with capacity for diameters up to ¾ inch. Three knurls are applied to the work, thus giving a good support, and the holder has a hollow handle which contains an extra set of knurls.

Drilling and Tapping Machine: Taylor & Fenn Co., Hartford, Conn. Radial drilling machine having two heads. One head is for drilling and the other, which is equipped with a reversing mechanism, can be used for tapping. The speeds of each head can be varied independently, if necessary.

Metal Saw: Peter Bros. Mfg. Co., Algonquin, Ill. Abrasive metal-saw designed primarily for the tool-room, for cutting off high-speed or other tool steels. The cutting wheel is 8 inches in diameter and 1/16 inch thick. It has a capacity for square bars up to ⅞ inch, and angles, channels, tees, etc., up to 1¼ inch.

Electric Hammer: Electro-Magnetic Tool Co., Chicago, Ill. Electric hammer having a motor of the series type and brush-holders attached to the tool casing so that the motor-head can readily be removed. Ball bearings are used throughout, and the hammer is equipped with a magnet which acts as a flexible clutch to prevent transmitting the strain and jar to the gears and motor.

Knurling Tool: Alert Tool Co., 221 N. Broad St., Philadelphia, Pa. Knurling tool having three knurls, thus giving a three-point contact which prevents bending or straining the work. By means of a winged nut, the knurl-holder is adjustable for pieces varying from 0 to 1¼ inch in diameter. This holder is applicable to all types of machines, such as engine lathes, bench lathes, etc.

Lathe: Whitcomb-Blaisdell Machine Tool Co., Worcester, Mass. New line of motor-driven lathes with from 13- to 30-inch swing. The headstock is designed to permit placing all the gearing at the forward end or close to the spindle nose, and the rear end is arranged for the motor, which is placed low to avoid top-heaviness. The headstock covering encloses all gears. The lathe has double back-gears which are shifted by a lever at the front.

Pipe Bender: Wallace Supply Co., 108 N. Jefferson St., Chicago, Ill. Pipe bender so designed that the wall of the pipe is supported where the bend is made, thus eliminating any distortion or flattening. A radius of 14 inches or more is recommended for pipe as large as 2 inches, but the machine has been successfully used for a radius as small as 9 inches on 2-inch pipe; 8 inches on 1½-inch pipe; 6 inches on 1¼-inch pipe, and 4 inches on 1-inch pipe.

Milling Machine: Kearney & Trecker Co., Milwaukee, Wis. Vertical milling machine known as No. 2½-B. This machine is similar in construction to the No. 1½ size illustrated and described in the February, 1912, number, but has a greater capacity. The table has a feed of 30 inches and a cross-feed of 15 inches. The vertical feed and the greatest distance from the end of the spindle to the top of the table is 20½ inches. The working surface of the table is 14 by 47 inches, and the diameter of the rotary table, 17¼ inches. There are eighteen speed changes ranging from 15 to 360 revolutions per minute, and twelve feed changes which vary from ½ to 16 inches per minute. The net weight of the machine is 5200 pounds.

Portable Drill: Cincinnati Electrical Tool Co., 652 Evans St., Cincinnati, Ohio. Two sizes of portable, universal drills for operating on either direct or alternating current. One size will drill holes up to 3/16 inch in steel or hard wood, or 3/8 inch in soft wood, and the other size has a maximum capacity for 1/4 inch holes in steel or hard wood, and 1/2 inch in soft wood. The motor armature is equipped with ball bearings. The gears are enclosed and run in grease, thus protecting the electrical parts from dust and grease. The body of these drills is made of aluminum, and the outside diameter is about 4 inches. The weights of the two sizes are 7½ and 8½ pounds, respectively. A spade handle and a straight handle are furnished.

Milling Machine: Gooley & Edlund, Syracuse, N. Y. Single-purpose milling machine designed for form and gang milling in connection with the manufacture of guns, automobiles, typewriters, sewing machines, and similar parts. The frame of the machine is a single casting having two uprights joined by an arch at the top and cast integral with the base. The inner faces of these uprights have dovetailed ways, to each of which the heavy bed is fitted. The bed can be rigidly clamped to the uprights by four ⅞-inch bolts. The front upright contains an adjustable sleeve bearing which acts as an outboard support for the cutter arbor. The table has a screw feed and a quick-return handwheel operating through a rack and pinion. Eight changes of feed are provided. The maximum distance from the center of the arbor to the surface of the table is 12 inches. The table is furnished in lengths of 32, 38 and 44 inches, as may be required, and it has a width of 10⅛ inches.

* * *

JOINT MACHINERY DEALERS' CONVENTION

The joint triple convention of the National Supply and Machinery Dealers' Association, the Southern Supply and Machinery Dealers' Association, and the American Supply and Machinery Manufacturers' Association was held in Norfolk, Va., at the Monticello Hotel, May 13-15. The National Supply and Machinery Dealers' Association was called to order by President W. L. Rodgers of the Pittsburg Gage & Supply Co., Pittsburg, Pa.; the Southern Supply and Machinery Dealers' Association by S. M. Price of the S. M. Price Machinery Co., Norfolk, Va.; and the American Supply and Machinery Manufacturers' Association by Willard Parker, president. The program included an address on "Workmen's Compensation," by F. C. Schwedtman; "Motion Study," by Charles S. Miller; "Accident Prevention and Relief," by F. C. Schwedtman and James A. Emery; "The Modern Machinery Supply Jobber a Necessary Adjunct to the Manufacturers," by W. T. Dodd; "Cost of Handling Small Orders in Broken Package Lots and Remedies Proposed" and "Resale Prices in Their Present Status," etc.

* * *

NEWARK INDUSTRIAL EXPOSITION

Newark Industrial Exposition, Newark, N. J., was held under the auspices of the Board of Trade of the city of Newark, May 13 to 25 in the First Regiment Armory, its object being to advertise the industries and advantages of the city. Newark has a population of 365,000 and with the immediate surrounding towns 565,000. It has a wharf frontage on the Passaic River of 10½ miles, and is served by the Pennsylvania, Lackawanna, Lehigh Valley and New Jersey Central Railroads. The exposition comprised 196 concerns who showed a great variety of machinery and products valued at over $1,000,000, produced in Newark. It was attended by thousands of interested visitors. Among the exhibitors were Gould & Eberhardt, makers of shapers and gear cutting machines; Newark Gear Cutting Machine Co., maker of gear cutting machines and cut gears; Zeh & Hahnemann, makers of screw, crank and hydraulic presses; Crocker-Wheeler Co., maker of electric generators and motors; A. & F. Brown, makers of transmission machinery; Garvin Machine Co., maker of milling machines and other machine tools.

GRINDING THIN ALUMINUM CASTINGS

The Gardner Machine Co., Beloit, Wis., recently completed a grinding test on some peculiarly shaped aluminum castings which, owing to the thinness of the sides that required grinding, presented some rather interesting difficulties owing to the distortion caused by the heat generated. These aluminum castings are used for making automobile horns, and Fig. 1 of the accompanying illustrations, shows how the flat sides were ground between two disk wheels on a No. 14 Gardner grinder.

As the sides of the casting were only about 1/16 inch thick, they could not be ground in the usual way because the thin sides were heated so quickly and bulged out to such an extent that the metal, in some cases, was ground entirely through near the center, before the other parts of the surface were finished true. In all cases, the sides were decidedly convex after the metal had become cool, showing that they had expanded or bulged because of the heat, which caused an excessive amount of stock to be ground away from the center; consequently, when a casting cooled and resumed its natural shape, the sides were convex.

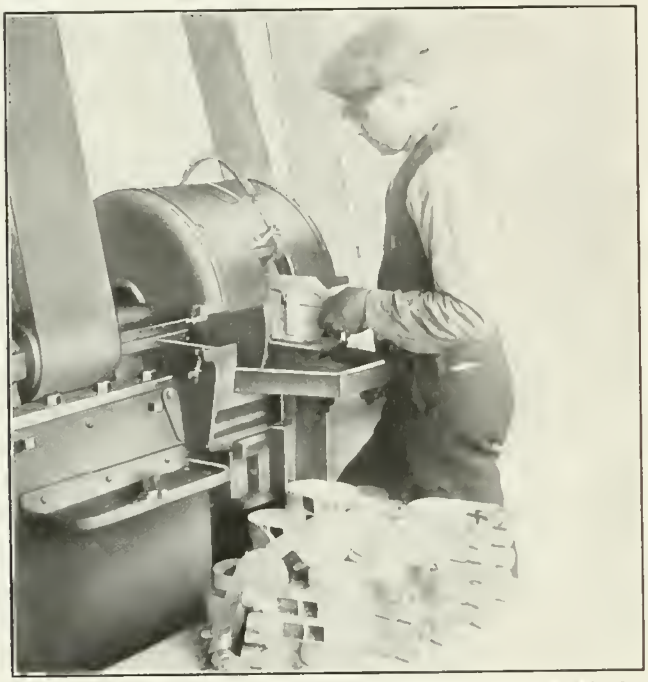


Fig. 1. Grinding Thin Aluminum Castings on a Gardner Two-wheel Disk Grinder

The idea was conceived of filling the hollow castings with cold water, and this was carried out as shown in Fig. 2. The open end or pipe was plugged with a cork of suitable size. The casting was then filled with water and placed in the hinged wooden holder shown in Fig. 2. The upper half of this holder was provided with a felt pad which pressed down, thus covering the rectangular opening in the casting and preventing the water from jarring out during the grinding operation. It was found that the water absorbed the heat and equalized its distribution so thoroughly that no further trouble was encountered from warping. The samples were ground to accurate dimensions, and finely finished flat surfaces were formed at the rate of 60 to 75 castings per hour.

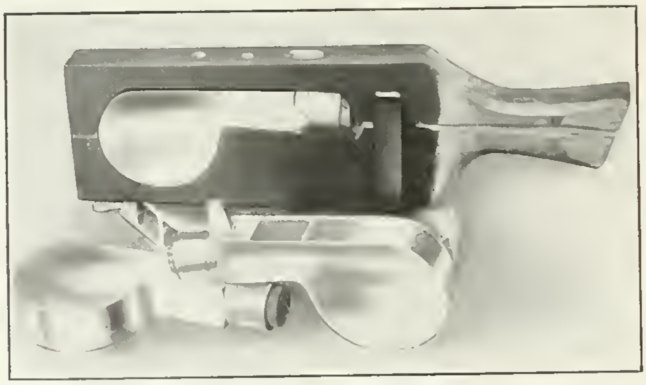


Fig. 2. Holder for Aluminum Castings

BROACHING A CONNECTING-ROD END

The method of finishing the end of an engine connecting-rod by broaching is illustrated in Fig. 1. The hole is 2¼ inches wide by 4½ inches long, and the end of the rod is 1⅞ inch thick. This rectangular opening is finished by broaching in from four to five minutes, the time depending somewhat upon the facilities for handling the work. The end of the rod prior to the broaching operation, is either blocked out by jig drilling as indicated at *A*, Fig. 2, or a rough hole is formed by forging. The full lines in these sketches show the rough surfaces in each case, and the dotted lines, the finished hole.

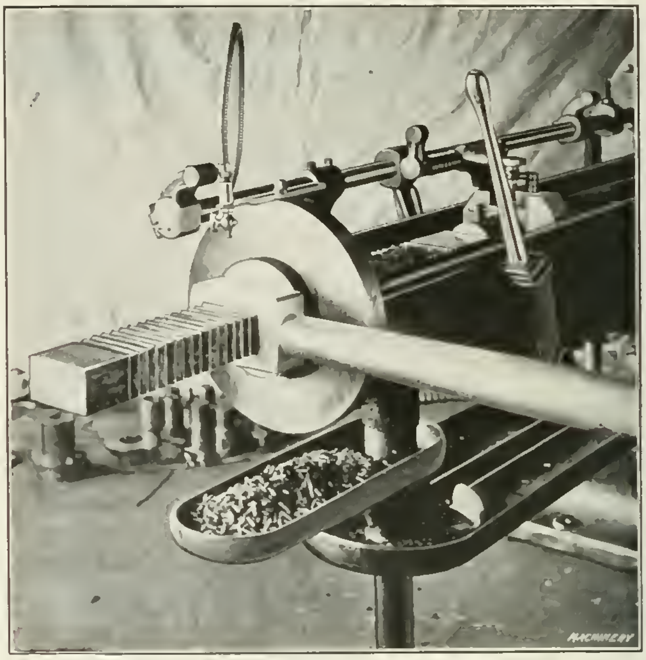


Fig. 1. Broaching Connecting-rod End in Lapointe Machine

For broaching an opening of this size, two operations are required; one for roughing and one for finishing. The roughing broach removes the greater part of the metal and enlarges the hole to within 1/16 inch of the required size, there being 1/32 inch left on each of the four faces for finishing. The starting end of the finishing broach fits into the hole made by the roughing broach. These broaches are made of a solid piece of steel and are approximately 48 inches long.

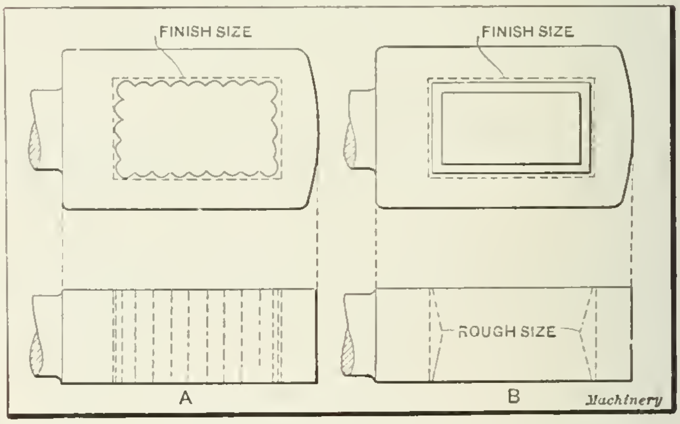


Fig. 2. (A) Rod End Blocked Out by Drilling. (B) Rod with Forged Hole

As each of these rods weighs from three hundred to four hundred pounds, they are usually handled by means of a hoist. The end of the rod to be broached is supported by the broach itself, and the opposite end rests on a suitable stand. In this way, the work is held parallel or in position to bring the finished hole in alignment with the rod. The broach operates in a fixed position and finishes the hole according to the way the rod is set. After the support is properly located, any number of pieces can be broached without further adjustment, the holes produced being uniform in size and in alignment with the rod. The broaching machine used for this work is built by the J. N. Lapointe Co., Marlboro, Mass.

SEMI-ANNUAL CONVENTION N. M. T. B. A.

The tenth semi-annual convention of the National Machine Tool Builders' Association was held at the Hotel Chalfonte, Atlantic City, N. J., May 16-17. While the representation of the concerns having membership was only about sixty, their seeming indifference was not justified by the work the association has done this year, as was apparent from the report of the committee that worked in Washington to modify the drastic provisions of the Underwood tariff bill which, if passed, will place machine tools on the free list.

Mr. E. P. Bullard, Jr., of the Bullard Machine Tool Co., in welcoming the members as president of the association, referred to the great value of the body when an emergency, like the proposed bill, arose. The industry, through its appointed representatives, could act practically as a unit before the congressional committees and win recognition that probably would be denied to individual manufacturers seeking to protect their interests.

Mr. James H. Herron was introduced as the general manager of the association instead of permanent secretary, the name of the position originally proposed. The fact that the constitution of the association requires the secretary to be a member made the change necessary. Mr. Herron, who will devote his entire time to the work of the association, outlined his views in the paper "What can the Association do for its Members?" in which he spoke of working for the common good, revising nomenclature, the importance of standardization, the protection of gears and other dangerous parts of machine tools, the collection of statistics, keeping technical indexes for the benefit of members, and cost keeping. Reference was made to the indefiniteness of the present system of designating the nominal capacity of engine lathes and it was suggested that something be done that would show in the nominal rating what the lathe will swing over the carriage and between the centers. Other excellent suggestions were made that merit the serious attention of the members.

Mr. W. A. Viall of the Brown & Sharpe Mfg. Co., read the report of the membership committee in the absence of Mr. C. A. Hoefer, chairman. Eleven concerns were proposed for membership as follows:

A. D. Quint, Hartford, Conn.
Landis Machine Co., Waynesboro, Pa.
Hisey-Wolf Machine Co., Cincinnati, Ohio.
Grant Mfg. & Machine Co., Bridgeport, Conn.
Geometric Tool Co., New Haven, Conn.
Gooley & Edlund, Syracuse, N. Y.
Joseph T. Ryerson & Son, Chicago, Ill.
Langelier Mfg. Co., Providence, R. I.
Baird Machine Co., Bridgeport, Conn.
Armstrong-Blum Mfg. Co., Chicago, Ill.
Acme Machinery Co., Cleveland, Ohio.

The following consolidations and changes of membership names were reported:

Stoever Foundry & Mfg. Co., Myerstown, Pa., to Treadwell Engineering Co., Easton, Pa.

Grant & Wood Mfg. Co., Chelsea, Mich., to Flanders Mfg. Co., Pontiac, Mich.

Miami Valley Machine Tool Co., Dayton, Ohio, to Conover-Overkamp Machine & Tool Co., Dayton, Ohio.

Fay Machine Tool Co., Philadelphia, Pa., to Jones & Lamson Machine Co., Springfield, Vt.

F. E. Reed Co., and Prentice Bros. Co., of Worcester, to Reed-Prentice Co., Worcester, Mass.

The membership has been increased by seven, making the total 173.

Mr. D. M. Wright of the Henry & Wright Mfg. Co., reported on standardization of machine tools, and counseled that no radical moves be made without giving them very careful consideration and obtaining the opinions of every member of the association affected by the proposed changes. The matter of revising the nomenclature of the trade was discussed, particularly the term "machine tool" which the courts have decided has a much broader significance than the machine tool builders generally believe. In view of the ambiguity, Mr. Wright offered a resolution to the effect that the name of the association be changed to "American Metal Working Machinery Constructors' Association." The resolution was referred to the executive committee.

Mr. C. Wood Walter of the Cincinnati Milling Machine Co., chairman of the committee on prices charged to educational institutions, made no definite recommendations but pointed out the inconsistency of the common practice of machine tool dealers in dealing with educational institutions as compared with the practice of all other concerns, such as builders, plumbers, publishers, etc. The latter, of course, obtain full prices, and it seemed that all interests would be best served by making the rule universal and letting the individual members make their contributions to the cause of education direct instead of in the form of rebates on the prices of equipment.

Mr. Walter also reported on the fight against placing machine tools on the free list before the Senate committee, in the absence of Mr. F. A. Geier, the president of the Cincinnati Milling Machine Co. It was pointed out that although the subject is by no means settled and adverse legislation may be passed, either in the form of the Underwood bill or the Cummins bill, the machine tool builders, through their representatives, have placed on record their arguments against unjust discriminations and the prospects are reasonably bright for a tariff of twenty-five per cent as against no protection at all, as originally proposed in the Underwood bill.

The paper "How can the Mechanical Journals be made of the Most Value to their Patrons?" by Mr. Fred E. Rogers, editor of MACHINERY, was read in the second session (see engineering section of this number), following which Mr. Charles E. Hildreth of the Whitcomb-Blaisdell Machine Tool Co., presented "What has the Future in Store for Us?" accompanied by a large chart on which the fluctuations of pig iron prices for the past eighty-five years had been plotted. From this chart the prospects for the next six years can be predicted if the observed cycles in the past are reproduced. The signs of the times and known conditions existing with the railroads seem to confirm the indication of the chart that an era of heavy pig iron consumption and general prosperity is close at hand, if it has not already begun.

The third session was given up entirely to meetings of the lathe, sensitive drilling machine, boring machine, gear cutting machine, grinding machine, hand screw machine, radial drilling machine, planing machine, milling machine, shaping machine, vertical drilling machine and turret lathe committees.

In the last session Mr. Charles E. Carpenter of E. F. Houghton Co., spoke on "The Value of the House Organ as an Advertising Medium." He outlined the history of the *Houghton Line* and the principles observed in its conduct, without giving conclusive statements as to the value of house organs to manufacturing concerns generally. The fact was made plain that, to be successful, a house organ must have a good organization, including editorial writers of exceptional ability and that the circulation list must be carefully selected.

The question of admitting the makers of woodworking machinery had been submitted to letter ballot, and the vote was against their admission, the opinion being that the woodworking machinery makers have to meet so many conditions out of common with these of the machine tool industry that there would be confusion and lack of harmonious action.

The committee on standardization was made permanent. Mr. L. P. Alford, editor of the *American Machinist*, reported on the progress of the investigation being made by the Bureau of Standards at Washington into the laws governing the behavior of metals beyond the limit of proportionality up to and including rupture. It is within this zone that all metal working machines act in changing the shape of metals, but comparatively little has been done scientifically to deduce the laws of action.

* * *

HYDRAULIC PRESS—PULLEY REAMING MACHINE

The illustrations show two homemade tools in the plant of the Cleveland Planer Works, Cleveland, Ohio, the first being a portable hydraulic press and the second a pulley reaming machine. The hydraulic press consists of a wheeled base containing the ram and carrying the hand pump and two uprights with a cross-rail at the top. The ram will safely exert a pressure of 100 tons, and, of course, has sufficient capacity for assembling all ordinary press fits met with in machine tool building. It is used also for straightening shafts. Being portable, the press is taken to the work when it is more convenient than to transport the work to the press.

The pulley reaming machine consists of a low cast-iron base supporting the table and enclosing the reaming spindle which runs in an oil bath. The bevel gears and pulley shaft also are immersed in the oil bath, thus providing lubrication for all running parts from one reservoir, by a simple construction that is practically proof against leakage and drip. The table carries the pulley dogs, these being two stationary uprights on opposite sides of the spindle.

The reamers have square shanks fitting the square socket in the vertical spindle and enter the pulley bore from the under side. The pulley is restrained from turning by the two uprights or dogs and "feeds" down by its own weight only, the pressure of the spokes against the uprights tending to keep the feed from being too rapid.

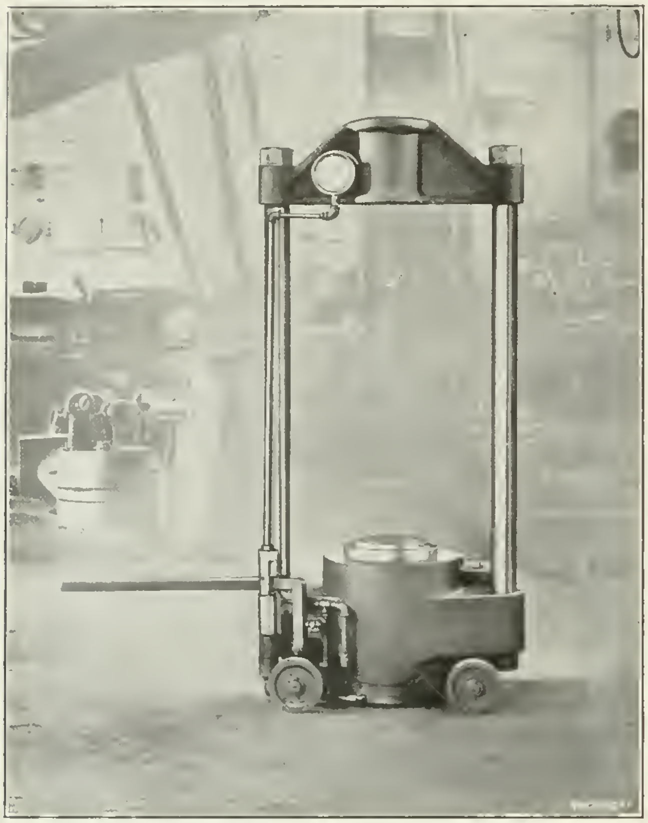


Fig. 1. Portable Hydraulic Press made and used by Cleveland Planer Works

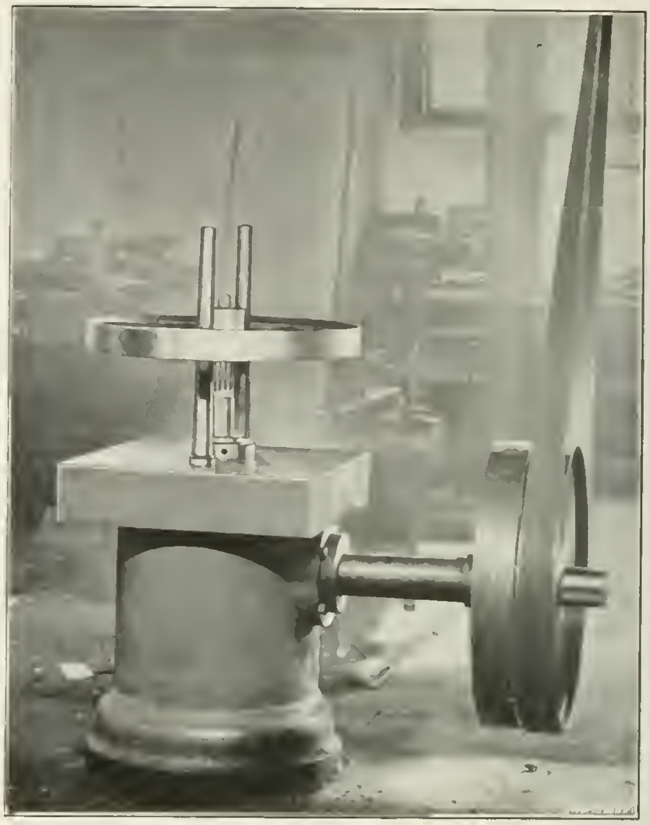
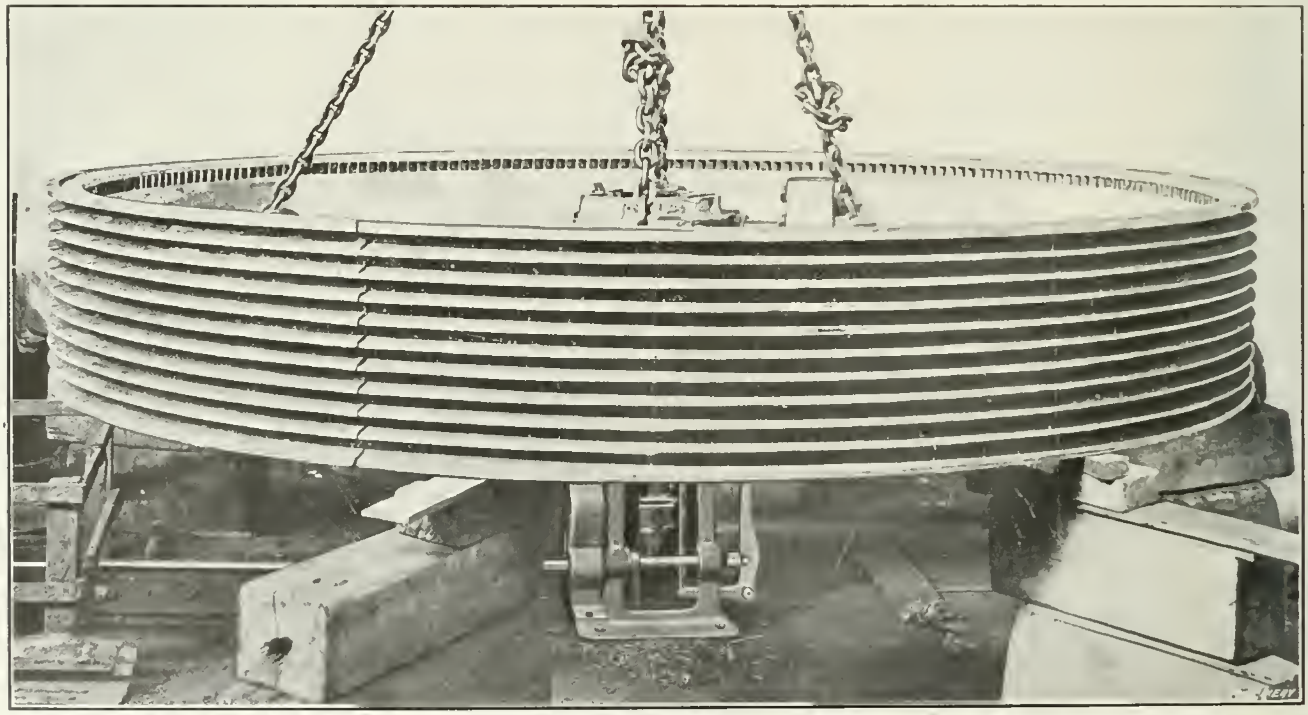


Fig. 2. Pulley Reaming Machine made and used by Cleveland Planer Works

KEYSEATING LARGE PULLEY IN AN INDIAN SHOP

The keyseating job illustrated herewith is of considerable interest because of the great difference between the size of the pulley and the machine. The casting is a large rope pulley which weighs ten and one-half tons, whereas the keyseating machine weighs only about one ton. The keyway cut is 2½ inches wide, and the machine used for cutting it was built by Mitts & Merrill, 843 Water St., Saginaw, Mich. The cutting of such a large keyseat on a machine of this size, to the required degree of accuracy, is made possible by the method of supporting the work and guiding the tool. The bored hub fits over a vertical post which forms a part of the machine, and this


Cutting Keyway in Hub of 10 1/2-ton Rope Pulley

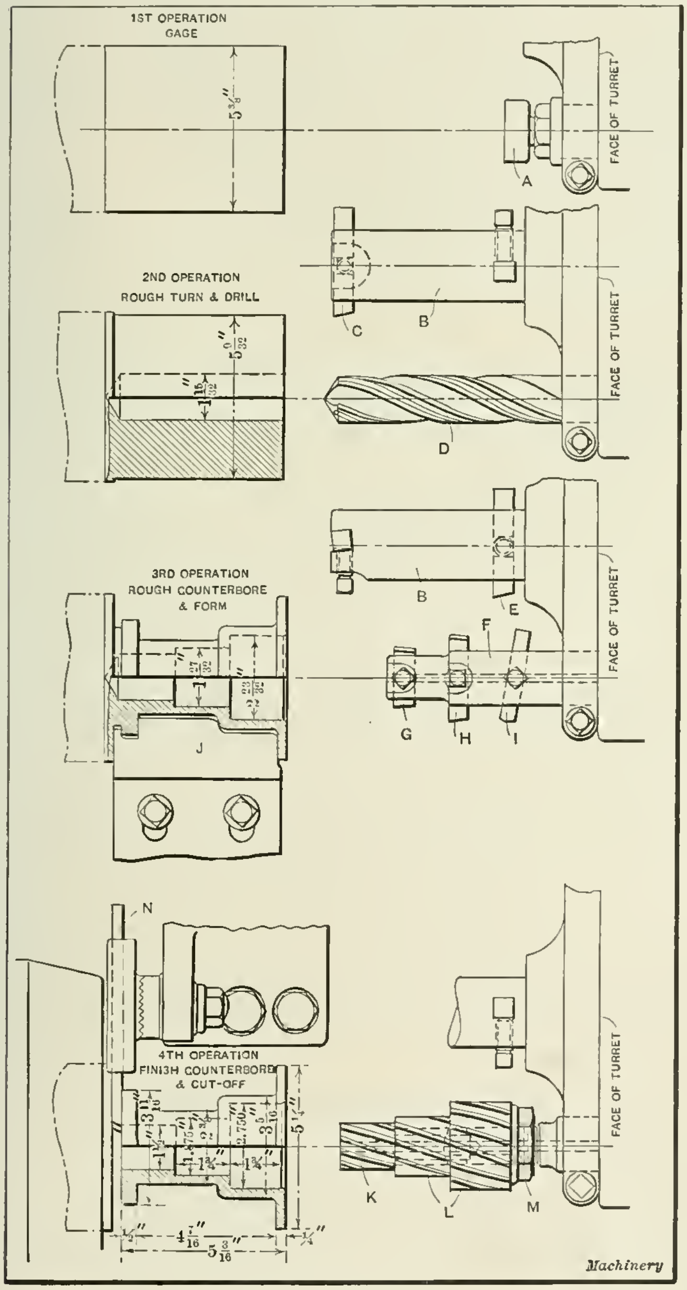
post is provided with a groove in which the cutter operates. The advantage of this construction is that the keyway is cut with reference to the bore, and the cutter has a positive and rigid support. Locating the pulley by the bore also makes it unnecessary to have the hub faced true, as far as cutting the keyway is concerned. This machine has a maximum stroke of nineteen inches and the stroke can be decreased to suit the length of the work. The cutter has a quick-return movement which is twice as fast as the cutting speed. It also has an automatic relief on the return stroke.

The photograph of this keyseating operation was received from Messrs. Burn & Co., Ltd., Bengal, India. This firm is said to be the largest engineering and shipbuilding concern in the Far East.

* * *

MACHINING CLUTCH HUBS IN A CLEVELAND AUTOMATIC

The different machining operations for producing motor car clutch hubs on a 6-inch standard model Cleveland automatic, are shown by the accompanying diagrams. These hubs are made of 14 point carbon, open-hearth steel and from rough bar stock. The first operation is feeding out the stock and gaging it to length by means of a stop-gage *A*, which is mounted in the No. 1 hole of the turret.



Successive Operations for Producing Motor Car Clutch Hub in Cleveland Automatic

During the second operation, the entire length of the clutch hub is rough-turned by an overhanging turning attachment *B*. A central hole is also drilled with a 1 15/32-inch high-speed oil-feed drill *D*, which is carried in the No. 2 turret hole. The turning tool *C* is made from square stock, and the cutting edge is formed by simply grinding the end. The holder that carries this tool is fastened against the face of the turret and is clamped around the stems of all the other tools, which gives a very rigid support.

The third operation consists of rough-counterboring, chamfering, forming the outside, and finishing the periphery of the large flange at the outer end of the hub. The rough-counterboring is done by two tools mounted in boring-bar *F*, which is provided with an oil feed. The forward tool *G* bores a 1 27/32-inch hole and tool *H*, a 2 23/32-inch hole. The rear tool *I* chamfers the outer edge of the larger hole, as shown. The finishing tool *E*, mounted in the overhanging turning attachment *B*, takes a finishing cut over the large flange. The flat forming tool *J*, which is mounted on an adjustable toolpost on the front of the cross-slide, forms the outside of the clutch hub at the same time that the tools previously referred to, are in operation.

The fourth operation is that of finish-counterboring. The tool for this work is of a three-step form, provided with an oil feed. This counterbore is not made of one piece, but is composed of three separate tools. The advantage of this construction is that if one tool wears out before the rest, it can be replaced, whereas, if the entire tool were solid, it would be difficult to grind and expensive to reproduce. The smallest part *K* has a taper shank with a tang similar to an end-mill. The part *L* is locked by a square key and is backed up by a nut *M*; it has longitudinal adjustment to compensate for grinding the front faces.

The cutting-off operation, which comes next in order, starts before the work of the finishing counterbore is completed, and the cutting off is half finished at the time this counterbore is withdrawn; then the cutting-off tool severs the piece from the bar.

The time for each of these operations is as follows: 1. Gaging to length (takes place during the idle movement of the machine). 2. Drilling and rough-turning, 9 minutes. 3. Rough-counterboring, forming and finishing large flange, 12 minutes. 4. Finish-counterboring, 4 minutes. 5. Cutting off, 4 minutes 26 seconds. Idle movement of machine, 50 seconds. Total time for each hub, 30 minutes 16 seconds.

These clutch hubs are machined accurately to size and require very little extra work after being severed from the bar. The actual labor cost is about five dollars per hundred. The simple design of tools used for these operations is an important feature, especially in the production of pieces of this kind in large quantities. Forming tool *J* is a high-speed steel tool and both ends are the same, although the engraving only shows one end. With this arrangement, if one end is worn to such an extent that it needs replacement, after a large number of parts have been made, it is simply necessary to turn the tool around and use the opposite end. The cutting-off tool is a strong, straight blade, which can be adjusted in a few minutes after grinding, and all of the tools are rigidly mounted.

* * *

The American Society of Engineer Draftsmen held its regular monthly meeting in the Engineering Societies Bldg., May 16. A paper was read by Mr. R. E. Boehck of Evansville, Ind., on "The Development of Logging Machinery," and Mr. F. F. Nickel of the Worthington Pump Co. delivered a lecture on "Practical Applications of the Slide Rule." The meeting was especially interesting on account of the fact that Miss Marie Oberlander, student of architectural drawing at Teachers College, Columbia University, was admitted to junior membership. Miss Oberlander is the first woman to be elected as a member of the society.

* * *

Within the past decade concrete has become one of the most important of building materials, but unless properly mixed with standard materials it is hardly ever satisfactory. Mr. Leonard C. Wason, president of the Aberthaw Construction Co., states that in his opinion five per cent taken out of the proper cost of a concrete building decreases its value one-half.

SEVENTEENTH ANNUAL MEETING OF THE N. A. M.

The National Association of Manufacturers held its seventeenth annual meeting at the Waldorf-Astoria, New York City, May 20-22. At the first session the reports of the various committees, including those on consular reform, bankruptcy, merchant marine, and union labor were presented. One of the most valuable features of the convention was the exhibition of safety appliances and the special motion picture exhibit which illustrated in a clear and interesting manner the methods of accident prevention. The exhibition of safety appliances consisted of a large number of working models, and two thousand photographs lent to the society for the occasion by the Wisconsin State Industrial Commission and the U. S. Steel Corporation. A model ten feet long of an ocean liner with full lifeboat equipment was exhibited by the Hamburg-American line, and a full-sized installation of a submarine bell signaling system, with both sending and receiving apparatus, was shown.

Four films of moving pictures relating to accident prevention were shown, the first being of the general dramatic moving picture type, illustrating the disregard of safety appliances which is frequently met with among experienced workmen, and showing the fatal results. Another film showed the practical application and use of safety appliances on many machines in the plant of the Brown & Sharpe Mfg. Co., Providence, R. I. These pictures illustrated probably better than could have been done by any other means the need for, and the application of, effective guards on machine tools. Incidentally, one was impressed with the great field for moving pictures for educational purposes, not only as regards accident prevention, but as regards machine operation in general.

Another film showed methods adopted in large factories for safeguarding the employes in case of fire. Typical fire drills were exhibited showing hundreds of employes forming in line in perfect order and descending the fire-escapes from the third and fourth stories of a factory building. Since the deplorable Triangle Waist Factory fire, in New York City, fire drills have been made compulsory by law in the state of New Jersey, and these moving pictures were taken under actual working conditions at the regular fire drills. An interesting feature mentioned in connection with this exhibition of pictures was that in the case where fire drills are inaugurated, it is highly important to have an organized system for keeping the employes together and in order after they have left the building until they are ready to enter the building again, so that there may be no unnecessary loss of time. This applies to the fire drill as well as to an actual fire, which might be put out in a few minutes. In one case, it was stated that, in a factory employing eight hundred girls, the fire drill proved a success, as far as leaving the building in order was concerned, but no provision had been made for the method of re-entering the building, and it took several hours to again collect the working force! An interesting film submitted by the North German-Lloyd Steamship Co. showed a life-boat drill on board one of their liners.

There is a good reason for dwelling so long upon this exhibition of moving pictures, as it seems beyond question that accident prevention and the safeguarding of life and limb of industrial workers has become a matter to which all associations of manufacturers and engineers must give due attention. At the same time, there is probably no more effective means to illustrate to both the employers and employes the causes of accidents and the means for their prevention, than is offered by the moving picture machine. To the National Association of Manufacturers is due considerable credit for having given so much attention to this subject, and for having cooperated with the moving picture film makers in producing films of this character.

During the second day of the convention, one of the main addresses was that by Mr. John Kirby, Jr., president of the association. His address was largely devoted to a bitter and uncompromising attack directed partly against the initiative, referendum and recall, and partly against the National Civic Federation and the labor unions. Mr. Edward S. Beach read a paper on the "Influence of Patent Laws on the Development of Industries," in which he defended the present patent laws and voiced his objections to the provisions for compulsory working contained in two bills now before congress. One manufacturer, commenting upon the paper, stated that he believed that the bills containing clauses for compulsory working secured to the inventor all that was intended to be secured by the patent law, and that such provisions did not involve additional hardship to inventors. Addresses were also made by Mr. James A. Emery, on "Legislation and Business," and by Mr. Franklin H. Wentworth on "Fire Prevention."

During the afternoon session, May 21, papers were read by Mr. Frank E. Law, on "Workmen's Compensation for Accidents," and by Mr. Walter E. Edge, on "Workmen's Compensation." Mr. Henry Weismann read a paper on "Immigration, Its Value to the Country, Past, Present and Future."

During the last day of the convention, addresses were made by Mr. Irving T. Bush, on "Currency Reform"; by Mr. M. L. Stewart, on "Trade Possibilities of the Philippine Islands and the Far East"; by Mr. W. M. Benney, on "The National Association of Manufacturers and its Work for Export Trade," and by Mr. C. A. Conant, on "The Panama Canal in Relation to Commerce and Transportation." Moving pictures showing the progress on the Panama Canal were shown. A banquet was held on the evening of May 22, which marked the conclusion of the convention.

The following officers were elected for the year: President, John Kirby, Jr., Dayton, Ohio; secretary, George S. Boudinot, New York; treasurer, A. B. See, New York; assistant treasurer, J. P. Bird, New York.

* * *

CONSOLIDATION OF THE HORTON CHUCK COMPANIES

S. E. Horton Machine Co., Windsor Locks, Conn., and E. Horton & Son Co., of the same place, manufacturers of lathe chucks, have been consolidated through the sale of stock owned by Ezra B. Bailey to interests affiliated with Stoddard Ellsworth Horton, the president and treasurer of the S. E. Horton Machine Co. Mr. Horton will be president, treasurer and general manager of the combined companies.

The E. Horton & Son Co. was started sixty-two years ago by Eli Horton, the inventor and patentee of the first geared universal chucks. Mr. Horton developed original methods of manufacture and made his product known for excellence throughout the manufacturing world. His grandson, S. E. Horton, was identified with the E. Horton & Son Co. beginning 1891 and was superintendent of the plant from 1896 to 1905. He left the company a few years ago and organized an independent company of which he was president and treasurer. The consolidation of the Horton chuck companies will make conditions favorable for a much stronger and more effective business organization.

* * *

REORGANIZATION OF THE WALTHAM WATCH TOOL CO.

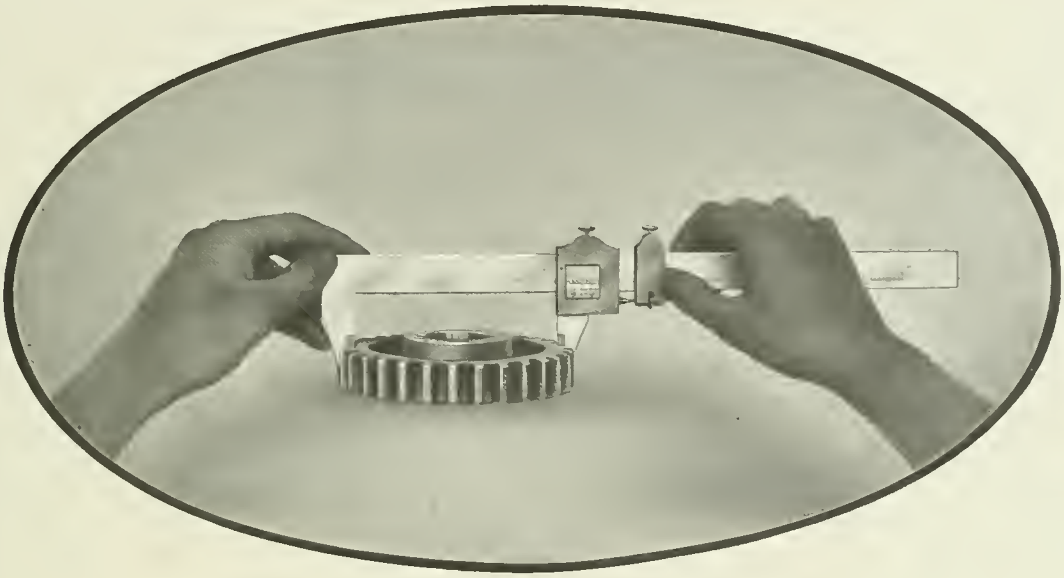
The Van Norman Machine Tool Co., Springfield, Mass., is a new corporation organized to take over the business and property of the Waltham Watch Tool Co., of that city. The authorized capital stock is $400,000, and the incorporators are: Frank H. Page, Clarence J. Wetsel, Charles E. Van Norman and Fred D. Van Norman, all of Springfield. Mr. Page, who is president of the National Equipment Co., will be president of the reorganized company; Mr. Wetsel, formerly manager of the Baush Machine Tool Co., of Springfield, will be treasurer; Charles E. Van Norman, vice-president; and Fred D. Van Norman, secretary. The Van Normans founded the Waltham Watch Tool Co. about eleven years ago, in Waltham, Mass.

The company will continue to manufacture the Van Norman milling machines, universal bench lathes, bench milling machines, internal grinding machines and other tools and accessories that have become well known during the past few years.

* * *

When springs are used for producing certain movements in quick succession, the strength of the springs should be from two to three times what would be required to produce the same movements at a slow speed.

A new adaptation of an old tool for determining accurately the depth of gear teeth



VERNIER CALIPER NO. 687

Measuring the bottom diameter of gears provides an accurate check on the cutting operation and insures the duplication of any desired standard.

This tool, therefore, is found especially valuable in the Automobile Shop for measuring automobile transmission gears, and in fact for measuring the bottom diameter of any gear where it is impossible to use our regular vernier calipers on account of the thickness of the jaws.

Outside of the measuring jaws this tool is exactly like our 12" vernier caliper, and can be used as such.

Write for further information.

BROWN & SHARPE MFG. CO.
PROVIDENCE, R. I., U. S. A.

PERSONALS

George B. Pickop, formerly master mechanic of the American Hardware Co., has entered the employ of the Universal Screw Machine Co., Hartford, Conn., as general superintendent.

Henry G. Dreses, president of the Dreses Machine Tool Co., Cincinnati, Ohio, sailed for Europe May 25. Mr. Dreses will make a tour of European manufacturing countries in the interests of his concern.

C. A. Nourse has resigned as general superintendent of the American-LaFrance Fire Engine Co., Elmira, N. Y., to become superintendent of the Reed-Prentice Co., of Worcester, Mass. He assumed his new duties June 1.

George Bradshaw has been appointed general safety agent of the New York Central & Hudson River Railroad Co. He will have his headquarters at New York, reporting to the general claims attorney and to the general manager.

Douglas T. Hamilton, associate editor of MACHINERY, has been made Western editor with headquarters in the Monadnock Block, Chicago, Ill. Mr. Hamilton will travel in the machine tool building territory west of Pittsburg and Erie.

H. W. Kreuzburg, president of the Champion Tool Works Co., Cincinnati, Ohio, sailed May 25 on the *Cincinnati* for a four months' trip in Europe in the interests of his company, taking in Great Britain and the Continental manufacturing countries.

J. C. Dufresne, formerly in charge of the speed and rate setting departments of the Providence Engineering Works, Providence, R. I., has resigned to become factory engineer and mediator for the Aurora Automatic Machinery Co., Aurora, Ill.

J. E. Fries, engineer with the Cutler-Hammer Mfg. Co., Ampere, N. J., has been transferred to the San Francisco office as Pacific Coast engineer, where he will be able to render prompter service to the rapidly growing business of the company on the Pacific Coast.

Duncan H. Macdonald has resigned as general manager and superintendent of the Southern Engine & Boiler Works, Jackson, Tenn. Frank W. Milbourn has been elected to succeed Mr. Macdonald as general manager, and H. M. Harris has been appointed superintendent.

Emile A. Tordet, manager of the Italian branch of Fenwick Freres & Co., of Paris, Turin, Liege, etc., is on a two-months' business trip in the United States to visit the firms represented by his concern in Italy. His address while in the United States is care of Brown & Sharpe Mfg. Co., Providence, R. I.

W. S. Quigley has withdrawn from the Rockwell Furnace Co., New York City, of which he was vice-president and general manager since the formation of the company. Mr. Quigley has formed the Quigley Furnace & Foundry Co., 50 Church St., New York, to carry out some advanced ideas in furnace construction.

Ezra B. Bailey of Windsor Locks, Conn., who recently sold out his entire interest in E. Horton & Son Co., of Windsor Locks, had been connected with the company for thirty-two years. He became treasurer and general manager of the company in 1880 and has been in the chuck business longer, with one exception, than any other man now engaged in it.

George I. Keyes (W. P. I. '97) has retired from the management of the Reed Foundry Co., Worcester, Mass., with which he was connected since it was first established in 1901. For the present Mr. Keyes will take a much needed rest and vacation. He was formerly a member of the firm of Keyes & Woodbury, Worcester, Mass.

John Harland Nelson has been elected professor of applied mechanics by the trustees of the Worcester Polytechnic Institute, Worcester, Mass., to succeed the late Prof. Edward L. Hancock. Prof. Nelson has been at the head of the department of applied mechanics, Case School of Applied Science, Cleveland, Ohio, for the past three years, and is a graduate of the South Dakota State College.

A. Bradley Burgess (W. P. I. '01) has been appointed general manager of the Standard Plunger Elevator Co., Worcester, Mass. Mr. Burgess, upon graduation from the Worcester Polytechnic Institute, became an estimating engineer, following which he filled the positions as sales manager, local manager and now that of general manager. Since he assumed control, the main offices have been removed from 115 Broadway, New York, to Worcester. The treasurer's office of the company will remain in New York.

W. H. Sherwin, for the past ten years Northwestern representative of Joseph T. Ryerson & Son, Chicago, located at Minneapolis, has resigned his position, and will become general manager and vice-president of the Alberta-American Ornamental Iron Co., of Redcliffe, Alberta. This concern is successor to the American Ornamental Iron & Steel Co., of Minneapolis, Minn., a well-known concern that is moving its entire plant to Redcliffe where it expects to add to its already large equipment and thus put the concern in a position to handle the business of that rapidly developing country.

John W. Hill, mechanical engineer, has resigned from the Brown & Sharpe Mfg. Co., Providence, R. I., to become sales engineer with the Bantam Anti-Friction Co., Bantam, Conn. Mr. Hill has a wide experience as mechanical engineer, having been connected with the General Electric Co., Westinghouse Electric & Mfg. Co., and the American Locomotive Co., at Providence. He was also associated several years ago with Mr. W. S. Rogers, president of the Bantam Anti-Friction Co., at the Watervliet Arsenal, in the design of heavy machinery for building the big guns for coast defense purposes, and is, therefore, well equipped for the position he now holds.

* * *

OBITUARY

Hugh Addison Reed, president of the Baird Machinery Co., Pittsburg, Pa., and one of the most prominent machine tool men in the Pittsburg district, died at his home 1232 Sheffield St., N. S., April 25, aged fifty-eight years. Mr. Reed was a native of Pittsburg, having been born in the old city of Allegheny, and spent his entire life in that vicinity. Although he had not been in good health for the past year, his death came as a shock to his many friends. He was one of the first to represent the machine tool business in Pittsburg, becoming interested in it at an early age. Mr. Reed was a member of the Engineers' Society of Western Pennsylvania, and Technischer Verein, and was well known by the machine tool builders throughout the country.

* * *

COMING EVENTS

June 12-14.—Annual convention of the American Railway Master Mechanics' Association at Atlantic City, N. J.

June 17-19.—Annual convention of the Master Car Builders' Association at Atlantic City, N. J.

June 17-22.—First annual gas engine show under the auspices of the National Gas Engine Association in the Auditorium, Milwaukee, Wis. Albert Stritmatter, secretary, Cincinnati, Ohio.

June 27-29.—Summer meeting of the Society of Automobile Engineers, Detroit, Mich., Hotel Pontchartrain, headquarters. Coker F. Clarkson, secretary, 1786 Broadway, New York.

July 9.—Annual convention of the American Railway Tool Foremen's Association in Chicago. H. L. Miller, secretary of the supply association, 835 Monadnock Bldg., Chicago, Ill.

August 20.—Annual convention of the International Railroad Master Blacksmith's Association at Hotel Sherman, Chicago, Ill. J. E. Carrigan, Rutland Railway, Rutland, Vt., chairman of the executive committee.

September 2-7.—Sixth congress of the International Association for Testing Materials at the Engineering Societies Building, 29 W. 39th St., New York. H. F. J. Porter, secretary, 1 Madison Ave., New York.

September 24-26.—Annual convention of the American Foundrymen's Association and allied bodies, in Buffalo, N. Y.; Hotel Statler, headquarters. Richard Moldenke, Watchung, N. J., secretary.

October 7-11.—Annual convention of the American Electric Railway Association and allied associations in Chicago, Ill. The exhibit will be at Dexter Pavilion, 43d and Halstead Sts. H. C. Donecker, secretary treasurer, 29 W. 39th St., New York.

NEW CATALOGUES AND CIRCULARS

Richard Dudgeon, Broome and Columbia Sts., New York, manufacturer of hydraulic jacks, hydraulic punches, and roller tube expanders. Booklet entitled, "Some Mathematical Recreations."

Gem Mfg. Co., Pittsburg, Pa. Catalogue No. 6 of steel and brass oilers, torches, oil carriers, tallow pots, flue scrapers, foundry chaplets, loose pulley lubricators, flexible shafts, portable drills, center grinders, clamp spindles, universal joints, electric polishing machines, stop clutches, etc.

Conover Overkamp Machine & Tool Co., Dayton, Ohio (successors to Miami Valley Machine Tool Co.). Catalogue of lathes and No. 1 grinder comprising 14-inch standard lathe; 16-inch standard lathe; 16-inch lathe, double back geared; plain turning lathe; and universal cutter and tool grinder, illustrating applications to various forms of cutters.

Egbert R. Morrison, Sharon, Pa. Circular of the "Morrison" water-tube boiler of the type consisting of cylindrical shells connected by water-tubes, there being two shells above and two below connected by tubes and surrounded by brick work which is provided with baffle-plates insuring thorough circulation of the hot gases over the heating surface.

Rochester Boring Machine Co., Rochester, N. Y. Sixteen-page catalogue, 8 by 10 inches, on floor type and table type boring machines. The machines are illustrated and details of construction are shown in line illustrations and halftones. Special tables and attachments are also shown.

Rockford Dailling Machine Co., Rockford, Ill. Booklet entitled "Jigging and Tooling." This booklet illustrates and describes how the Rockford gang drills built by this company may be used to best advantage in manufacturing work. A number of examples from practice giving detailed data of possibilities in production form the basis of the contents.

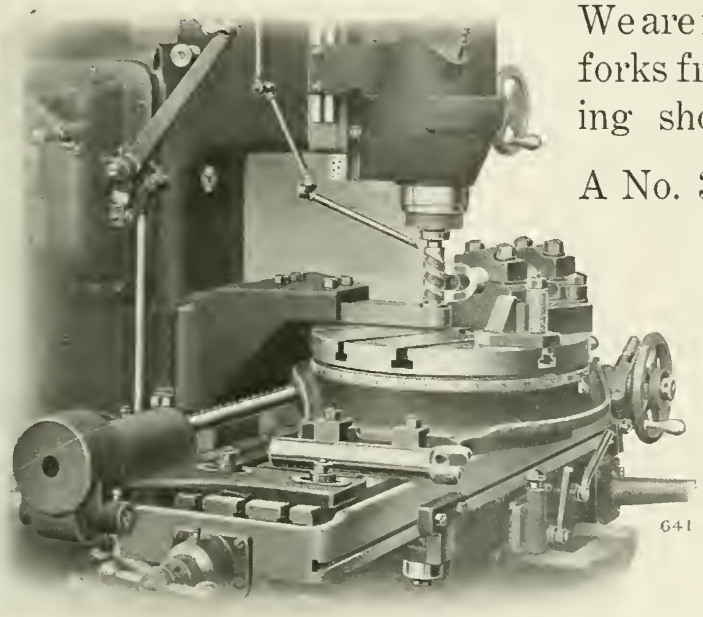
E. T. Copeland Co., 100 William St., New York. Booklet entitled "Circulation of Water in Steam Boilers," containing a general treatise on circulating devices and especially on the Copeland patent automatic circulating system, describing its general construction, how it works, what it accomplishes, etc. The text matter of the booklet is clearly illustrated by engravings.

Hess-Bright Mfg. Co., 2111 Fairmount Ave., Philadelphia, Pa. Pamphlet entitled "Ball Bearings in Woodworking Machinery," illustrating a large variety of woodworking machinery to which ball bearings have been successfully applied; also showing the approved construction of ball bearing mountings adapted to the peculiar conditions in woodworking machinery.

Hyatt Roller Bearing Co., Newark, N. J. Miniature bulletin 400 C of twenty pages on roller bearing line shafting boxes. Data of tests made by the United Shoe Machinery Co., showing a large saving in power, are included; also data on a test made by the American Can Co. A price-list is given of Hyatt standard line-shaft bearings and extra heavy main shaft bearings, and dimensions of Hyatt standard boxes, etc.

Makutchan Roller Bearing Co., 1541-42 McCormick Bldg., Chicago, Ill. Catalogue of roller bearings and roller bearing hangers. The principle of the Makutchan roller bearing is illustrated and described and tables of sizes and price lists of roller bearings, roller bearing hangers of various types, and thrust ball bearings are given. A number of halftone illustrations are included, showing views of installations where the Makutchan bearings are used.

Time Per Piece—7 Minutes

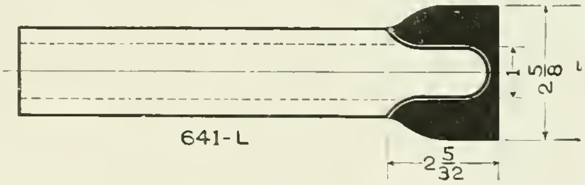


We are now cutting our universal shaft forks from solid steel bars. The drawing shows them ready for milling.

A No. 3 Vertical with a 20" Circular Attachment forms up the outside at one setting and at one cut.

This is possible because all feeds are set and controlled from the front of the knee without stopping. A combination of table, cross and circular feeds is used.

Speed, 94 Revolutions.
Feed, 2 1-4" per minute.
Time per piece, 7 minutes.



The next operation consists of milling out the fork for the ball seat. There are two fixtures. While the operator is filling one, the other piece is being milled. Time for this cut, one minute.

You will notice that the cutter is different from the usual end mill—suggests some of our advanced ideas in cutter design.

We are pretty far ahead in everything that relates to milling.

Ask for our New Examples of Modern Milling Practice.

The Cincinnati Milling Machine Co.

Cincinnati, Ohio, U. S. A.

EUROPEAN AGENTS—Alfred H. Schutte, Cologne, Berlin, Brussels, Milan, Paris and Barcelona. Donauwerk Ernst Krause & Co., Vienna, Budapest and Prague. Sam Lagerlofs, Stockholm, Sweden. Axel Christiernsson, Abo, Finland. Chas. Churchill & Co., London, Birmingham, Manchester, Newcastle-on-Tyne and Glasgow. CANADA AGENT—H. W. Petrie, Limited, Toronto, Montreal and Vancouver. AUSTRALIAN AGENTS—Thos. McPherson & Son, Melbourne. JAPAN AGENTS—Andrews & George, Yokohama. CUBA AGENT—Krajewski-Pesant Co., Havana. ARGENTINE AGENTS—Robert Pusterla & Co., Buenos Ayres.

Skinner Chuck Co., New Britain, Conn. 1912 catalogue and price list covering independent, universal and combination lathe chucks; drill chucks; planer chucks; faceplate jaws; drill press vises and reamer stands. A new line has been added to the products of this company, consisting of all-steel independent lathe chucks and all-steel faceplate jaws. The catalogue gives complete tabulated dimensions and price lists of all the tools illustrated and described.

Lincoln-Williams Twist Drill Co., Taunton, Mass. Catalogue of carbon and high-speed steel twist drills, reamers and milling cutters; also arbors, disks, countersinks, mandrels, saws, sockets and sleeves, taps and dies. The catalogue includes a number of tables of general value on cutting speeds, decimal equivalents of listed sizes, dimensions of Morse taper shanks, dimensions of Brown & Sharpe taper shanks, drill feeds and speeds, melting points of the elements, and tap drill sizes.

Watson-Stillman Co., 192 Fulton St., New York. Catalogue No. 83, entitled "Hydraulic Benders," covering 64, 6- by 9-inch pages, and illustrating and describing hydraulic and motor-driven rail benders; shaft straighteners for lathes; portable shaft straighteners; straightening presses; pipe benders; axle straightening presses; bar straighteners; hydraulic shaft straightening presses; plate straightening and forming presses; beam bending presses; strake benders; crank pin presses; bending jacks, etc.

Eugene Dietzgen Co., 214-220 E. 23d St., New York. Circular illustrating the "Dietzgen" economy box for storing blueprints, drawings, tracing paper, etc. The box is especially adapted for the storing and preservation of blueprint paper, the construction being such that light is excluded. Provision is made for measuring and cutting off the paper to the exact required length. This feature of economy means a substantial saving in almost any drafting-room using blueprint paper, tracing paper and other paper in rolls.

Yale & Towne Mfg. Co., 9 Murray St., New York. Catalogue No. 12-D, 1912, of chain blocks, electric hoists, trolleys and cranes. This catalogue, containing 96, 6 by 9-inch pages, illustrates and describes in detail the various types of hoisting devices built by the company. Constructional features are plainly illustrated and carefully described and parts and details are numbered and named so as to make it easy to order duplicate parts. All dimensions necessary for preliminary layouts are included, making the book, in general, valuable for the designing engineering and manufacturer.

National-Acme Mfg. Co., Cleveland, Ohio. Booklet entitled "Parts for the Trade," illustrating a large number of specialties made on National-Acme automatic screw machines to customers' specifications and to order only. The parts shown comprise spark plugs, automobile engine parts, special screws and nuts, carbureter and magneto parts, sundry accessories, lubrication parts, motorcycle parts, heavy machinery parts, screws, bushings, nuts, etc., for speedometers, cyclometers, indicators, typewriters, phonographs, sewing machines, washing machines, hardware, tools, plumbing supplies, gas appliances, locomotives, cars, etc.

Westinghouse Electric & Manufacturing Co., East Pittsburg, Pa. Descriptive leaflets No. 2303, Direct-current Crane Motors; Nos. 2313, 2314, and 2315, Commutating Pole Mine Motors; No. 2368, Strap Wound Armature Coils of Westinghouse Railway Motors; No. 2370, Details of Railway Motors; No. 2376, Box Frame Interpole Railway Motor for use on 600- to 1200-volt service; No. 2377, Box Frame Interpole Railway Motor for Locomotive Work; No. 2393, Dynamotor-Compressor for 1200- to 1500-volt Direct-current Service; No. 2444, Equalizer Flywheel Hoisting Sets; No. 2464, Rheostats for Direct-current Motors.

Standard Machinery Co., Providence, R. I. Catalogue, eighth edition, on drop presses, comprising plain drop presses in eight sizes with hammers weighing from 60 to 800 pounds; power lifters for plain drop presses for 40- to 1000-pound hammers; automatic drop presses in eight sizes with hammers weighing from 50 to 1200 pounds. A valuable chapter on foundations is included illustrating the construction of approved forms. The company also builds trimming presses, roller bearing and plain bearing rolling mills, rotary swaging machines, wire-drawing machinery, roller bearings, ball bearings and special machinery.

J. H. Williams & Co., 61 Richards St., Brooklyn, N. Y. Catalogue of drop-forged wrenches for all uses, spanners, wrench sets for automobilists, "Ratcho" wrenches, lathe dogs of the safety and ordinary forms, C-clamps, machinists' clamps, strap clamps, external caliper gages (unfinished), machine balanced handles, toolpost fittings, thumb nuts, eye-bolts, swivels, hoist hooks, rope sockets, rod ends, yoke ends, shafting collars or bushings, key forgings, weldless pipe ferrules and flanges, chain pipe vises, chain pipe wrenches, crankshafts, connecting rods, valve stem forgings, levers, etc. The company makes drop forgings of iron, steel, copper, bronze and aluminum. The front cover of the catalogue is double, bearing on the front face a drop-forged engineer's wrench with the "flash." The second cover shows the trimmed wrench, the opening in the front cover having the effect of a trimming die used for removing the flash of drop-forgings. The design is unique and peculiarly appropriate.

Wiener Machinery Co., 50 Church St., New York. Catalogue of Ernst Schiess, Ltd., Dusseldorf, Germany, builder of heavy machine tools. This well-known German concern has built some of the largest machine tools in the world as, for example, a turning and boring mill with table 36 feet 1 inch diameter, weighing approximately 660,000 pounds. The catalogue illustrates the works' interior, erecting shop, heavy type roughing lathes, "sliding and surfacing lathe" for turbine shafts, turning lathe for turbine shafts, turning lathe for large turbine shafts and drums, weighing 732,600 pounds, heavy roll roughing lathe, hollow boring lathe, turning and boring lathe, turning and boring mill, portable boring mill, planing and milling machine, standard type planing machine, pit planing machine, transverse planing machine, shaping machine, triple slotting machine, combined slotting and drilling machine, universal radial drilling machine, horizontal boring and milling machine, cylinder boring machine, double punch press, bending machine, horizontal cold saw, etc.

Cincinnati-Bickford Tool Co., Oakley, Cincinnati, Ohio. Catalogue of "Cincinnati" heavy pattern upright drilling and tapping machines, comprising 20-inch high-speed sliding head drill, square or round table and hand or power feed, with or without tapping attachment, belt or motor drive; 21-inch stationary head, heavy pattern drill, with and without back gears, belt or motor drive; 21 inch sliding head, heavy pattern drill with and without tapping attachment; 24- to 42-inch regular heavy pattern drill, with and without tapping attachment, belt or motor drive; 24- to 36-inch, special pattern drill with geared tapping attachment; 20-inch high-speed sliding head gang drill, furnished with two to six spindles, each with or without tapping attachments and with or without power feed; and 21- to 42-inch heavy pattern gang drill with four spindles. The details of table equipment are illustrated; also right angle drive, belted motor drive, geared motor drive, motor and speed-box drive, friction back gear and tapping attachment, feed box, depth gage, automatic trip, etc.

TRADE NOTES

Hill, Clarke & Co., Inc., has removed its Philadelphia office from 512 Arch St., to 1011 Chestnut St.

Cutler-Hammer Mfg. Co., Ampere, N. J., opened an office in the Title Insurance Bldg., in Los Angeles, Cal., April 1.

Niles-Bement-Pond Co., removed its Chicago offices from the Commercial National Bank Bldg. to the McCormick Bldg., 332 S. Michigan Ave., May 1.

Brown & Sharpe Mfg. Co.'s drafting-room gave a minstrel show and entertainment for the benefit of the "League for the Suppression of Tuberculosis," May 3.

Toledo Machine & Tool Co., Toledo, Ohio, has contracted for a three-story iron and brick building 90 by 115 feet which will be used in connection with the present business.

William Ganschow Co., Chicago, Ill., gear cutter, has taken another floor in the building now occupied, adding new machinery and increasing the capacity one-third. The company has also fitted up a finely equipped office.

Standard Roller Bearing Co., 50th St. and Lancaster Ave., Philadelphia, Pa., recently purchased and installed over $100,000 worth of additional machinery equipment to increase its facilities for the manufacture of ball and roller bearings.

Philadelphia Gear Works, 1120-1122 Vine St., Philadelphia, Pa., has established a special automobile service for local customers, thereby shortening local delivery time considerably, and also enabling the company to quickly place cut gears in the express companies' care when ordered from out of town.

Norton Co., Worcester, Mass., broke ground April 5 for a $100,000 administration and research laboratory building which will be situated between the present buildings and those of the Norton Grinding Co., facing on New Bond St. The new building is to be of brick, and will be three stories high, with a basement 98 by 157 feet.

Bignall & Keeler Mfg. Co., Edwardsville, Ill., manufacturer of Peerless, Duplex and P. D. Q. C. pipe threading and cutting machines, emery surfacers, die grinders and rolling cutters, has made an exclusive sales agency arrangement with Manning, Maxwell & Moore, Inc., for the sale of its machines throughout all the Eastern states.

Quigley Furnace & Foundry Co., 50 Church St., New York, has been formed by Mr. W. S. Quigley, formerly vice-president and general manager of the Rockwell Furnace Co., New York. The new company will carry out some advanced ideas in furnace construction and has secured the services of able furnace engineers who have been associated with Mr. Quigley for a number of years.

Billings & Spencer Co., Hartford, Conn., and Claire L. Barnes Co., Chicago, Ill., have discontinued the selling arrangements existing between them by mutual consent. In future the Billings & Spencer Co. will market its products of drop forgings and tools direct. During the past two years the company has more than doubled its manufacturing capacity, and its new plant at Dividend, Conn., devoted exclusively to the making of drop forgings, is now in full operation.

Cincinnati Electrical Tool Co., 652 Evans St., Cincinnati, Ohio, announces that it has just completed two sizes of universal drills which will operate on direct current as well as alternating current. Type OX2 will drill up to 3/16 inch in steel and hard wood and up to 3/8 inch in soft wood. Type OX3 will drill 1/4 inch in steel and hard wood and 1/2 inch in soft wood. The armature runs in ball bearings, and the gears are enclosed and run in grease.

Kelly Reamer Co.'s stockholders held their annual meeting at the company's office in Cleveland, Ohio, April 20 and elected Wm. E. Kelly, W. A. Calhoon, H. J. Maxwell, O. H. P. Davis, E. B. Jessup, George Bauer and Thomas A. Torrance, directors, who elected the following officers for the year; president and general manager, Wm. E. Kelly; vice-president, W. A. Calhoon; secretary, H. J. Maxwell; and treasurer, O. H. P. Davis. The company reports a large increase in business during the past year.

Joseph Tracy and Henry F. Donaldson have associated themselves as automobile engineers to undertake consultation, research and development work, design and construction, laboratory and road tests, and have removed the office which Mr. Tracy has maintained for several years at 116 West 39th St., to 1786 Broadway (cor. 58th St.), New York. The testing laboratory in New Jersey, near New York City, will be maintained as heretofore, and its facilities will be increased by additional equipment.

Stark Tool Co., Waltham, Mass., manufacturer of precision bench lathes and attachments, bench milling machines, watchmakers' lathes and fine tools completed its fiftieth year in business May 1. Since the business started it has not had a shutdown, lock-out or cessation of the regular work, beyond the regular yearly vacation of a week. The business was founded by John Stark who was succeeded by the present John Stark at his death. The company is the fourth oldest industry in Waltham, being antedated only by the Boston Mfg. Co., Davis & Farnum Co., and the Waltham Watch Co.

J. L. Osgood Tool Co., 121 Erie Co. Bank Bldg., Buffalo, N. Y., recently took over the business of J. L. Osgood, manufacturer of Osgood's indestructible tool handles. Several new types of indestructible handles have been added; also a line of black diamond hand tools, and the "junior class" indestructible file and tool handles. These handles will not split, having a steel-bound inner core which resists the splitting action of the file tang. A line of screwdriver handles made on the same principle has also been added, having hard wood handles with steel reinforced core and transverse scores on the grip, making a strong and powerful handle.

W. Robertson Machine & Foundry Co., 32 Greenwood Pl., Buffalo, N. Y., is a new concern recently organized under the laws of the state of New York with $15,000 capitalization, $12,000 of which is paid in. The officers are: W. Robertson, president and manager; T. J. Reed, vice-president; F. H. Keil, secretary; and F. M. Robertson, treasurer. The company will manufacture machine tool specialties, including a complete line of power hacksaws for all kinds of metal cutting, and special drilling machines. It will also manufacture, to order, gray iron pistons, cast within 0.005 inch of finished size by a new process which insures the wrist-pin holes being absolutely round and to the dimensions specified in the drawings, and produces a balanced piston which is very essential for quiet and serviceable motors. Mr. W. Robertson, the president of the company, has been a successful designer of tools and appliances, having placed over 1600 of his power hacksaws on the market. He was formerly connected with the Frontier Iron Works of Buffalo, N. Y.

Earle Gear & Machine Co., Stenton and Wyoming Aves., Philadelphia, Pa., was recently awarded a contract for one of the most interesting features in connection with the operation of the locks of the Panama Canal, that is, the mechanism which controls the collapsible hand-rails on the top of the various gates, forty in number. When these gates are closed a standing rail on each side serves to prevent persons from falling into the water. As the gates are opened to permit the passage of vessels, these rails are automatically collapsed or folded by means of a unique driving mechanism, motor operated. The worms, gears and screws for this device incorporate some very interesting engineering features. All parts are exceptionally heavy and the design of the entire outfit has been made with a view to quick operation and accessibility. There are eighty sets—forty right-hand and forty left-hand. Each gate is approximately seventy feet long, and some idea of the rugged construction necessary can be gained from consideration of this dimension. The company, to which the contract was awarded, is a specialist in the manufacture of work of this character; it recently produced a large number of lock-working mechanisms for the New York state barge canal.

Supplement to

Tables for Article in this number en

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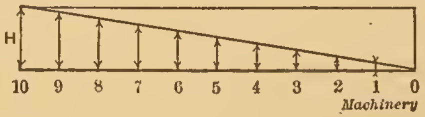
ORDINATES OF PARABOLAS FOR CRANE GIRDER DESIGN—I

H = end ordinate,
X = required ordinate,
N = number of equal spaces into which base line is divided,
M = number of equal spaces from 0 to required ordinate.



Then $X = H \times \frac{M^2}{N^2}$

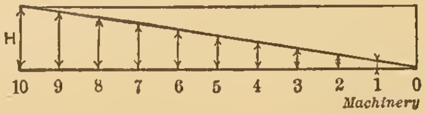
	Ordinates in Inches								
H	9	8	7	6	5	4	3	2	1
6	4 7/8	3 27/32	2 15/16	2 5/32	1 1/2	31/32	17/32	1/4	1/16
6¼	5 1/16	4	3 1/16	2 1/4	1 9/16	1	9/16	1/4	1/16
6½	5 1/4	4 5/32	3 3/16	2 11/32	1 5/8	1 1/32	19/32	1/4	1/16
6¾	5 15/32	4 5/16	3 5/16	2 7/16	1 11/16	1 3/32	19/32	9/32	1/16
7	5 11/16	4 15/32	3 7/16	2 17/32	1 3/4	1 1/8	5/8	9/32	1/16
7¼	5 7/8	4 21/32	3 9/16	2 5/8	1 13/16	1 5/32	21/32	9/32	1/16
7½	6 1/16	4 13/16	3 11/16	2 11/16	1 7/8	1 7/32	11/16	5/16	1/16
7¾	6 9/32	4 31/32	3 13/16	2 25/32	1 15/16	1 1/4	11/16	5/16	1/16
8	6 15/32	5 1/8	3 15/16	2 7/8	2	1 9/32	23/32	5/16	3/32
8¼	6 19/32	5 9/32	4 1/32	2 31/32	2 1/16	1 5/16	3/4	11/32	3/32
8½	6 7/8	5 7/16	4 5/32	3 1/16	2 1/8	1 3/8	3/4	11/32	3/32
8¾	7 3/32	5 19/32	4 9/32	3 5/32	2 3/16	1 13/32	25/32	11/32	3/32
9	7 9/32	5 3/4	4 13/32	3 1/4	2 1/4	1 7/16	13/16	3/8	3/32
9¼	7 1/2	5 15/16	4 17/32	3 9/32	2 5/16	1 15/32	27/32	3/8	3/32
9½	7 11/16	6 3/32	4 21/32	3 7/16	2 3/8	1 1/2	27/32	3/8	3/32
9¾	7 29/32	6 1/4	4 25/32	3 1/2	2 7/16	1 9/16	7/8	13/32	3/32
10	8 3/32	6 13/32	4 29/32	3 19/32	2 1/2	1 19/32	29/32	13/32	3/32
10¼	8 5/16	6 9/16	5	3 11/16	2 9/16	1 5/8	15/16	13/32	3/32
10½	8 1/2	6 23/32	5 5/32	3 25/32	2 5/8	1 11/16	15/16	13/32	3/32
10¾	8 11/16	6 7/8	5 1/4	3 7/8	2 11/16	1 23/32	31/32	7/16	3/32
11	8 29/32	7 1/32	5 13/32	3 31/32	2 3/4	1 3/4	1	7/16	1/8
11¼	9 1/8	7 3/16	5 1/2	4 1/16	2 13/16	1 13/16	1	7/16	1/8
11½	9 5/16	7 3/8	5 5/8	4 5/32	2 7/8	1 27/32	1 1/32	15/32	1/8
11¾	9 1/2	7 17/32	5 3/4	4 17/32	2 15/16	1 7/8	1 1/16	15/32	1/8
12	9 3/4	7 11/16	5 7/8	4 5/16	3	1 29/32	1 3/32	15/32	1/8

Contributed by Charles B. Gilbert

No. 156, Data Sheet, MACHINERY, July, 1912

ORDINATES OF PARABOLAS FOR CRANE GIRDER DESIGN—II

H = end ordinate,
X = required ordinate,
N = number of equal spaces into which base line is divided,
M = number of equal spaces from 0 to required ordinate.



Then $X = H \times \frac{M^2}{N^2}$

		Ordinates									
H		9		8	7	6	5	4	3	2	1
Ft.	In.	Ft.	In.	Inches	Inches	Inches	Inches	Inches	Inches	Inches	Inches
1	0		9 3/4	7 11/16	5 7/8	4 5/16	3	1 29/32	1 3/32	15/32	1/8
1	0¼		9 15/16	7 27/32	6	4 13/32	3 1/16	1 31/32	1 3/32	1/2	1/8
1	0½		10 1/8	8	6 1/8	4 1/2	3 1/8	2	1 1/8	1/2	1/8
1	0¾		10 5/16	8 5/32	6 1/4	4 19/32	3 3/16	2 3/32	1 1/8	1/2	1/8
1	1		10 17/32	8 5/16	6 3/8	4 11/16	3 1/4	2 3/32	1 5/32	17/32	1/8
1	1¼		10 9/16	8 15/32	6 1/2	4 25/32	3 5/16	2 1/8	1 3/16	17/32	1/8
1	1½		10 15/16	8 5/8	6 5/8	4 7/8	3 3/8	2 5/32	1 7/32	17/32	1/8
1	1¾		11 1/8	8 7/8	6 3/4	4 15/16	3 7/16	2 3/16	1 1/4	9/16	1/8
1	2		11 11/32	8 31/32	6 7/8	5 1/32	3 1/2	2 1/4	1 1/4	9/16	5/32
1	2¼		11 17/32	9 1/8	7	5 1/8	3 9/16	2 9/32	1 9/32	9/16	5/32
1	2½		11 3/4	9 9/32	7 3/32	5 7/32	3 5/8	2 5/16	1 5/16	19/32	5/32
1	2¾		11 15/16	9 7/16	7 7/32	5 5/16	3 11/16	2 3/8	1 5/16	19/32	5/32
1	3	1	0 5/32	9 19/32	7 11/32	5 13/32	3 3/4	2 13/32	1 11/32	19/32	5/32
1	3¼	1	0 11/32	9 3/4	7 15/32	5 1/2	3 13/16	2 9/16	1 3/8	19/32	5/32
1	3½	1	0 9/16	9 15/16	7 19/32	5 19/32	3 7/8	2 1/2	1 13/32	5/8	5/32
1	3¾	1	0 3/4	10 3/32	7 23/32	5 21/32	3 15/16	2 17/32	1 13/32	5/8	5/32
1	4	1	0 31/32	10 1/4	7 27/32	5 3/4	4	2 9/16	1 7/16	5/8	5/32
1	4¼	1	1 5/32	10 13/32	7 31/32	5 27/32	4 1/16	2 19/32	1 15/32	21/32	5/32
1	4½	1	1 3/8	10 9/16	8 3/32	5 15/16	4 1/8	2 5/8	1 15/32	21/32	5/32
1	4¾	1	1 9/16	10 23/32	8 5/32	6 1/32	4 3/16	2 11/16	1 1/2	11/16	5/32
1	5	1	1 25/32	10 7/8	8 11/32	6 1/8	4 1/4	2 23/32	1 17/32	11/16	5/32
1	5¼	1	1 31/32	11 1/32	8 7/16	6 7/32	4 5/16	2 3/4	1 9/16	11/16	3/16
1	5½	1	2 3/16	11 3/16	8 9/16	6 5/16	4 3/8	2 13/16	1 9/16	11/16	3/16
1	5¾	1	2 3/8	11 3/8	8 11/16	6 13/32	4 7/16	2 27/32	1 19/32	23/32	3/16
1	6	1	2 19/32	11 17/32	8 13/16	6 15/32	4 1/2	2 7/8	1 5/8	23/32	3/16

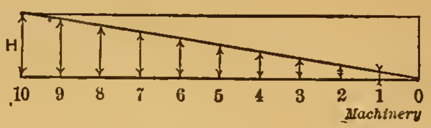
Contributed by Charles B. Gilbert

No. 156, Data Sheet, MACHINERY, July, 1912

ORDINATES OF PARABOLAS FOR CRANE GIRDER DESIGN—III

H = end ordinate,
X = required ordinate,
N = number of equal spaces into which base line is divided,
M = number of equal spaces from 0 to required ordinate.

Then $X = H \times \frac{M^2}{N^2}$



H	9	8	7	6	5	4	3	2	1
Ordinates									
Ft. In.	Ft. In.	Ft. In.	Inches	Inches	Inches	Inches	Inches	Inches	Inches
1 6	1 2 19/32	11 17/32	8 13/16	6 15/32	4 1/2	2 7/8	1 5/8	23/32	3/16
1 6 1/4	1 2 25/32	11 11/16	8 15/16	6 9/16	4 9/16	2 15/16	1 21/32	23/32	3/16
1 6 1/2	1 3	11 27/32	9 1/16	6 21/32	4 5/8	2 31/32	1 21/32	3/4	3/16
1 6 3/4	1 3 3/16	1 0	9 3/16	6 3/4	4 11/16	3	1 11/16	3/4	3/16
1 7	1 3 13/32	1 0 5/32	9 5/16	6 27/32	4 3/4	3 1/32	1 23/32	3/4	3/16
1 7 1/4	1 3 19/32	1 0 5/16	9 7/16	6 15/16	4 13/16	3 3/32	1 23/32	3/4	3/16
1 7 1/2	1 3 25/32	1 0 15/32	9 9/16	7	4 7/8	3 1/8	1 3/4	25/32	3/16
1 7 3/4	1 4	1 0 21/32	9 11/16	7 1/8	4 15/16	3 5/32	1 25/32	25/32	3/16
1 8	1 4 3/16	1 0 13/16	9 13/16	7 3/16	5	3 3/16	1 13/16	13/16	3/16
1 8 1/4	1 4 13/32	1 0 31/32	9 15/16	7 9/32	5 1/16	3 1/4	1 13/16	13/16	3/16
1 8 1/2	1 4 19/32	1 1 1/8	10 1/32	7 3/8	5 1/8	3 9/32	1 27/32	13/16	7/32
1 8 3/4	1 4 13/16	1 1 9/32	10 5/32	7 15/32	5 3/16	3 5/16	1 7/8	27/32	7/32
1 9	1 5	1 1 7/16	10 9/32	7 9/16	5 1/4	3 3/8	1 7/8	27/32	7/32
1 9 1/4	1 5 7/32	1 1 19/32	10 13/32	7 21/32	5 5/16	3 13/32	1 29/32	27/32	7/32
1 9 1/2	1 5 13/32	1 1 3/4	10 17/32	7 3/4	5 3/8	3 7/16	1 15/16	7/8	7/32
1 9 3/4	1 5 5/8	1 1 15/16	10 21/32	7 27/32	5 7/16	3 15/32	1 31/32	7/8	7/32
1 10	1 5 13/16	1 2 3/32	10 25/32	7 15/16	5 1/2	3 17/32	1 31/32	7/8	7/32
1 10 1/4	1 6 1/32	1 2 1/4	10 29/32	8	5 9/16	3 9/16	2	29/32	7/32
1 10 1/2	1 6 7/32	1 2 7/16	11 1/32	8 3/32	5 5/8	3 19/32	2 1/32	29/32	7/32
1 10 3/4	1 6 7/16	1 2 9/16	11 5/32	8 3/16	5 11/16	3 5/8	2 1/16	29/32	7/32
1 11	1 6 5/8	1 2 23/32	11 9/32	8 9/32	5 3/4	3 11/16	2 1/16	15/16	7/32
1 11 1/4	1 6 15/16	1 2 7/8	11 13/32	8 3/8	5 13/16	3 23/32	2 3/32	15/16	7/32
1 11 1/2	1 7 1/32	1 3 1/32	11 17/32	8 15/32	5 7/8	3 3/4	2 1/8	15/16	1/4
1 11 3/4	1 7 1/4	1 3 3/16	11 5/8	8 9/16	5 15/16	3 13/16	2 1/8	31/32	1/4
2 0	1 7 7/16	1 3 3/8	11 3/4	8 21/32	6	3 27/32	2 5/32	31/32	1/4

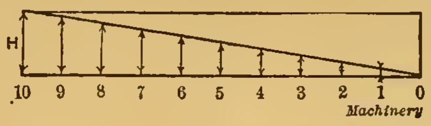
Contributed by Charles B. Gilbert

No. 156, Data Sheet, MACHINERY, July, 1912

ORDINATES OF PARABOLAS FOR CRANE GIRDER DESIGN—IV

H = end ordinate,
X = required ordinate,
N = number of equal spaces into which base line is divided,
M = number of equal spaces from 0 to required ordinate.

Then $X = H \times \frac{M^2}{N^2}$



H	9	8	7	6	5	4	3	2	1
Ordinates									
Ft. In.	Ft. In.	Ft. In.	Ft. In.	Inches	Inches	Inches	Inches	Inches	Inches
2 0	1 7 7/16	1 3 3/8	11 3/4	8 21/32	6	3 27/32	2 5/32	31/32	1/4
2 0 1/4	1 7 21/32	1 3 17/32	11 7/8	8 23/32	6 1/16	3 7/8	2 3/16	31/32	1/4
2 0 1/2	1 7 27/32	1 3 11/16	1 0	8 13/16	6 1/8	3 15/16	2 7/32	31/32	1/4
2 0 3/4	1 8 1/32	1 3 27/32	1 0 1/8	8 29/32	6 3/16	3 31/32	2 7/32	1	1/4
2 1	1 8 1/4	1 4	1 0 1/4	9	6 1/4	4	2 1/4	1	1/4
2 1 1/4	1 8 15/32	1 4 5/32	1 0 3/8	9 3/32	6 5/16	4 1/32	2 9/32	1	1/4
2 1 1/2	1 8 21/32	1 4 5/16	1 0 1/2	9 3/16	6 3/8	4 3/32	2 9/32	1 1/32	1/4
2 1 3/4	1 8 27/32	1 4 15/32	1 0 5/8	9 9/32	6 7/16	4 1/8	2 5/16	1 1/32	1/4
2 2	1 9 1/16	1 4 21/32	1 0 3/4	9 3/8	6 1/2	4 5/32	2 11/32	1 1/32	1/4
2 2 1/4	1 9 1/4	1 4 13/16	1 0 7/8	9 15/32	6 9/16	4 7/32	2 3/8	1 1/16	1/4
2 2 1/2	1 9 15/32	1 4 31/32	1 1	9 17/32	6 5/8	4 1/4	2 3/8	1 1/16	1/4
2 2 3/4	1 9 21/32	1 5 1/8	1 1 3/32	9 5/8	6 11/16	4 9/32	2 13/32	1 1/16	1/4
2 3	1 9 7/8	1 5 9/32	1 1 1/4	9 23/32	6 3/4	4 5/16	2 7/16	1 3/32	9/32
2 3 1/4	1 10 1/16	1 5 7/16	1 1 11/32	9 13/16	6 13/16	4 3/8	2 15/32	1 3/32	9/32
2 3 1/2	1 10 9/32	1 5 19/32	1 1 15/32	9 29/32	6 7/8	4 13/32	2 15/32	1 3/32	9/32
2 3 3/4	1 10 15/32	1 5 3/4	1 1 19/32	10	6 15/16	4 7/16	2 1/2	1 1/8	9/32
2 4	1 10 11/16	1 5 15/16	1 1 23/32	10 3/32	7	4 15/32	2 17/32	1 1/8	9/32
2 4 1/4	1 10 7/8	1 6 3/32	1 1 27/32	10 3/16	7 1/16	4 17/32	2 17/32	1 1/8	9/32
2 4 1/2	1 11 3/32	1 6 1/4	1 1 31/32	10 1/4	7 1/8	4 9/16	2 9/16	1 5/32	9/32
2 4 3/4	1 11 9/32	1 6 13/32	1 2 3/32	10 11/32	7 3/16	4 19/32	2 19/32	1 5/32	9/32
2 5	1 11 1/2	1 6 9/16	1 2 7/32	10 7/16	7 1/4	4 21/32	2 5/8	1 5/32	9/32
2 5 1/4	1 11 11/16	1 6 23/32	1 2 11/32	10 17/32	7 5/16	4 11/16	2 5/8	1 3/16	9/32
2 5 1/2	1 11 29/32	1 6 7/8	1 2 15/32	10 5/8	7 3/8	4 23/32	2 21/32	1 3/16	5/16
2 5 3/4	2 0 3/32	1 7 1/32	1 2 19/32	10 23/32	7 7/16	4 3/4	2 11/16	1 3/16	5/16
2 6	2 0 5/16	1 7 7/32	1 2 23/32	10 13/16	7 1/2	4 13/16	2 23/32	1 7/32	5/16

Contributed by Charles B. Gilbert

No. 156 Data Sheet, MACHINERY, July, 1912

MACHINERY

July, 1912

HOBS FOR SPUR AND SPIRAL GEARS[*]

By JOHN EDGAR[†]

THE success of the hobbing process for cutting teeth in spur and spiral gears depends as much upon the hob as upon the machine, and at the present stage of development the hob is the limiting factor in the quality of the product. It is well known that hobs at the present time are far from being standardized, and that the product will not be interchangeable if the hob of one maker is substituted for that of another; in fact, the using of two hobs from the same maker successively will sometimes result in the production of gears which will not interchange or run smoothly. This is not a fault of the hobbing process, but is due to the fact that the cutter manufacturers have not given the question of hobs the study it requires. This is also the reason why there are so many complaints about the hobbing machine. Nevertheless, with the proper hob the hobbing machine is the quickest method of machining gears that has ever been devised. Its advantage lies in the continuous action and in the simplicity of its mechanism. There is no machine for producing the teeth of spur gears that can be constructed with a simpler mechanism, and even machines using rotary cutters are more complicated if automatic.

Hobs with Few Teeth give Best Results

The ideal form of hob, theoretically speaking, would be one that had an infinite number of cutting teeth. In practice, however, a seemingly contradictory result is obtained, as hobs with comparatively few teeth give the best results. The reasons for this are due to purely practical considerations. Strictly speaking, a theoretical tooth curve is no more possible when the tooth is produced by the hobbing process than when produced by the shaper or planer type of generator, but for all practical purposes, the curve generated under proper working conditions is so nearly correct as to be classed as a theoretical curve. If this result is not often met with under ordinary working conditions, it is due to the fact that the hob is not as good as present practice is able to make it.

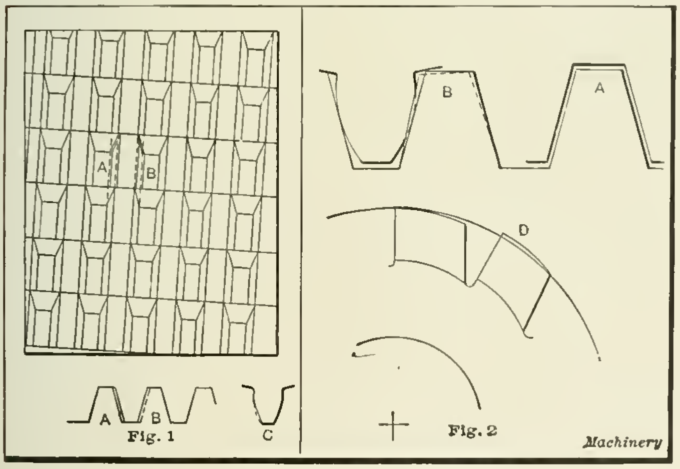


Fig. 1

Fig. 2

Figs. 1 and 2. Distortion of Hob Teeth and its Effect

Eccentricity and Variation in Hob Teeth Causes of Defects in Gears

In order to obtain a proper curve and not a series of flat surfaces, the teeth of the hob must follow in a true helical path. In ninety-nine cases out of one hundred the hob is at fault when a series of flats is obtained instead of a smooth curved tooth face. It is the deviation of the teeth of the hob from the helical path that is at the root of most hobbing machine troubles. There are several causes for the teeth being out of the helical path: The trouble may have originated in the relieving or forming of the teeth; the machine on which this work has been done may have been too light in construction, so that the tool has not been held properly to its work, and has sprung to one side or another causing thick and thin teeth in the hob; a hard spot may have been encountered causing the tool to spring; the gashes may not have been properly spaced, or there may have been an error in the gears on the relieving lathe influencing the form; the hob may also have been distorted in hardening; it may have been improperly handled in the fire or bath, or it may have been so proportioned that it could not heat or cool uniformly; the grinding after hardening may be at fault; the hole may not have been ground concentric with the form, thus causing the teeth on one side of the hob to cut deeper than on the other. Any one or a combination of several of these conditions may have thrown the teeth out of the true helical path.

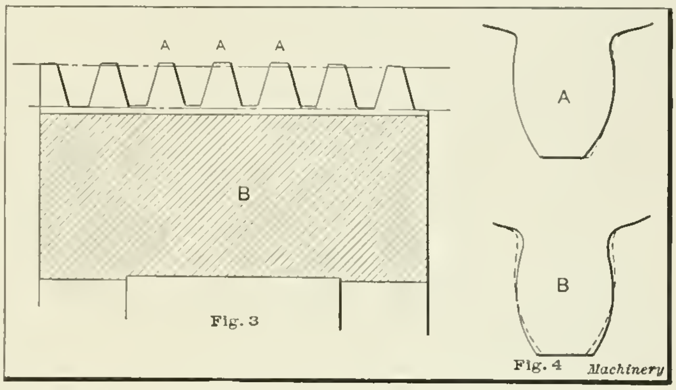
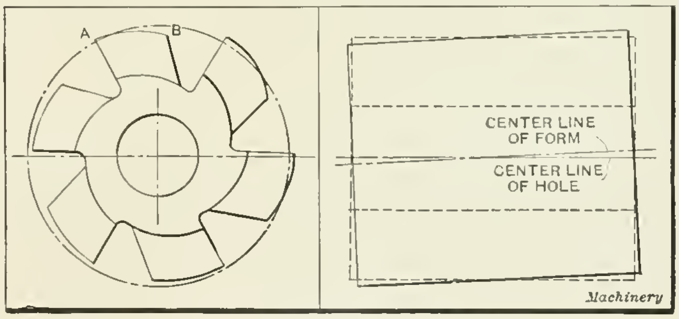


Fig. 3

Fig. 4

Figs. 3 and 4. Distortion of Hobs and Result on the Shape of the Teeth



Figs. 5 and 6. Hobs with the Center Hole out of True with the Outside of the Tooth Form

Fig. 1 illustrates the difficulty of thick and thin teeth. The tooth *A* is too thick and *B* is too thin, the threading tool having sprung over from *A* and gouged into *B*. Fig. 1 also shows a developed layout of the hob. At *C* is shown the effect that thick and thin teeth may have on the tooth being cut in the gear—that of producing a flat on the tooth. This flat may appear on either side of the tooth and at almost any point from the root to the top, depending upon whether the particular hob tooth happens to come central with the gear or not. If it does come central or nearly so, it will cause the hob to cut thin teeth in the blank. The only practical method to make a hob of this kind fit for use is to have it re-formed.

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[*] For additional information relating to the hobbing process for generating gear teeth, and kindred subjects, see the following articles previously published in MACHINERY; "Unusual Hobbing Operation," May, 1912; "Spiral-fluted Hob Angles," April, 1912; "Farwell Universal Gear Hobbing Machine," March, 1912; "Sharpening a Hob in a Shaper," January, 1912; "Gould and Eberhardt Automatic Hobbing Machine," December, 1911; "Calculating Gears for Generating Spirals on Hobbing Machines," December, 1911, engineering edition; "Sharpening a Hob in a Shaper," October, 1911; "The Gear Hobbing Machine—A Fundamental Defect," June, 1911; "Ins and Outs of Gear Hobbing," June, 1911, engineering edition; "Ins and Outs of Gear Hobbing," February, March, and April, 1911; "A Friendly View of the Hobbing Process," March, 1911; "British Automatic Hob Sharpening and Worm Grinding Machine," February, 1911, engineering edition; "Ins and Outs of Gear Hobbing," January, 1911, engineering edition; "Barber-Colman Gear Hobbing Machine," November, 1910; "Meisselbach-Catucci Hob Grinding Machine," November, 1910; "How Many Gashes Should a Hob Have," April, 1909; "Hob Sharpening Attachment for the Walker Universal Grinder," March, 1909; "How Many Gashes Should a Hob Have," January, 1909, engineering edition; "Gear Cutting Machinery," May, 1908, engineering edition.

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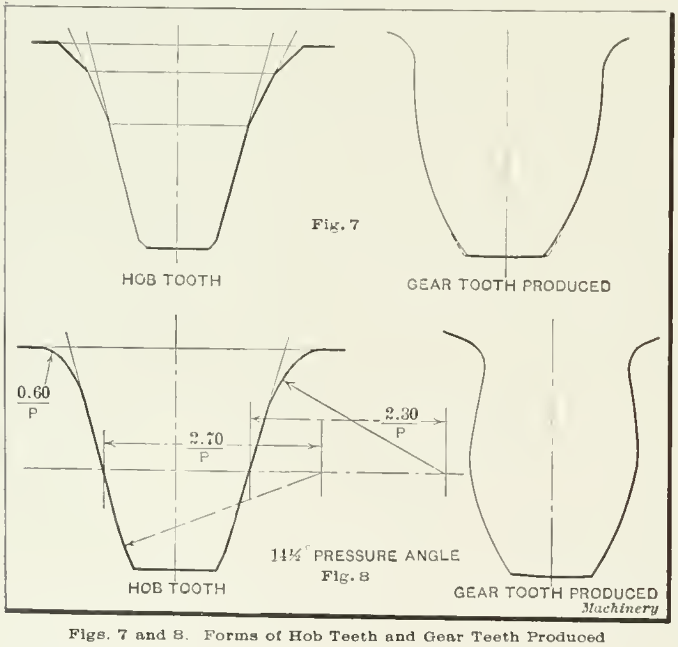
In Fig. 2 is shown at *A* the result of unequal spacing of the teeth around the blank. Owing to the nature of the relief, the unequal spacing will cause the top of the teeth to be at different distances from the axis of the hob. This would produce a series of flats on the gear tooth. One result of distortion in hardening is shown at *B*, Fig. 2, where the tooth is canted over to one side so that one corner is out of the helical path. This defect also produces a flat and shows a peculiar undercutting which at first is difficult to account for. Sometimes a tooth will distort under the effects of the fire in the manner indicated at *D*, Fig. 2.

These defects may be avoided by proper care and by having the steel in good condition before forming. The blank should be roughed out, bored, threaded, gashed and then annealed before finish-forming and hardening. The annealing relieves the stresses in the steel due to the rolling process.

The proportions of the hob have a direct effect on distortion in hardening. This is especially noticeable in hobs of large diameter for fine pitches. Fig. 3 shows the results obtained in hardening a 4-inch hob, 10 pitch, with 1¼ inch hole. There is a bulging or crowning of the teeth at *A*. This is accounted for by the fact that the mass of metal at *B* does not cool as quickly as that at the ends. Consequently, when the hob is quenched, the ends and outer shell cool most quickly and become set, preventing the mass at *B* from contracting as it would if it could come in direct contact with the cold bath and cool off as quickly as the rest of the metal. The effect of this distortion on the shape of the gear teeth is indicated in Fig. 4, where the tooth *A* is unsymmetrical in shape due to the fact that the teeth near the center of the hob cut deeper into the blank, undercutting the tooth on one side and thinning the point. This effect is produced when the gear is centered near the ends of the hob. If the gear is centered midway of the length of the hob, the tooth shape produced is as shown at *B*, Fig. 4. This tooth is thick at the point and undercut at the root.



Figs. 7 and 8. Forms of Hob Teeth and Gear Teeth Produced

A hob in this condition makes it impossible to obtain quiet running gears. In this case, it would be useless to anneal and re-form the hob, as the same results would be certain to be met with again, on account of the proportions of the hob. Hence, defects of this kind are practically impossible to correct, and the hob should either be entirely re-made or discarded.

Figs. 5 and 6 show in an exaggerated manner two common defects due to poor workmanship. In Fig. 5 the hole is ground out of true with the outside of the tooth form. The hole may run either parallel with the true axis of the hob, or it may run at an angle to it, as seen in Fig. 6. The effect of the first condition is to produce a tooth shaped like that shown by the full lines at *B* in Fig. 4, and the effect of that in Fig. 6 is about the same, except that the hob will cut thin teeth when cutting to full depth. Gears cut by either hob will lock with meshing gears, and instead of smooth rolling, the action will be jerky and intermittent.

Gashes which originally were equally spaced may have become unequally spaced by having more ground off the face of some teeth than of others. The greater the amount of relief, the more particular one must be in having the gashes equally spaced.

Grinding to correct Hob Defects

These various faults may be corrected to a greater or less extent in the following manner: Place the hob on a true arbor and grind the outside as a shaft would be ground; touch all of the teeth just enough so that the faintest marks of the wheel can be seen on the tops. The teeth that are protruding and would cause trouble, will, of course, show a wide ground land, while on those that are low, the land will be hardly visible. Now grind the face of each tooth back until the land on each is equal. This will bring all the teeth to the same height and the form will run true with the hole. To keep the hob in condition so that it will not be spoiled at the first re-sharpening, grind the backs of the teeth, using the face as a finger-guide, the same as when sharpening milling cutters, so as to remove enough from the back of each tooth to make the distance *AB*, Fig. 5, the same on all the teeth. Then, when sharpening the teeth in the future, use the back of the tooth as a finger-guide. If care is taken, the hob will then cut good gears as long as it lasts. It is poor practice to use the index head when sharpening hobs, because the form is never absolutely true with the hole, and unless the hob has been prepared as just described, there is no reliable way to sharpen it. If the hob, after having been prepared as described, is sharpened on centers by means of indexing, it will be brought back to the original condition.

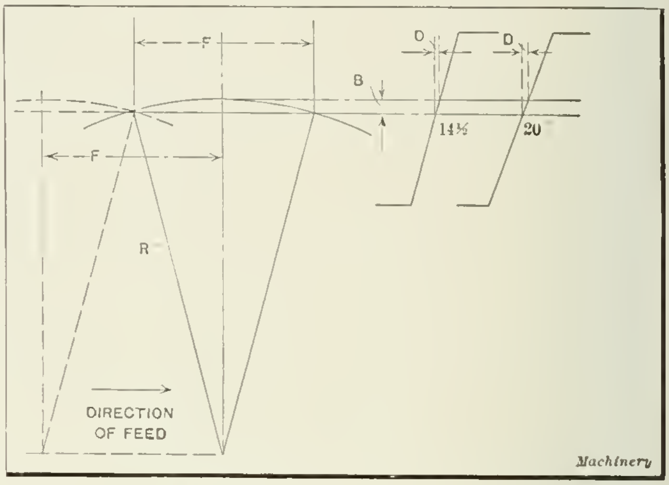


Fig. 9. Illustrating Effect of Feed in Hobbing

The defect shown in Fig. 6 is corrected in the same manner. The gash when so ground will not be parallel with the axis in a straight-fluted hob, nor will it be at an exact right angle with the thread helix in a spiral-fluted hob, because the teeth at the right-hand end are high while those at the left-hand end are low, and the amount that must be ground off the faces of the hob teeth will be greater at one end than at the other. The angle will be slight, however, and of no consequence.

Shape of Hob Teeth

The first thing that is questioned when a hob does not produce smooth running gears is the shape of the hob tooth. The poor bearing obtained when rolling two gears together would, in many cases, seem to indicate that the hob tooth was of improper shape, but in nearly every case the trouble is the result of one or more of the defects already pointed out.

Theoretically, the shape of the hob tooth should be that of a rack tooth with perfectly straight sides. This shape will cut good gears from thirty teeth and up, in the 15-degree involute system, but gears under thirty teeth will have a reduced bearing surface as a result of undercutting near the base circle, which increases as the number of teeth grows smaller. The shape produced by such a hob, if mechanically perfect, would be a correct involute, and the gears should interchange without difficulty. In order that the beginning of contact, however, may take place without jar, the points of the teeth should be relieved or thinned, so that the contact takes place gradually, instead of with full pressure. This is accomplished by making the hob tooth thicker at the root, starting at a point considerably below the pitch line. This is illustrated in Fig. 7, which shows the standard shape adopted by the Barber-Colman Co. The shape of the tooth produced is also shown. The full lines show the shape generated, and the dotted, the lines of the true involute. The amount removed from the points is greater on large gears and less on small pinions, where the length of contact is none too great even with a full shaped tooth, and where any great reduction must be avoided. This shape of hob tooth does not, however, reduce undercutting on small pinions. The fact that hobbed gears have undercut teeth in small pinions, while those cut with rotary cutters have radial flanks with the curve above the pitch line corrected to mesh with them is the reason why hobbed gears and those cut with rotary cutters will not interchange.

In Fig. 8 is shown a hob tooth shape which will produce teeth in pinions without undercutting, the teeth, instead, having a modified radial flank. The radii of the correction curves are such that the gear tooth will be slightly thin at the point to allow an easy approach of contact. The shape shown in Fig. 8 is approximately that which will be produced on hobs the teeth of which are generated from the shape of a gear tooth cut with a rotary cutter, which it is desired to reproduce.

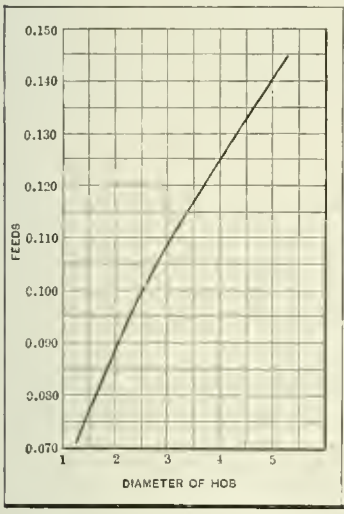


Fig. 10. Diagram showing Comparative Feeds for Hobs of Various Diameters

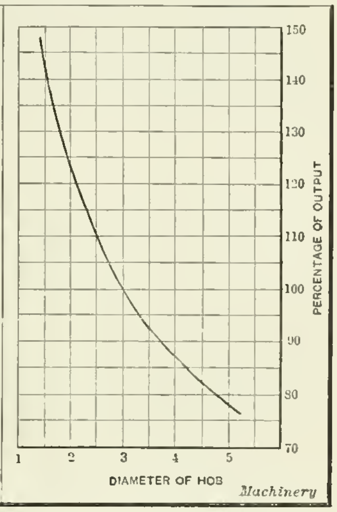


Fig. 11. Diagram showing Comparative Output of Hobs of Various Diameters based on 3-inch Hob

Diameters of Hobs

The diameters of hobs is a subject which has been much discussed. Many favor large hobs because the larger the hob the greater the number of teeth obtainable. This, however, has already been shown to be a fault, because the greater is the possible chance of some of the teeth being distorted. For the same feed, the output of a small hob is greater, because of being inversely proportional to the diameter. The number of teeth cut is directly proportional to the number of revolutions per minute of the hob. The number of revolutions depends on the surface speed of the hob; therefore, the small hob will produce more gears at a given surface speed.

It may be argued that, on account of the large diameter, the large hob can be given a greater feed per revolution of the blank than the smaller hob, for a given quality of tooth surface. This argument is analyzed in Fig. 9. Let R be the radius of the hob and F the feed of the hob per revolution of the blank. Then B may be called the rise of feed arc.

Since the surface of the tooth is produced by the side, the actual depth of the feed marks is D, which depends on the angle of the side of the tooth, the depth being greater for a 20-degree tooth than it would be for a 14½-degree tooth for the same amount of feed. The relations between F, R, and B may be expressed as follows:

$$F = 2\sqrt{2RB - B^2}$$

Since B is a very small fractional quantity, B^2 would be much smaller and can, therefore, be disregarded, giving the very simple approximate formula $F = 2\sqrt{2RB}$. A rise of 0.001 inch would mean a depth D of about 0.00025 inch on a 14½-degree tooth. The allowable feed is 0.126 inch for a 4-inch hob and 0.108 inch for a 3-inch hob for a 0.001 inch rise. The curve in Fig. 10 shows the feeds for this rise for various hob diameters. Fig. 11 shows a curve based on a 3-inch hob that shows the comparative output for an equal rise. This curve shows that the smaller hob is superior in matter of production.

The larger hobs are also more liable to distortion in hardening and they do not clear themselves as well as the smaller ones when cutting; consequently, they need a greater amount of relief. Large hobs also require a greater over-run of feed at the start of the cut. When cutting spiral gears of large angles this greatly reduces the output, as the greater amount of feed required before the hob enters to full depth in the gear is a pure waste.

The question of whether the gashes or flutes should be parallel with the axis or at right angles to the thread helix has two sides. From a practical point of view, it appears to make very little difference in the results obtained in hobs of small pitch and angle of thread. In hobs of coarse pitch, however, the gashes should undoubtedly be normal to the thread. The effect of the straight gash is noticed when cutting steel, in that it is difficult to obtain a smooth surface on one side of the tooth, especially when cutting gears coarser than 10 pitch. What has been said in the foregoing, however, applies equally to straight and spirally fluted hobs.

* * *

MOVING PICTURES IN THE INDUSTRIES

At the Turin Exposition last year, the Siemens-Schuckert Works had arranged for an exhibition of moving pictures showing the processes of manufacture in their works, and also the performance of machinery built by them, when installed and in use. These exhibitions of moving pictures were highly appreciated by the visitors at the exposition, which showed processes of manufacture in a manner hitherto unrivaled. The highly educational value of exhibitions of this kind has been thoroughly appreciated by educational authorities, and the Siemens-Schuckert Works have offered to exhibit the pictures free of cost before the higher grades in the public schools in Germany. These pictures show clearly and explicitly how small motors are being built at the Charlottenburg works of the firm, how the housings are bored, the pole pieces made, the armatures wound, and the motors assembled.

Another film shows complete blast furnaces and steel mill processes, where the work of producing iron and steel can be observed without the discomfort from heat, smoke and dust accompanying the actual inspection. The loading of the ore from the vessels onto railway cars by means of electric cranes at the Walsum harbor is shown at the beginning, and the raw material is then followed until it is finally rolled into commercial shapes in a steel mill driven by a Siemens-Schuckert motor of 10,000 K.W. maximum capacity.

Still another film shows the use of the electric motor in agricultural fields. An electric plough is illustrated at work, in this case. A number of other interesting operations in various engineering fields where electric motors are used are also shown. Certainly no better method for instructing pupils in public schools of the actual processes of the world's work could possibly be devised. It would not be surprising if the instruction in the schools of the future would be largely by means of moving pictures, at least when subjects relating to the engineering fields, geography and the natural sciences are covered.

* * *

Samples of cloth made in England by a process recently discovered, from the fiber of a species of sea-weed found in southern seas, have been received by the Bureau of Manufactures in Washington. The fiber, after treatment, is soft, pliable and strong, somewhat similar to wool, and easy to spin. It also takes dyes well, except green.

PIERCING AND EMBOSSING DIE FOR AN AUTOMOBILE HEAD LAMP FRONT

By ARON LAWRENCE

The piercing and embossing die shown in Fig. 2 was designed to pierce eight holes in the periphery of the automobile head lamp front shown in Fig. 1, and at the same time to emboss an arch-shaped rib around the sloping neck portion. This rib or ledge is used to support the head of the lamp when assembled to prevent it from being buckled out of shape when polishing. The pierced holes are for attaching the front to the lamp body, and also for fastening the door hinge and catch.

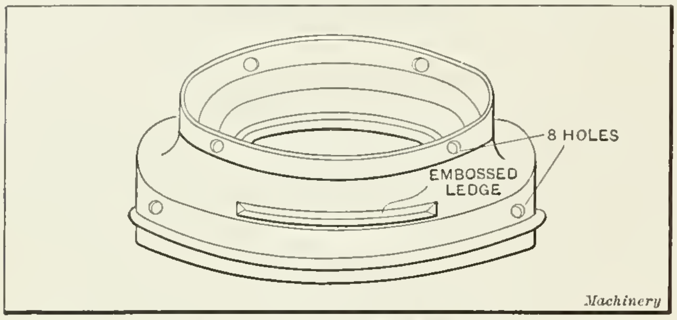


Fig. 1. Automobile Head Lamp Front

Referring to Fig. 1, it will be seen that the punches for the body rivet holes in the small diameter or top portion of the front must have a considerably longer stroke than the punches for the hinge and catch holes. The base *A* of the die shown in Fig. 2, is a gray iron casting bored out in its upper central portion to fit the locating ring *B*, also made of cast iron. The ring *B* is fastened to base *A* with large screws and dowels. The piercing die bushings *C* and *D* are pressed into the locating ring *B*, and are made from hardened tool steel. The scrap from the punches passes in toward the center of the die and falls down through the opening to the bolster plate. The hardened tool-steel embossing punch *E* is let into the ring *B*, as shown in the section at *X*—*X*, and is fastened to it by suitable screws.

Cast integral with the base *A* are two blocks projecting upward for the reception of the hinge and catch punches, and four blocks for the punches used in piercing the holes in the body. The shape of these blocks is clearly shown in the sectional views at *Y*—*Y* and *Z*—*Z*, respectively. The punches *F* are of hardened tool steel, set into the heavy punch carriers *G*, which are provided with a tool block *H* against which a helical compression spring acts to withdraw the punches. The punches are operated by the angular-faced lugs *I*, cast integral with the upper portion *T* of the die. The punch holders *G* are slotted out to receive a cross-pin *J*, which limits the length of the return stroke.

The lower punches *K* are similar in construction to those just described except that the punch carriers *L* are shouldered and are returned by means of helical springs *M*, held in counterbored holes in projecting bosses on the base *A*. The punches are limited in their outward travel by a pin *N* which works in an elongated slot in the base. This pin also serves to preserve the proper alignment of the angular end of the carrier *L* under the angular projections *I*. Oil holes are provided for the proper lubrication of the various plungers.

The embossing die *O* is of hardened tool steel, set into a cast-iron ring *P*, which slides vertically below the upper die member *T*, being guided by four steel pins *Q*, and limited in its travel by the shoulder screws *R*. A heavy rubber ring *S*, of sufficient resiliency to accomplish the embossing before further compressing, is introduced between the ring *P* and the casting *T*. Of course this rubber ring must be under initial tension or it will not operate properly.

In operation, the die is used in a heavy arch press with a stroke of about 8 inches; the piece, Fig. 1, is located over the ring *B*, and the press is tripped. The arch-shaped rib is first embossed, after which the rubber ring compresses, allowing the piercing punches to be operated. This method of holding the work while forming and piercing insures the correct relation between the various holes.

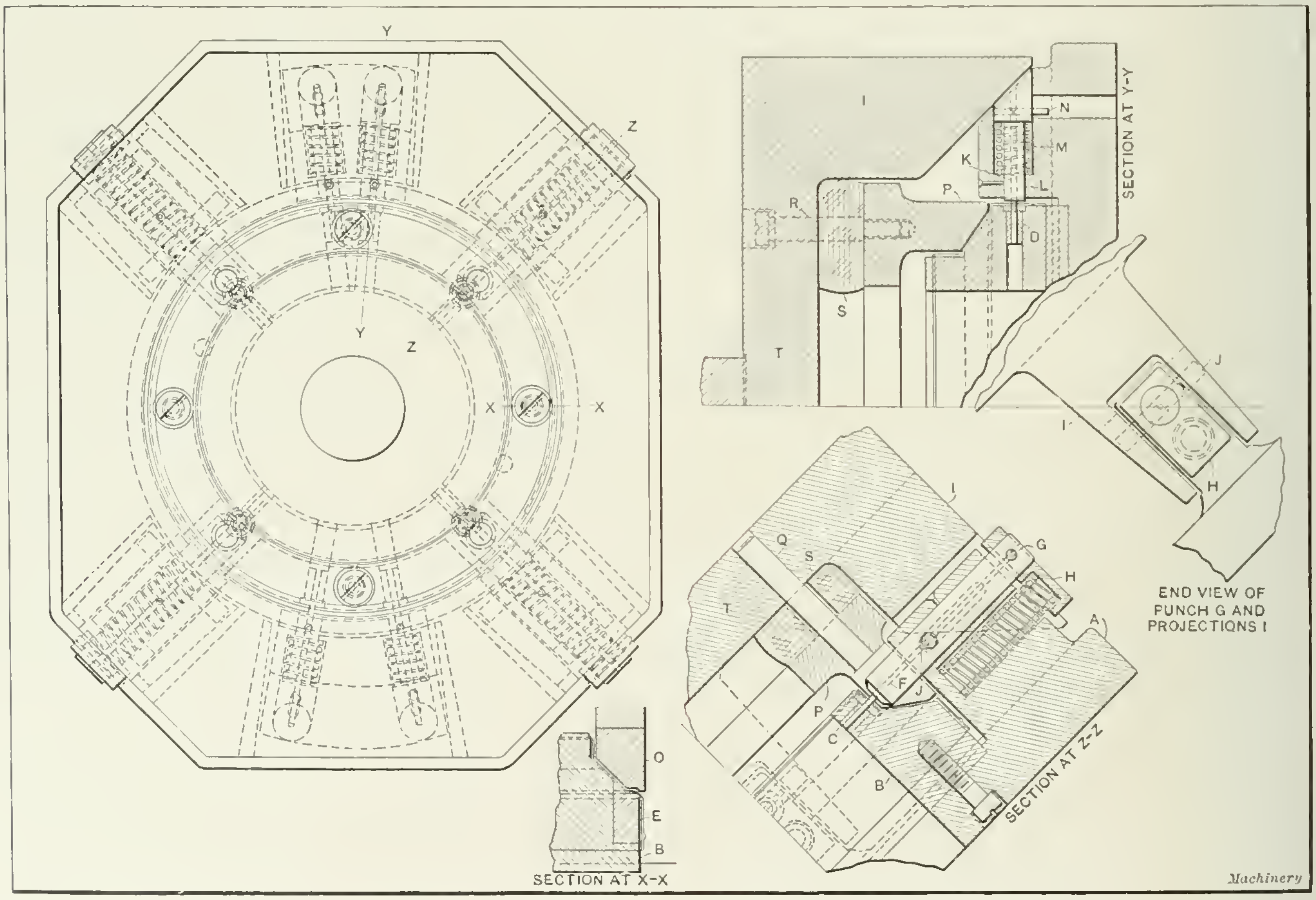


Fig. 2. Piercing and Embossing Die for Automobile Head Lamp Front

* * *

The value of good appearance does not apply merely to the machine being built, but will return dividends when applied also to the appearance of the factory, both inside and outside.

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* Address: Detroit, Mich.

GRINDING AND CORRUGATING FLOUR MILL ROLLS*

By F. B. JACOBS†

In the process of flour milling, the grain is first fed between spirally corrugated rolls, generally called breaking-down rolls. The rolls in common use are from six to twelve inches in diameter, and from one to three feet in length, and are made of cast iron, the surface of which is chilled to a depth of from one-half to two inches. The crushing of the grain which often contains foreign substances, nails, pebbles, etc., soon wears away the corrugations. In this case the rolls are repaired by grinding away the worn corrugations in a regular roll-grinding machine, and cutting new corrugations in a machine built especially for the purpose. The machine shops of the larger milling concerns are equipped for this purpose; the smaller milling concerns, however, depend on contract shops which make a specialty of this class of work.

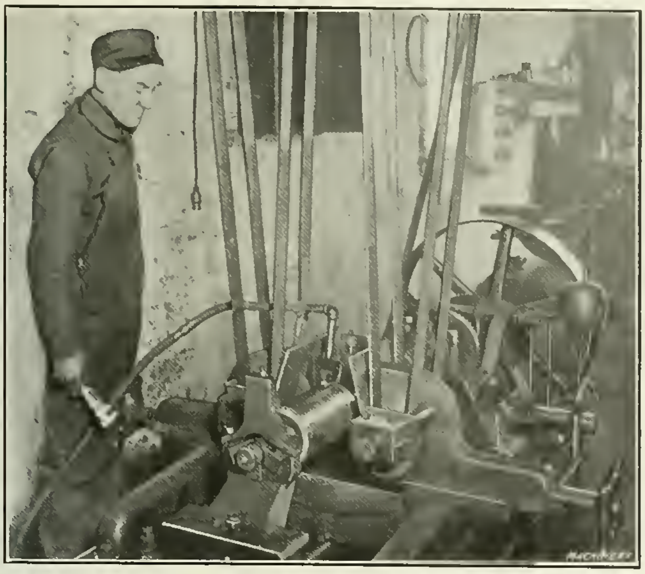

Fig. 1. The Grinding of Corrugated Flour Mill Rolls

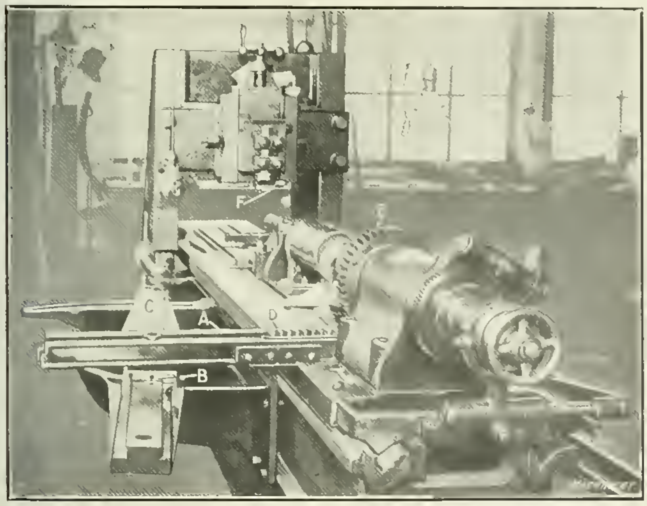

Fig. 2. Machine for Corrugating the Rolls

The grinding operation is shown in Fig. 1, the roll being located by its journals or necks and driven by a shaft having two toggle-joints. The object of the toggle-joints is to overcome the tendency of cramping. The grinding wheels used on this machine are carborundum, 10½ inches in diameter, 1½-inch face, 80 grit, K grade, G-4 bond, and are run at a surface speed of approximately 5000 feet per minute. The roll shown is 6 inches in diameter and 12 inches long, and is revolved at a speed of 40 revolutions per minute. The traverse speed is ¾ inch advance for each revolution of the work. When removing 1/32 inch, the grinding time on this roll was 12 minutes and the finish left was excellent. In grinding rolls of this kind, but little attention is paid to size, the object of the grinding being to remove the worn corrugations only. It may be added, however, that it is absolutely necessary that the rolls be parallel. This is accomplished by adjusting the rests that carry the shoes in which the journals run, until the roll is in line with the travel of the wheel carriage. In the roughing operation the depth of cut should be as great as the wheels will stand, which in some cases equals 1/64 inch. The final finish is produced by allowing the wheels to pass the work several times until they cease to spark heavily. With free-cutting wheels, this will be accomplished in a very few passes.

In Fig. 2 is shown the type of machine generally used for the corrugating operation; this, at first glance, looks like an ordinary iron planer equipped with a taper attachment. In Fig. 3 it is seen that the roll is located from its centers and also supported by its journals on V-blocks. In setting up the machine for the corrugating operation, the operator determines the amount of spiral by practically the same method as is used by a toolmaker in setting up a universal milling machine for cutting a spiral cutter. By referring to Fig. 2, it will be seen that the bar *A* is moved by the block *B* which travels over the taper slide *C*. The rack *D* meshes with the gear *E* which imparts the spiral motion to the roll. By setting the taper slide at a greater or less angle, different spirals are obtained. This adjustment is of great importance as usually no two rolls, if they come from different milling concerns, have the same spiral, owing to the fact that the various milling concerns hold widely different views regarding the correct spiral for rolls of this kind.

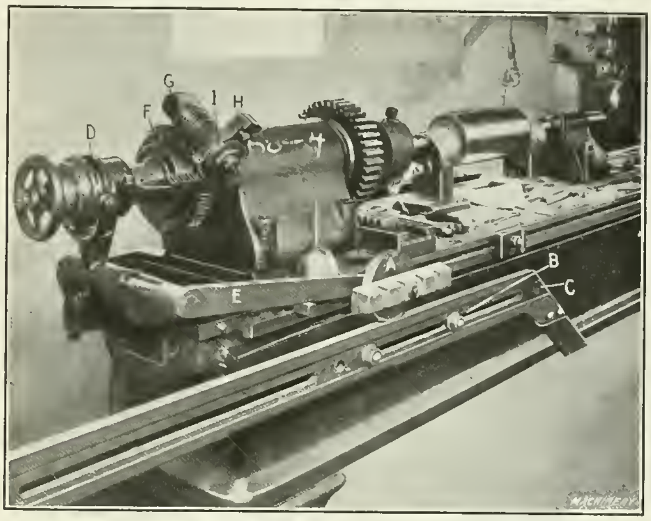

Fig. 3. Indexing Arrangement of Corrugating Machine

At *A* in Fig. 4 are shown several corrugating tools. These are made of a high grade of tool steel, hardened and drawn to a straw color. As they have several teeth, they work on the principle of a gang tool, thus making it possible to corrugate a roll to the required depth by going around it once. The tool, which is securely clamped in a tool-holder as shown at *F* in Fig. 2, is set at an angle with the roll; thus the first tooth barely scratches the roll, the next going a little deeper and so on until the correct depth is reached by the last tooth. As the material cut is hard chilled iron, the speed for this operation is necessarily slow—one foot in twenty-five seconds. For every stroke of the platen the roll is turned three teeth, this being accomplished by the ingenious arrangement shown in Fig. 3. When the platen is nearing its forward position, the roll *A*,

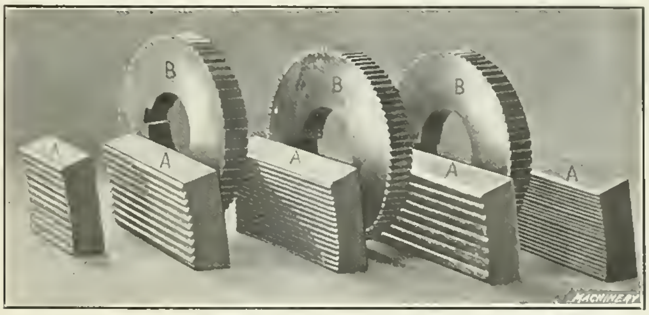

Fig. 4. Tools and Ratchets used in the Corrugating Machine

running over the guide *B*, drops upon reaching *C*. By means of the clutch *D*, the lever *E* actuates the rack *F* which turns the sector *G*, thus causing the pawl *H* to slide over the teeth of the ratchet *I*. At the return stroke of the platen, pawl *H* engages the ratchet teeth, thus turning the worm, worm-wheel and roll. By adjusting the slide *B* and substituting different ratchets, a few of which are shown at *B*, Fig. 4, the roll can be turned from one to as many teeth as the operator desires. Where very deep teeth are to be cut, the roll is generally turned one or two teeth for each stroke of the platen. In cutting fine teeth, however, it is often turned several teeth for each stroke.

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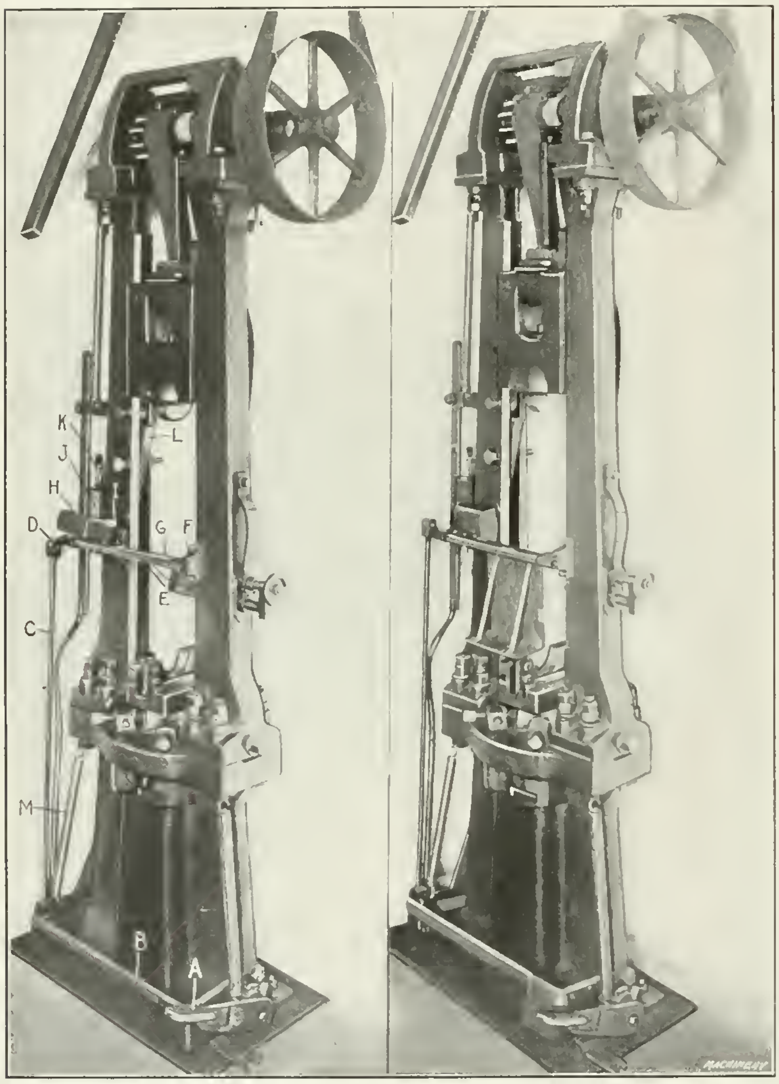
* See MACHINERY, May, 1909, "Grooving Chilled Flour Mill Rolls," and June, 1906, "Roll Corrugating Device."

† Address: Care of Carborundum Co., 826 Arch St., Philadelphia, Pa.



Figs. 1 and 2. Safety Device applied to a Drop Hammer

As there are many different sizes and shapes of corrugations it is necessary that the machine be provided with adjustments to cover a wide field. The time for corrugating a roll of the same size as shown in the grinding operation, was one hour and fifteen minutes. The corrugations were 0.010 inch deep and spaced twenty to the inch. As roll grinding and corrugating is a special branch of the machinist's trade that calls for skill and judgment along special lines, an expert who is experienced on this particular line of work generally receives the highest wages paid to machinists in the locality in which he is employed.

* * *

In an article in *Industritidningen Norden*, issue of April 12, attention is called to the fact that the Tesla steam turbine described in the November, 1911, number of MACHINERY makes use of a principle which is by no means new, as in 1894, Messrs. P. Nordenfelt and A. Christophe, the former a Swede, the latter a Frenchman, applied for a Swedish patent on the same type of steam turbine, which was granted. This turbine, however, was never developed beyond the experimental stage. Whether or not the Tesla turbine, employing the same principle, will meet with a better fate remains to be seen.

A MECHANICALLY AND ELECTRICALLY OPERATED SAFETY DEVICE

By BENJAMIN C. WAITE, JR.[*]

The problem of properly equipping machine tools with safety devices is a difficult one and, as a rule, the older the machine, the more difficult it is to guard. A great many firms of late have been forced to properly safeguard their machine tools on account of the stringent laws recently passed for the safeguarding of workers. There is one machine especially which is very difficult to guard, and that is the drop hammer.

In the accompanying illustration an efficient guard for a machine of this type is shown. This guard is operated by moving the foot from the trip lever shown at the lower right-hand side at *A* to the treadle *B* in front of the machine and the operator. The tripping of this extra treadle does not require any more action or effort on the part of the operator than was required before the guard was put on, for previously the foot was in continuous motion from the floor to the trip lever, while now the foot movement is from the trip lever to the treadle, which is held down while the work is removed and replaced. While the foot is in this position, the swinging guard *G* is located as shown in Fig. 1, and is held practically in a horizontal position, being operated by the shaft, crank, and straight rod and spring shown to the left of the hammer. These parts constitute the mechanical connections of the swinging guard.

The electrically controlled parts of the safety device are also shown to the left of the frame immediately above shaft *E*. The box cover *H* protects a small carbon contact switch which opens the circuit when the swinging guard is in the horizontal position, thus causing the dog *L* which is controlled by the magnet *J* and connected to it by the link *K*, to fall into the path of the hammer head, thereby preventing the hammer from falling. Hence the hammer cannot "repeat" or be accidentally tripped, these being the usual causes of most accidents in hammers of this type. When the foot releases the safety treadle *B*, the guard swings down to a vertical position, the circuit is closed, and the magnet, pulling downward, draws dog *L* within the housing of the hammer, providing a clear path for the falling hammer, as soon as it is tripped. While the swinging guard is in the vertical position, as shown in Fig. 2, it is so located that the operator cannot conveniently reach underneath or around it.

This combination of a mechanically and an electrically operated safeguard has been in successful operation for nearly two years, and although there may not be many hammers in use of the exact type shown in the illustration, the principles can be applied to many other tools. An important and unique feature of the device is that should the electrical current fail, the hammer is instantly placed in the safety position, because dog *L* will then immediately fall into the path of the hammer. This condition is shown in Fig. 2.

* * *

TREATING TUNGSTEN FOR WIRE MAKING

A process for increasing the ductility of tungsten so that it can be made into wire for lamp filaments with less difficulty than formerly has recently been patented by Werner von Bolton of Charlottenburg, Germany. The tungsten is treated at a red heat with a mixture of hydrogen and chloride of sulphur. This serves to remove any oxide of tungsten in the metal which is a cause of brittleness. The oxide is converted into sulphide which is, in turn, decomposed by the hydrogen. The metal thus purified contains some sulphur. It is heated to a white heat in a vacuum furnace to expel it, when pure, metallic tungsten of great ductility is obtained which can be easily drawn into wire. When the oxide is reduced by hydrogen in the usual manner, some hydrogen is left which causes brittleness; by the sulphur method, this is avoided.

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WATCH CASE MANUFACTURE*—1

COMPOSITION PLATE—TYPES OF CASES—FORMING CENTER, CAP, BACK AND BEZEL—THREADING

A watch case is simply a metal box which acts as a container for the movement and protects it from injury and dust. Watch cases are made from alloyed gold (pure gold—24 carat—is too soft), silver, gunmetal and other composition metals. A material which is used extensively is what is known as "gold filled"; this consists of a bar of composition metal to which a thin strip of gold is soldered. These built-up bars, shown at *A* and *B* in Fig. 2, are rolled out to the desired thickness, and worked up in punch presses to form the various members of the case. A gold filled watch case wears as well if not better than a solid gold case, does not tarnish, and is a stronger protector for the movement.

Preparing the Gold-plated Bars

Considerable experience is necessary, in preparing gold-plated bars, to produce a uniform thickness of gold on the surface of the bar. The gold plate, of course, is much softer than the composition metal to which it is soldered, and does not harden as quickly or as much during the rolling operation as does the composition metal. Hence, it is absolutely necessary to have a perfect union between the two metals.

Before uniting the gold strip and composition bar, it is necessary that the surfaces which come in contact should be made as nearly true planes as possible. The solder for uniting the composition bar and gold strip is made from alloyed silver, which is rolled out to the proper thickness. The composition bar, solder and gold strips are first coated with soldering acid on those faces which come in contact. If the plated bar is to be used for a bezel, center or cap, it is furnished with a gold plate on one side only, but if the bar is to be used for the back of either a screw or hinged case, a strip of gold is soldered to both faces, as shown at *B* in Fig. 2.

After the bar has been prepared in this manner it is wired so that the various strips will be held in close contact with each other. Then it is placed in a furnace where it is heated to about 1000 degrees F., which is sufficient to melt the solder and join the various strips. When the bar has remained in the furnace long enough for the solder to melt, it is taken out and allowed to cool off gradually. The wires used in binding are then removed, leaving the bar in a condition to be rolled out into a sheet of the desired thickness. The bar is first passed through "breaking-down" rolls, and after about ten passes through the rolls, it is annealed and pickled. This procedure is continued until the bar is rolled out into a strip of approximately the desired thickness. To bring the strip to the exact thickness, it is passed through finishing rolls which give it a better surface.

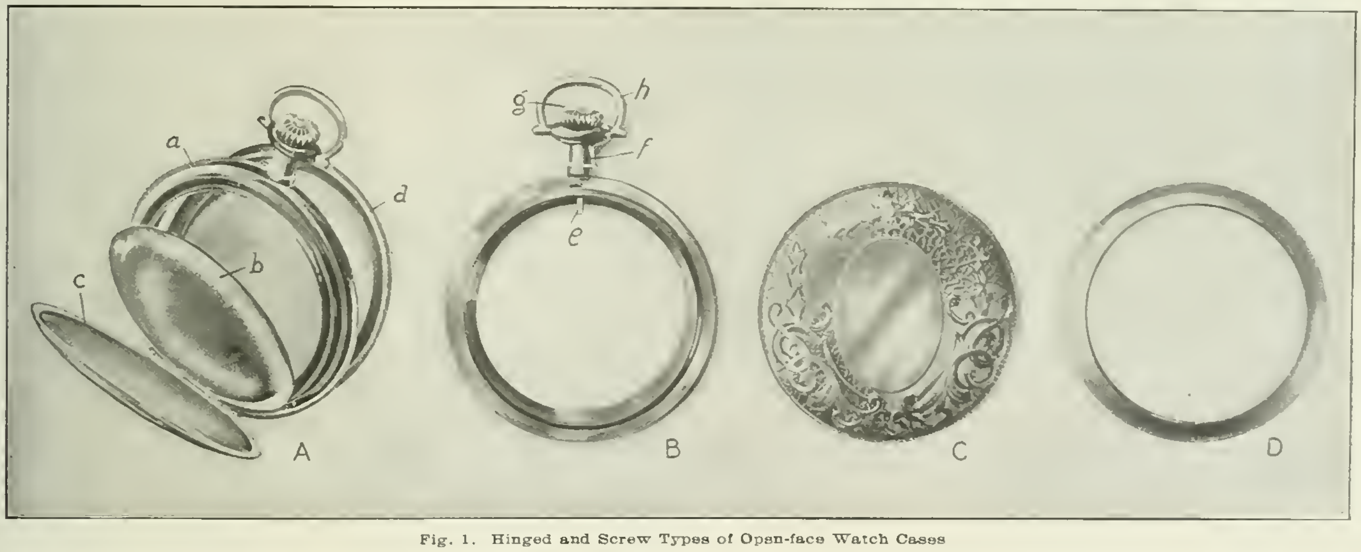

Fig. 1. Hinged and Screw Types of Open-face Watch Cases

Types of Watch Cases Manufactured

At the present time there are six distinct types of watch cases made. The first and the most common is the open face case, shown at *A* in Fig. 1. This consists of a center *a*, cap *b*, back *c*, and bezel *d*. The stem *e*, pendant *f*, crown *g*, and bow *h*, of course, are common to all ordinary watch cases. Another type of case which has come into prominence of late is the screw case shown dismantled at *B*, *C* and *D*. This consists of a center, back and bezel, the center *B*, back *C*, and bezel *D* being threaded so that the various parts of the case can be screwed together. There are other cases which are made to suit individual requirements and consequently are of a special nature. There are four cases, however, which are made regularly: the hunting case, consisting of a center, cap, two backs and a bezel; the cup case, consisting of a screw-cup, bezel and a ring to hold the watch movement; the swing-ring case, consisting of a center, cap, bezel, and swing ring; and the bracelet case consisting of a back, center and bezel. The latter case is made in an open face.

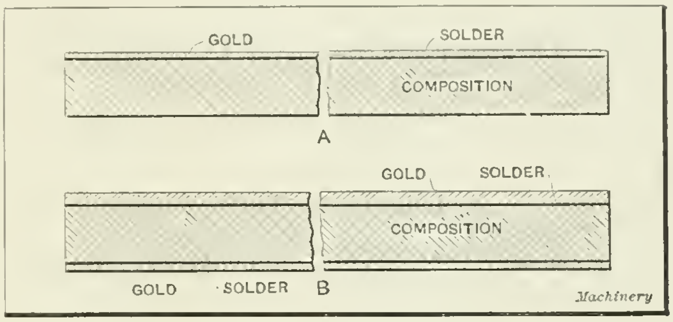

Fig. 2. How the Stock used in making "Gold Filled" Watch Cases is prepared

In this article is given a description of the methods employed in manufacturing an open face case of the type shown at *A*, Fig. 1. Occasional references are also made to the screw case, parts of which are shown at *B*, *C*, and *D*.

Making the Watch Case Center

After the bars previously referred to have been rolled out into strips of the desired thickness, they are cut up in a small power shear into squares, as shown at *A*, Fig. 3. These squares are then taken to the punch press department where they are worked up to form the various members of the case. The case centers are blanked out and cupped up in one operation in a double-action punch press, their condition after the operation being shown at *B*, Fig. 3.

From the punch press the cups are taken to the annealing furnace where they are annealed, and then pickled to remove the scale. They are then again taken to a punch press, the next operation consisting in "coaxing over" the top edge of the cup so that it assumes the shape shown at *C*. It is next taken to a spinning machine in which it is given the shape indicated at *D*. The next operation is what is known as the inletting operation for the movement; this consists in turning away the material on the inside edge of the case center, so that it will fit the movement, and is accomplished in the inletting machine shown in Fig. 4. The center, which, by the way, has been fitted up with a pendant, is placed in the spring chuck *A*, the latter being tightened by the knurled nut *B* with a spanner wrench. Tool arbor *C* is now placed in the U-rests *D* and *E*, located at right angles to the axis of the spindle. This tool arbor *C* carries cutters *F*, which are used for making the various cuts, and are held by set-screws in the tool arbor.

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* For articles on watch making previously published in MACHINERY, see "Watch Movement Manufacture," in the May and June, 1912, numbers, and articles there referred to.

In action, the operator grips the tool arbor *C* in both hands, holding it rigidly in the U-rests. He then brings the cutting tools *F*, one at a time, into contact with the work, allowing them to bear or rest on the strip *G*, which is placed across the face of the chuck. The tool arbor is located so that the cutting tools will cut to the correct diameter for the various steps on the case center by means of the stop-screw *H*, held in collar *I*, which comes against the rear face of the U-rest *E*.

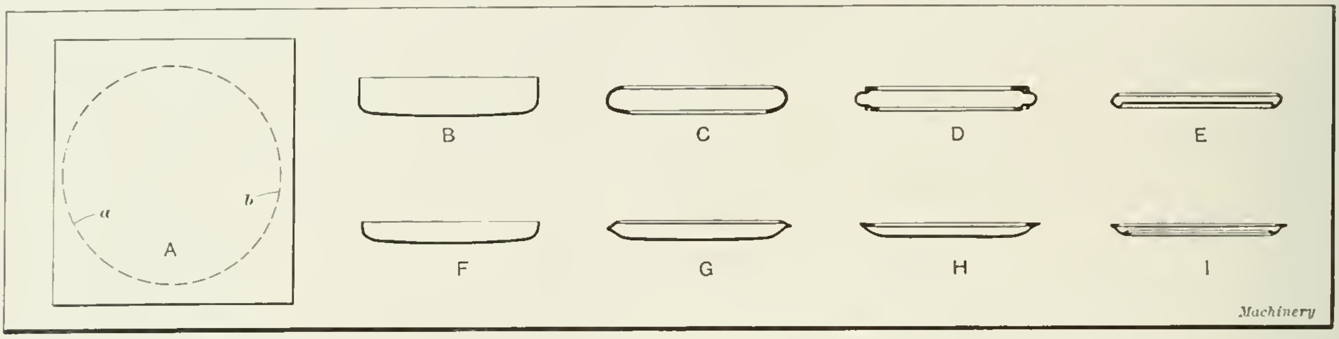

Fig. 3. Evolution and Development of a "Gold Filled" Open-face Jointed Watch Case—Punch Press and Spinning Operations

Threading the Case Center

The case center for the screw back and front type of case shown at *B*, Fig. 1, is threaded in the machine shown in Fig. 5. A case center of the type shown at *A* is placed in the spring chuck *B* and the nut *C* is tightened. The belt *D* is then shifted to run the spindle forward, and the work is prepared for threading by means of the tools held in the turret *E*, which latter is operated by handles *F* and *G*. When the turning is completed, the spindle is reversed to run backward, and the clutch which drives the rear driving shaft through change gears is thrown in by operating the handle *H*. The rear driving shaft carries cams *I* and *J* for operating the tool carriage which holds the circular threading tool *K*. Face cam *I* in conjunction with the change gears traverses the tool-slide longitudinally at the proper speed in relation to the rotation of the spindle, to cut a thread of the desired pitch—40 threads per inch.

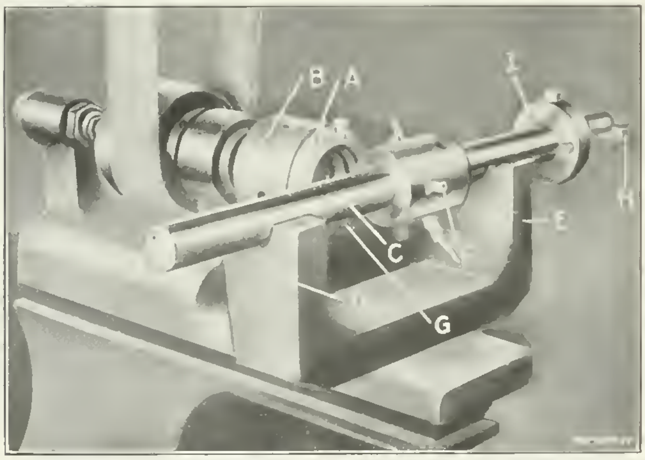

Fig. 4. Inletting the Watch Case Center for the Movement

The threading tool *K* is brought in to and out of action by means of the cam *J* which is timed with cam *I* to bring the tool in to action while the slide is being traversed toward the head of the machine. When the roll attached to the slide drops into a cut-away portion in both cams *I* and *J*, the tool *K* is withdrawn from the work and returned to the starting point by springs. The threading tool is fed in to the correct depth by means of handwheel *L*, operating the top slide *M*, which is provided with an adjustable stop. The case center for the hinged type of case is not threaded, but is jointed. This operation consists in cutting two grooves in the side of the case in which two short pieces of gold-plated hollow wire* are soldered. The grooves are cut with two slitting saws, thus enabling the grooves in both sides of the case center to be cut at the same time.

Making the Cap and Back

The cap and back *b* and *c*, Fig. 1, used in the hinged case for protecting the movement are also made from squares of gold-plated stock which are blanked and drawn up in a double-action punch press. The condition of the cap after this operation is shown at *F* in Fig. 3. The only difference between the back and cap is that the latter is slightly smaller in diameter than the former. After the back and cap are drawn up into the condition shown at *F* they are annealed and pickled after which they are "coaxed" over. The "coaxing" die and punch bend the top edge of the cap over slightly, as at *G*, Fig. 3. After the "coaxing over" operation, the cap is "snapped" by a punch and die, which operation consists in flattening out the edges and forming it so that it fits the center of the case, as indicated at *H*. The die used for the snapping operation also produces the little thumb catch on the edge, which is used for opening the cap. This finishes the cap with the exception of jointing and polishing. The same operations are performed on the back. The jointing consists in soldering a short piece of gold-plated hollow wire on the edge of the cap and back, which, in conjunction with the hollow wire soldered onto the case center, forms the hinges, a piece of gold wire being used as a pin. A seat for the hollow wire is milled in a small milling machine which is provided with a cutter for this purpose, and a chuck for holding the work. The polishing of the cap and back will be taken up in another installment of this article.

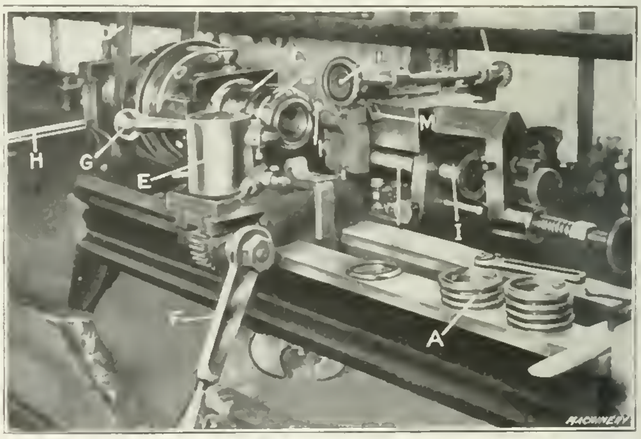

Fig. 5. Cutting the Thread on a Screw Watch Case Center

Threading the Back

The back shown at *c* in Fig. 1, which is used on the screw case is threaded in the machine shown in Fig. 6. The work is held in a draw-in chuck *A*, which is operated by handle *B*. The work spindle is provided with a master thread *C* of the same pitch as that which is to be reproduced on the back—40 threads per inch—and a leader held in the forward end of handle *D* is brought into contact with this master thread by the operator. Shaft *E* is connected to the carriage which holds tool-slide *F*, and as this shaft is traversed by the master thread, it evidently carries the tool-slide with it.

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* For information regarding the manufacture of gold-plated hollow wire, see the article entitled "The Making of Seamless Gold Wire," March, 1911, engineering edition.

Before cutting the thread, the back is prepared for it by a tool *H* which is held on slide *I* and is operated by a foot treadle. When ready for threading, the operator grasps handle *D* with one hand, and operates handle *J* with the other. The leader is brought into contact with the master thread, and at the same instant the circular tool *G* is fed into the work. The handle *D* is then dropped, and the carriage is returned by a spring. The handle *J* feeds the slide in to an adjustable stop. The screw back is practically completed after the threading operation with the exception of polishing and engine turning.

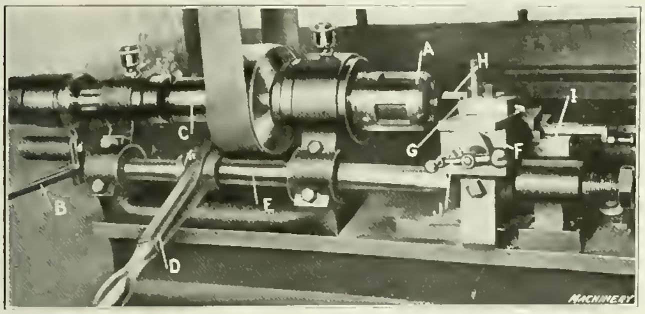


Fig. 6. Cutting the Thread in a Screw Back for a Watch Case of the Type shown at B, Fig. 1

Making the Bezel

The bezel for the hinged case is shown at *d* in Fig. 1, and also at *E* and *I* in Fig. 3; it is used to retain the glass and is made from a square of gold-plated stock in a similar manner to the other parts of the case. The first operation consists in forming it into a cup, similar to that shown at *F* in Fig. 3. This is accomplished by a combination blanking and cupping die *A*, punch *B*, and plunger *C*, shown in Fig. 7.

After blanking and cupping, the bezel is annealed and pickled; then it is coaxed over in the die *D* by punch *E*. This leaves it in the condition shown at *E* in Fig. 3. After this operation, the bezel is taken to the punch press and the center blanked out with the die *F* and punch *G*, shown in Fig. 7. This leaves the bezel in the condition shown at *I* in Fig. 3, when it is ready for inletting for the glass. This operation is accomplished in a machine of the type shown in Fig. 4. The bezel is then jointed and pinned to the center. The bezel *D*, shown in Fig. 1, which is used on the screw case is threaded in the machine shown in Fig. 6.

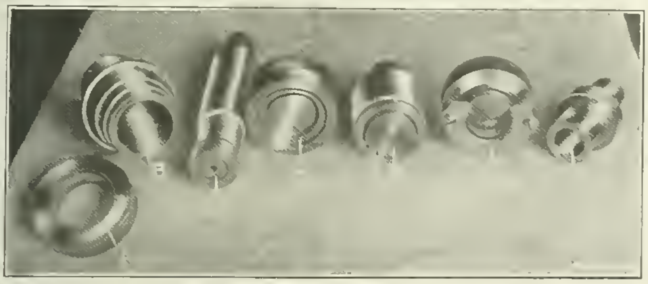


Fig. 7. Punch Press Tools used in Producing the Bezel for a Jointed Open Face Watch Case

* * *

PATENT LAW INVESTIGATING COMMISSION

A special message sent by the president to Congress, relating to the appointment of a commission to investigate the patent laws and report on necessary changes, is one which will be endorsed by all persons who have a wish for the sound development of the country's industries at heart. One of the main reasons given by the president for this message is that the present patent laws make it possible for large corporations to buy up patents and suppress their manufacture, so that the public never receives the benefit of many inventions during the life of the patent. Meanwhile any other inventor is prevented from developing ideas of his own, if they should have enough similarity to the already patented but unused devices to constitute an infringement.

COMBINATION FORMING AND TESTING MACHINE

By F. B. HAYS

Recently the writer had occasion to make a series of experiments with plastic masses pressed into hard substances of various shapes. As the experiments covered an entirely new field of development, special machines were required for treating the raw materials used in producing the plastic masses, for pressing the latter into the required shape, for accurately determining the pressure used in the compression, and for testing the compressive strength of the shapes after forming. After considerable study and a few preliminary tests the machine shown in Fig. 1 was designed and built for performing the last three operations.

The machine consisted of a heavy cast-iron frame *A*, and a screw *B* operated by a steel gear *C*. This was driven by the pinion *D* which was keyed and pinned to the shaft *E*. The screw was kept from turning by a key. The lower half of the casting was bored and reamed vertically and horizontally as shown, and then bushed by steel tubing *R*, ground externally and internally. The ends of these holes were closed by absolutely tight plugs and gaskets after the pistons *F* and *H* had been inserted into the bushed holes, and the space back of them filled with a very heavy oil.

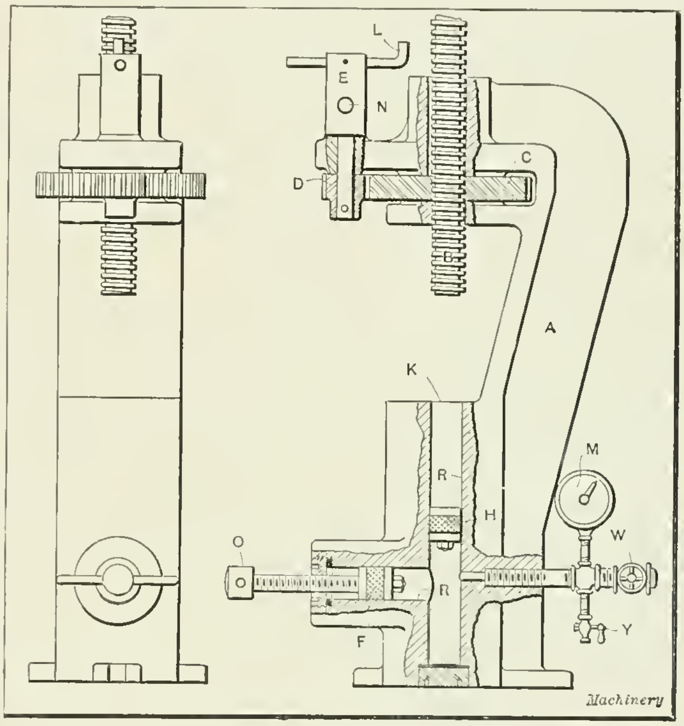
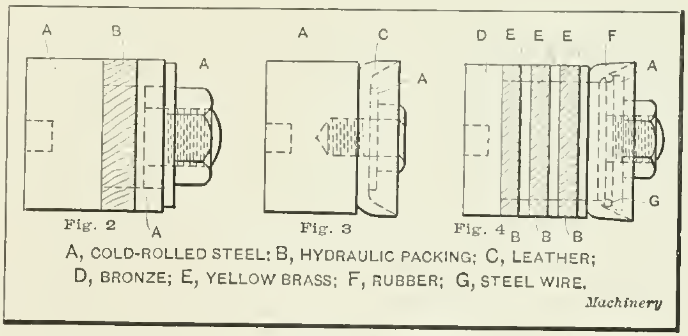


Fig. 1. Combination Forming and Testing Machine


A
B
A
A
C
A
D
E
E
E
F
A
G
Fig. 2
A
Fig. 3
Fig. 4
B
B
B
A, COLD-ROLLED STEEL; B, HYDRAULIC PACKING; C, LEATHER;
D, BRONZE; E, YELLOW BRASS; F, RUBBER; G, STEEL WIRE.
Machinery

Figs. 2 to 4. Various Forms of Pistons for Hydraulic Testing Machine

The operation of the machine is as follows: A split die is inserted at *K*, so that it rests on the piston *H*. The die is partly filled with the plastic composition, and a steel plunger is inserted into it at the top. The screw *B* is then run down by means of the crank *L* until it presses on the top of the plunger. A round steel lever is then inserted into the hole *N*, and the screw *B* run down until the pressure desired is registered by the gage *M*. The screw is then run up, and the valve *W* permits water to enter from a city water main, which causes the piston *H* to rise to the top of hole *R*, thus pushing the die and plunger out of the machine.

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When testing, the formed composition (after being treated) is placed on the piston *H* and the screw run down upon it until it cracks. The piston compresses the oil and water so that the pressure at which the test piece cracks is registered by the gage *M*, the valve *W* being closed. The cock *Y* is then opened and the water drains from the machine so that the piston may be pushed back into place. The heavy oil will not pass through the cock. The hand screw *O* and the piston *F* are used when the city water pressure is not sufficient to raise the piston *H*. In this manner the machine both made and tested the formed pieces.

In making experiments with this machine a number of interesting facts were noted which may be useful to persons coming in contact with high-pressure hydraulic work. The pressure used in the experiments varied from 40 to 20,000 pounds per square inch.

The first interesting fact noted was that water worked through the heavy cast-iron walls at about 1800 pounds pressure per square inch, and that it ran through so rapidly at 6000 pounds pressure that it was impossible to increase the gage pressure. Upon the substitution of heavy black oil this leakage was eliminated below 5000 pounds. Upon coating the internal walls with water glass and pressing in the steel bushings, practically all leakage was prevented up to 20,000 pounds per square inch, so long as oil was used. Originally the greatest source of leakage was around the pistons, which were first made as shown in Figs. 2 and 3. These pistons leaked a great deal at 1400 pounds when water was used, and at 2500 pounds when oil was used. Pistons of the type shown in Fig. 4 were then substituted with very satisfactory results up to 16,000 pounds pressure per square inch. This type of piston leaks less after being used for a short time than when first inserted.

* * *

An alloy of iron and cobalt in the proportions of iron from 65 to 70 per cent and cobalt from 30 to 35 per cent is highly magnetic; the magnetism of this alloy at saturation is stated to be 10 per cent greater than that of the pure iron.

CONTENTS OF HORIZONTAL CYLINDRICAL TANKS

By FRANCIS J. FRENCH*

When a cylindrical tank placed in a horizontal position is partly filled with a liquid, the cross-sectional area of the fluid in the tank is, of course, a circular segment. The usual way of calculating the volume of the fluid in the tank would be to find the area of this segment and multiply this area by the length of the tank. In this way, the volume of the fluid would be found in cubic feet or cubic inches, according to the unit of measurement used. This expression, then, would usually have to be converted into gallons.

A rapid approximate method is provided by the accompanying diagram, the use of which is illustrated by an example in dotted lines. The scale on the left-hand side of the diagram gives the ratio of the depth of the fluid in the tank to the total diameter. The diagonal lines on the diagram give, respectively, the diameter of the tank and the total length. The scale on the right-hand side of the diagram gives the volume of the contents in U. S. gallons per foot of length, while the scale at the bottom of the diagram gives the total contents of fluid in the tank.

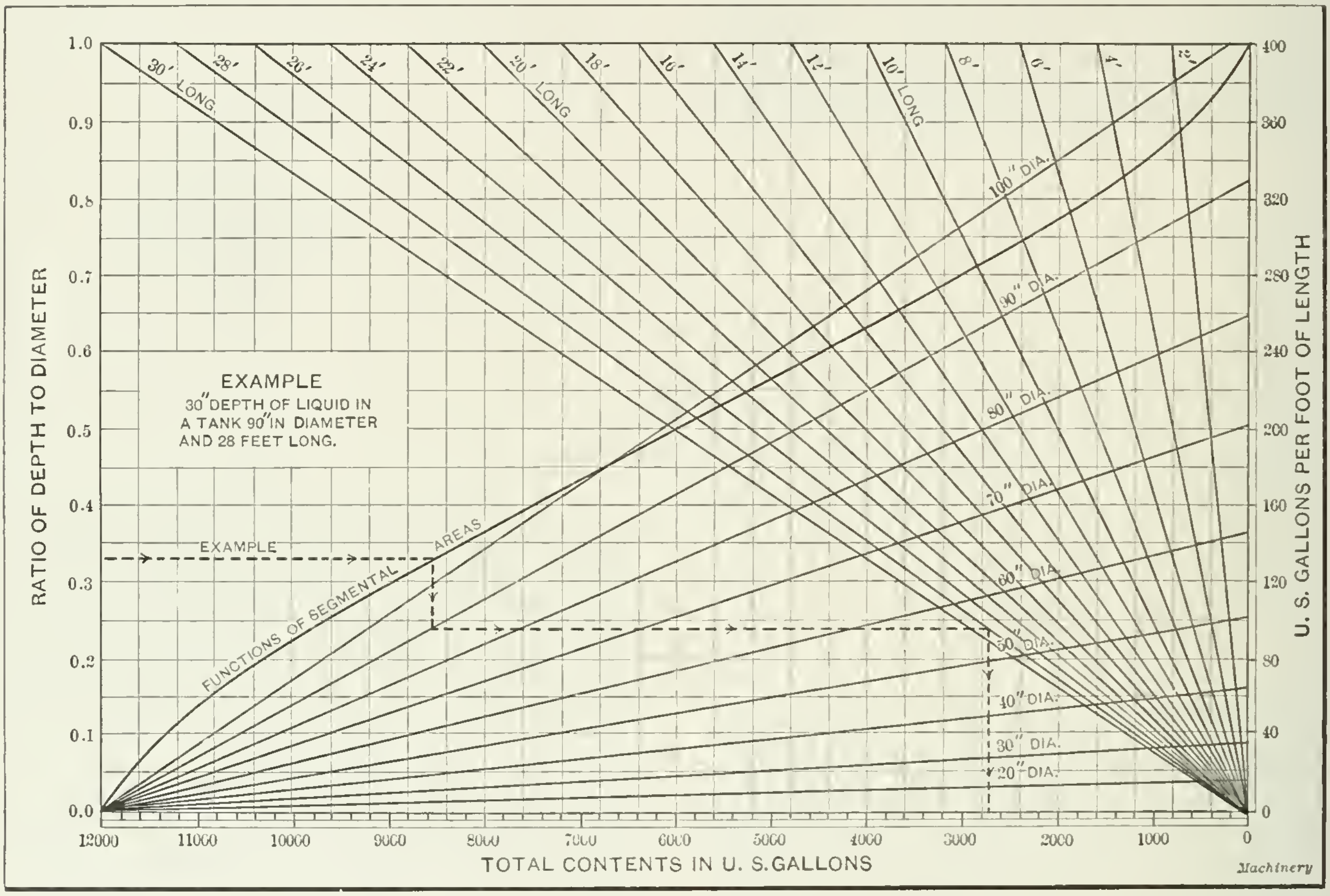

Diagram for Finding the Contents of partly filled Horizontal Cylindrical Tanks

As an example, let us assume that the liquid fills the tank to a depth of 30 inches, that the total diameter of the tank is 90 inches, and that it is 28 feet long. The ratio of depth to diameter is then one-third, and, beginning at this point on the scale to the left, we follow a horizontal line until it intersects the line marked "functions of segmental areas." From this line we follow a vertical line until it intersects the line denoting the diameter of the tank, and then again a horizontal line until it intersects the line for the total length of the tank; from this point we follow a vertical line to the bottom scale which gives the volume of the liquid in U. S. gallons. If from the last point of intersection we had continued following a horizontal line, instead of a vertical line to the bottom scale, we would have located a point on the scale to the right which would have given the volume of liquid per foot of length of tank in U. S. gallons.

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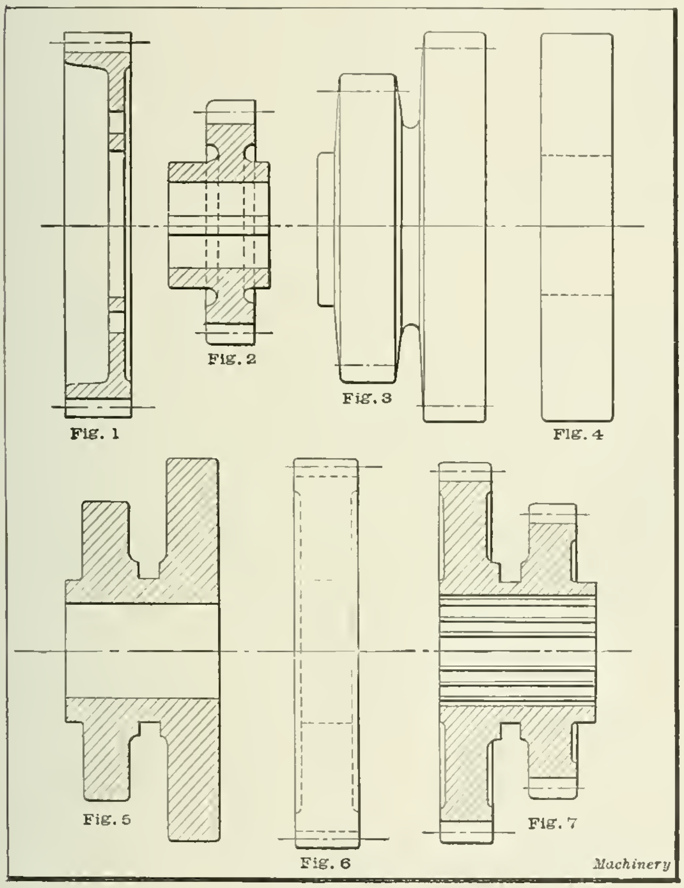
PROCESSES IN PRODUCTION OF AUTOMOBILE TRANSMISSION GEARS[*][†]

One of the most important problems in modern automobile construction, and one which has received a great deal of attention from mechanical engineers during the past few years, is that of the quiet working of the running parts. Next to the engine itself, the gears have proved the greatest offenders in making noise. Therefore, the demand for gears which are accurate, interchangeable and silent, together with the necessity for producing them both rapidly and at a low cost, has caused a great deal of attention to be devoted to the various processes, tools and appliances whereby that demand may be satisfied. We thus find that there are being placed on the market an increasing number of machine tools, steels and carbonizing materials, each of which claims some advantage over its predecessors, such as increased output, greater simplicity, superior generating features, and better hardening results. It is the intention, however, to deal here chiefly with the processes of manufacturing gear-box gears by means of a complete equipment of gages, tools, jigs, etc., with the object of insuring interchangeability. To a very large extent fitting is thus dispensed with. After the final machining operation has been performed, the parts should be ready to be assembled. When a duplicate part is wanted it can be supplied from stock, as the methods here to be described insure that it will fit into its correct position without trouble.



Figs 1 to 7. Automobile Transmission Gears at Various Stages of Completion

There is probably no part of an automobile that is subjected to greater use—and abuse—than the gears, especially the gear-box gears. Carrying, as they do, practically all the power developed by the engine, and receiving at the hands of a careless driver the strains imparted by suddenly applied load or by rapid changes, it is absolutely necessary that the gears be made of the highest grade materials, and that the very greatest care and the best workmanship should be bestowed upon them. As the saving in weight is an important factor in the design of the transmission, the gears must be made as small and as light as possible, and yet be sufficiently strong to carry suddenly applied loads with no danger of breaking. Owing to the methods by which the speeds are changed, and the clashing and bruising to which the gears are thus subjected, the transmission mechanism must be made of material which is both hard and tough. Different kinds of steel have been used, and each has been treated by various methods in the attempt to discover the perfect gear material. Although this has not yet been found, so much progress has already been made that the transmission gear of a modern well made automobile, when carefully handled, will last nearly as long as the car itself.

Steels used for Automobile Gears

Of the various kinds of steel which have hitherto been employed, nickel, nickel-chrome and chrome-vanadium steels seem to have more advocates than any others. In most factories the gears are casehardened, and it is this class of gear which will be dealt with in the following. Gears treated in this way have been taken out of cars which have been run many thousands of miles, and in some instances the original tool-marks on the face of the teeth were still visible.

The processes in the manufacture of low carbon nickel-steel casehardened gears, such as the finished gears shown by Figs. 1, 2 and 8, will be described in the following. The various processes will be explained in the order in which they are performed. The composition of nickel steel, suitable for high-speed gears, is as follows: Carbon, 0.20 per cent; manganese, 0.65 per cent; silicon, not exceeding 0.20 per cent; phosphorus, not exceeding 0.04 per cent; sulphur, not exceeding 0.04 per cent; and nickel, 3.50 per cent. Steel with 3.50 per cent nickel rolls and forges well, and when hardened, the ratio of the elastic limit to the ultimate strength is very great. The influence of nickel on steel is that it increases the tensile strength and the elastic limit.

Nickel steel of the composition just mentioned should have an elastic limit, after treatment, of about 30 tons per square inch. The influence of silicon on the results of quenching is similar in many ways to that of carbon. It is dependent on the co-existing amount of carbon and manganese, and it is difficult to obtain silicon in steel without the presence of manganese. Silicon appears to increase the tensile strength and diminish the ductility; but for various reasons it is generally considered objectionable.

Phosphorus is the least desirable element in steel, but up to one per cent it appears to increase the tensile strength. Sulphur tends to produce hot-shortness and difficulty in working, but in the presence of manganese the effect is diminished.

The Gear Blanks

Blanks for gears of the type shown in Fig. 1 should be cut from the bar, since it has been proved that steel is not improved by drop forging, although some steels are less sensitive to injury than others. An investigation of drop forged and bar-cut nickel steel gears, details of which were given in a paper read by Mr. John A. Mathews before the Franklin Institute (see MACHINERY, August, 1909, engineering edition, "Alloy Steels for Motor Car Construction"), showed that under static tests the bar-cut gears were fully 25 per cent stronger, and also that the resistance to shock was greater. The gears shown in Fig. 8 should be made from a drop forging, as shown by Fig. 3, although when only small quantities are required, it would not pay to make dies. In this case ordinary forgings should be considered. Gear blanks should be annealed previous to machining.

The reasons for leaving so much extra metal will be explained in the order in which they concern the various operations necessary in the attempt to get a perfect gear—an end which, it is needless to say, is seldom, if ever, attained. In the case of a gear as shown in Fig. 2, made from a bar, it is not necessary, for reasons which will be seen later, to leave any extra metal. Much of the trouble due to distortion in the heat-treatment is caused by the forging operations being done at too low a temperature, in which case the metal does not have a chance to flow properly, but is merely forced into shape by the die. This sets up internal strains that will be released when the part is annealed.

Rough-turning and Annealing

The first operation is to rough-turn the part all over for the purpose of removing the outer skin, previous to the second annealing, leaving a one-sixteenth inch case on the parts required to be hardened, such as the top diameter of the gear, and the sides of the teeth. For the bore a one-eighth inch allowance is required, in gears where the hole is to be a running fit, or castellated, and has to be hard. A one-quarter-inch allowance, however, is necessary when the gear has to be bolted to a center, or to another gear, in which case the bore need not be hard, as it is only used for locating the gear centrally. In rough-turning, allowance must be made for the extra metal, the gears, after machining, appearing as shown in Figs. 4 and 5.

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[*] Paper read by Mr. Walter Betterton before the Graduates' Section of the Birmingham (England) Branch of the Institute of Automobile Engineers, April 25, 1912.

[†] See the following articles previously published in MACHINERY: "Alloy Steels for Motor Car Construction," August, 1909, engineering edition; "Casehardening," August, 1905, engineering edition. See also MACHINERY'S Reference Book No. 63, "Heat Treatment of Steel."

When making gears it is, of course, necessary to have the steel carefully and uniformly annealed. The process of annealing is one of great importance, and is better performed in a specially designed sealed furnace, constructed as a muffle, so that the required heat is obtained uniformly by radiation, without any flame to impinge on the steel. In addition to softening the steel, and making it easy to machine, annealing has the effect of bringing it to a more homogeneous condition by eliminating the molecular strains which are set up by rolling, hammering and stamping. Hence, when the steel is heated preparatory to hardening, equal expansion should follow, and also equal contraction when cooled.

It will thus be seen that should the steel not be annealed uniformly throughout, the risks of warping when hardening are considerably increased. The object of rough-machining is to break down the scale preparatory to the second annealing, and as the strains set up by rough-machining are released by the second annealing, the metal is then in as normal a condition as possible. At the present time there are many compounds used for annealing. A few years ago, the ashes from the forge were considered sufficient for properly annealing steel, but today many special preparations are manufactured and sold for the purpose.

The more common materials used are powdered charcoal, charred leather and hydro-carbonated bone-black. These same materials are used for carbonizing, but after having been used once they are of very little use for that purpose. However, their use for annealing has the additional merit of economy, because they can be used repeatedly, adding each time a little that has only been used for the carbonizing process. Air-slacked lime may also be used for this process. The piece to be annealed is usually packed in a wrought-iron box, using one of the previously mentioned materials, or combinations of them, for the packing. The whole is then heated to the proper temperature, which is about 1760 degrees F. In the case of the gears in question, this temperature should be maintained for one hour. The box may then be set aside with the cover on in order to cool down to atmospheric temperature, or it may cool off with the furnace. It should be noted that the annealing temperature ought always to be higher than that for carbonizing. For all kinds of steel and for all grades of annealing, the slow-cooling furnace gives the best results, because the temperature can easily be raised to the right point, kept there as long as necessary, and then regulated to cool down as slowly as desired. Gas, oil, or electric furnaces are, of course, the easiest to regulate.

Finish-boring and Broaching

Gears to be broached as shown in Fig. 8, should be finish-bored with an allowance of 0.015 inch for grinding after hardening, and faced on one end true with the bore to take the thrust of the broaching on a La Pointe or similar broaching machine. The broaches should be made of carbon steel, oil hardened, tempered and ground, and should be specially treated. It is necessary to treat the steel with some carbonaceous material until it will harden in oil, as it is well known that steel hardened in oil is less likely to spring than if hardened in water. The tendency for steel to crack is almost eliminated and it has a maximum of toughness, unless, of course, the steel has been improperly treated in the fire. The special treatment consists essentially in supplying the surface of the steel with an additional amount of carbon by some material that will not injure the steel. No form of bone should be used on tool steel for this process, as bone contains a high percentage of phosphorus, and the effect of this is to make the steel weak and brittle. Charred leather gives the best results.

The over-all length of the broach suitable for the gears shown in Fig. 8 is about 26 inches, the cutting portion being about 17 inches, and the teeth of 5/8-inch pitch, cut straight and backed off. The pilot should be about 3 inches long. The teeth should never on any account be cut spiral, as this tends to twist the broach while in operation, and consequently the castellation would not be true. To produce an accurate castellated hole, as shown by Fig. 8, in nickel steel, it is necessary to use about ten roughing broaches and one finishing broach, especially when this operation is to be performed to very fine limits, as in the case of the gears in question. The last four teeth in each broach should be parallel, and the rest tapered in equal progression. On the first broach the pilot should be round and of the same diameter as the hole in the gear to be broached. On the following ones the pilot should be a sliding fit in the hole produced by the previous broach, and should at the same time be located from the castellations.

The finishing broach should have a piece at the rear end, about 3 inches long, of the exact size of the castellated shaft on which the gear is to be fitted when finished. This will act as a burnisher. The broaches are pulled through the work, which is quite a good feature, as it tends to keep them straight while in operation. The cutting portion being so long enables the operation to be performed without previous rough-slotting, which is required when the gears are drifted on the power press. After broaching, the gears should be turned.

Finish-turning

Castellated gears should be turned on a mandrel, locating from the castellations. The parts required to be hard, such as the top diameter of the gears, which should have an allowance of 0.005 inch for gear-cutting purposes, and the sides of the teeth and fork groove are then finished, leaving the gear as shown in Fig. 5. In the case of the gear in Fig. 1, the top diameter should be finish-turned with an allowance of 0.005 inch, and the sides of the teeth and the bore with an allowance of 0.125 inch, so that the latter can be bored out again after carbonizing, which would leave the hole soft, as it is not required to be hard. The finish-turning leaves the gear as shown in Fig. 4. Gears such as shown in Fig. 2 can be finish-turned and bored complete at this operation.

Cutting the Teeth

One of the most important operations is the cutting of the teeth after annealing. The method to be described is at present in practice and gives very successful results. The teeth should be roughed out on the hobbing machine and, where possible, several gears should be placed on the work-arbor at one setting. A great deal of time is saved by placing several gears on the work-arbor, which should always be steadied at the top. Suppose six are to be cut at one setting; this would mean that the hob would only have to travel into and clear the work once instead of six times, which would be necessary if they were cut singly. When putting several gears on the arbor, they must be faced exceedingly true, or the arbor will be bent. This is especially true when the hole is small and the gears large in diameter. Plenty of lubricant should be applied in this operation, oil being most commonly used. The hob should be made of high-speed steel, a six-pitch hob being 3 inches in diameter, and a five-pitch hob, 3½ inches in diameter. On account of the accuracy required, single-threaded hobs are preferable. For the roughing operation a cutting speed of sixty feet per minute of the hob, and 0.020 inch feed per revolution, are considered good practice for a nickel steel six-pitch gear.

For the finishing operation at least 0.010 inch should be allowed for a six-pitch gear and other pitches in proportion. If the finishing cut is merely a scraping cut and not enough stock is removed to let the cutter get a real chip, the cutter may glaze over the work, especially if the cutter and the work-arbor are not held rigidly. The gears should be finished one at a time, excepting plate gears, in which case several can be placed on the arbor at one setting. For this purpose a Fellows gear shaper should be used, because the cutter can be made far more accurate than a hob or a rotary cutter. The teeth of this cutter can be ground after hardening, and this corrects any inaccuracies that may have crept in. On the cutter-arbor, at the back of the gear-cutter, should be placed a round disk made of high-speed steel, hardened, ground and backed off, which will act as a shaving tool and will take off the 0.005 inch left on the top diameter, as previously stated. This will make the outside diameter true with the pitch line. The teeth should be cut about 0.001 inch thin at the pitch line to produce a running fit. The gears should now be tested for center distance, for which purpose a plate with two pins for the bores, set at the correct center distance, should be used.

Owing to the courtesy of Mr. Ward, of the Universal Gear Grinding Co., the author has had the opportunity of seeing in operation a machine for grinding gear teeth, which has the appearance of filling a long-felt want in the automobile industry. If it is—and the author believes it is—what the makers claim for it, it would not be necessary to finish-cut the teeth, as, with the exception of those of the gear shown in Fig. 8, they could be ground after hardening. This would obviate the final process of "grinding-in" with emery and oil, a process which at present is so unsatisfactory. In the case of the gear teeth shown in Fig. 8, the grinding wheel would foul the large gear when grinding the small one, to overcome which it would be necessary to re-design the gear and make it in two parts. The machine has many good features, the main one being that the shape of the wheel is maintained by three diamonds which dress the wheel, and which are controlled by one former. One is used for truing up the top diameter of the wheel, and one is placed on each side for truing the curvature.

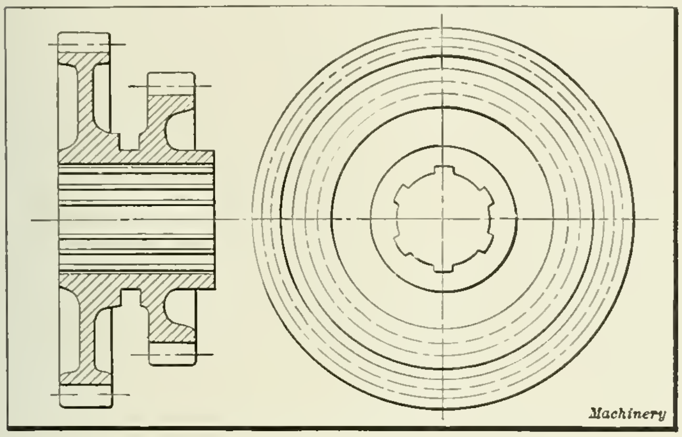

Fig. 8. Completed Gear, shown in Progress of Evolution in Figs. 3, 5 and 7

The tooth-rounding should be performed on an automatic tooth-rounding machine. Several gears should be mounted on the same arbor, and the teeth of the wheels may be rounded in succession at one setting. No doubt most readers are quite familiar with the reason for this operation, which, therefore, requires little explanation, unless it be to say that it is done to facilitate the changing of the gears, and also to prevent the teeth from being chipped when engaging, which would occur if the corners were left square. The sides of the teeth which are not rounded should be fraised before carbonizing, which is the next operation.

The Carbonizing Process

In carbonizing, great care should be taken, as, to a very great extent, the life of the gear depends on this process. The result of the process is determined by four factors, namely: the nature of the steel; the nature of the carbonizing materials; the temperature of the carbonizing furnace; and the time taken by the process. The carbonizers in general use at the present time are animal charcoal, hydro-carbonated bone-black, charred leather, and a few other compositions sold under various names. Owing to the various conditions under which the operation is carried out, experience must largely guide the operator. Theoretically, the perfect carbonizer should be a simple form of carbon, and charred leather gives very satisfactory results. Care should be taken to avoid poorly charred leather, or that made from old boots, belting, etc. Good charred leather should contain about 88 per cent of carbonizing matter.

As it is essential that the core of the gears should be left soft in order to withstand the high speed and sudden shocks to which they are subjected, the carbon content in the core should be low. For this reason preference is given to 0.20 per cent carbon steel. The carbonizing pots are made from both cast and wrought iron; the former are cheaper in first cost, but the latter bear reheating so many times that they are really cheaper in the end. The carbonizer having been thoroughly dried and reduced to a fine powder, a layer of not less than 1½ inch in depth is placed in the carbonizing pot and well pressed down. Upon this, are placed the articles to be treated. Care must be taken to have sufficient space all around each piece so as to prevent them from touching each other or the walls of the pot. About 1½ inch is sufficient. Another layer of carbonizing material is then put in and well pressed down, care being taken not to displace any of the gears. The process is then continued until the pot is full, finishing with a layer of about 1½ inch at the top.

The object in view is to make the contents of the pot as compact as possible, consistent with a sufficiency of carbonizer in contact with the gears. The more solidly the pot is packed, the more complete the exclusion of air. The lid is then put on, and the joint all round luted with clay. The pot should be placed in a furnace similar to that used for annealing, and heated to about 1700 degrees F., which heat should be maintained constant for from six to ten hours. The length of time occupied is regulated by the depth of casing required, which should be about three-sixty-fourths inch, and also by the dimensions of the gears. At the close of the carbonizing period, the pot is withdrawn and put in a dry place where it is allowed to cool to atmospheric temperature. It is then opened, the articles are taken out, and the process is completed by brushing to remove all adhering matter.

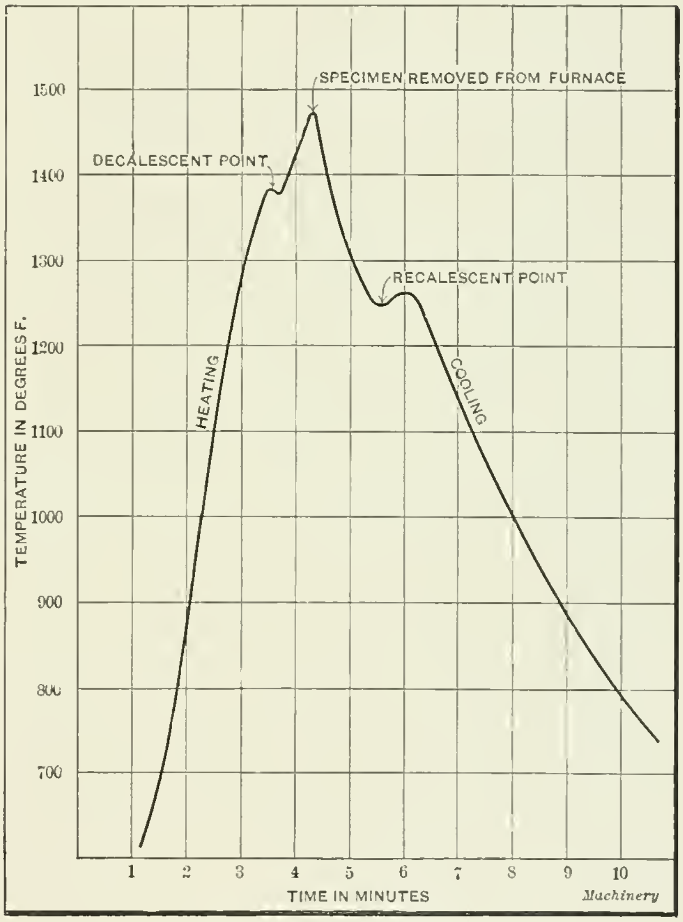

Fig. 9. Curve showing the Decalsscent and Recalescent Points for Low Carbon Nickel Steel

It may be noted here that the case should only be deep enough to resist wear and battering. If the case is so deep as to form a considerable part of the cross-section of the teeth, the teeth may break unless the case is considerably tempered.

Turning Operations Preceding Hardening

The next operation is to turn out the carbon from the parts required to be soft. In the case of the plate gear shown in Fig. 1, which is to be bolted to another gear or center, as previously stated, the hole need not be hard. For this reason, it was left with an allowance of 1/8 inch at the previous turning operation. It should now be bored with an allowance of 0.015 inch for grinding after hardening, and faced down on both sides. This refers to both plate and castellated gears as shown in Figs. 6 and 7. The boring operations should be performed while the gear is held in a collet-chuck, locating from the top of the teeth, which were trued up with the pitch line by the shaving tool used when cutting the teeth, as previously explained. This method has been found to be more efficient than locating with balls or rollers on the pitch line. The penetration of carbon being only about three-sixty-fourths inch it is now removed from the parts which have just been turned. Consequently these parts will not be hardened. The excess metal is left as shown in Figs. 6 and 7 until after hardening, in order to prevent warping, which would undoubtedly happen if the gears were finished as shown by Figs. 1 and 8.

The Casehardening and Oil Tempering

Steel of the composition mentioned can be hardened as follows: Heat from 1450 to 1525 degrees F. and quench in water; re-heat to about 1400 to 1450 degrees F., and quench in water. The re-heating must be conducted at the lowest possible temperature at which the steel will harden. It will be found that this is sometimes as low as 1300 degrees F. Then, as a safeguard, re-heat to a temperature of between 250 and 500 degrees F., in accordance with the requirements of the case, and cool slowly in oil. Parts of intricate shape, such as the gears dealt with, having sudden changes of thickness, sharp corners and the like, should always be tempered or drawn in order to relieve internal strains.

Another method of procedure is as follows: Heat from 1450 to 1525 degrees F., and quench in hot brine. Re-heat from 1450 to 1525 degrees F., and quench in oil. The temperature need not be drawn when the gears are quenched in oil. The final quenching should be done at the lowest temperature at which the piece will harden, as stated in the first method.

A small gas muffle should be used for hardening. A properly constructed gas muffle can be regulated with the greatest nicety, and in hardening this is most important. When steel is gradually heated, there is a certain point at which a great molecular change takes place, and perfect hardness can only be obtained by quenching at this critical point. This would lie between 1300 and 1450 degrees F. When steel is cooled, whether slowly or not, it bears in its structure a condition representative of the highest temperature to which it was last subjected. From this it will be quite clear that in casehardening, as in all methods of hardening, the steel must be quenched on a rising heat. Steel which is overheated previous to the final quenching, is very brittle and liable to fracture easily, and although quenched and subsequently hardened, the metal has little or no cohesion, and rapidly wears away. Steel so hardened breaks with a very coarse crystalline fracture, in which the limits of the case are badly defined. If quenching takes place below the critical point previously mentioned, the steel is not sufficiently hard. If above, though full hardness may be obtained, strength and tenacity are lost, in part or completely, according to the degree of heat by which the critical temperature is exceeded.

It may be asked why it is not sufficient, when the pieces are heated at the first re-heating to about 1500 degrees F., to place them in another furnace and reduce to the critical temperature and quench, instead of quenching twice. The answer is that the high temperature has already created a coarse crystalline condition in the steel, and that, until it has been cooled down below the critical point, and re-heated to the critical temperature, a suitable molecular condition cannot be obtained.

As a further means of illustrating what is meant by the critical point, Fig. 9 shows a curve plotted from results obtained by a recording pyrometer, in which the decalescent and recalescent, or critical points are shown. From this it will be seen that the absorption of heat occurred at about 1375 degrees F. on the rising temperature; and the evolution of heat at 1250 degrees F. on the falling temperature which was allowed to fall slowly. The relation of these critical points to hardening is that it cannot take place unless a temperature sufficient to produce the first action is reached in order to change the pearlite carbon to hardening carbon; and also unless it is cooled with sufficient rapidity to eliminate the second action. The temperature would, of course, be gaged with a pyrometer.

Sandblasting

The sandblasting, which serves to scour off any roughness or stains which have been left on the surface during the heat-treatment, etc., is best conducted in a building separated from the remainder of the shop. The sand should be kept in a bin in one corner, and sucked up by a centrifugal blower and forced by air pressure through a blow pipe which terminates in a nozzle. The sand being forced by the air at a high velocity, may be directed at all parts of the piece to be cleaned. This is one of the most efficient methods of polishing and cleaning the gears, and does not injure the hard surface in any way.

Hardness Testing

The gears should now be tested for hardness. The scleroscope appears to be the best instrument for doing this. If a gear shows a considerable drop in hardness, a file should be used to determine whether the cause is due to the piece not being hard, or to crystalization. If the parts can be scratched with a file, it shows that it is not hard enough. If, however, the file will not bite on the spot where the scleroscope reads low, then it is positively known that it has been overheated and is crystalized. A good method of testing the teeth is the drop test. By this method a ten-pound weight with a 56-inch drop is directed at one tooth. The number of blows necessary to break the tooth should be noted. This test would only be applied occasionally, say, on one out of each batch of gears. A gear which has given satisfaction should be tested, and the result used as a standard for future comparison.

Final Turning Operations—Grinding

The metal left for supporting the gears while undergoing heat-treatment is now removed. This operation should be carried out with the gear held in a collet-chuck, and care should be taken that the outside diameter runs true before starting. The hole having been bored after carbonizing, is now soft. The metal can be turned out on both sides, or on one side, as the case may be, leaving 0.005 inch on the face of the web for grinding. This operation should come next, and is most essential in order to get a true running gear when in position. The castellated gears which were finish-bored with an allowance of 0.015 inch before carbonizing are now hard, this being necessary as they have to be a sliding fit on the shaft. The part of the bore which bears against the lands of the castellated shaft is all that can be ground. Unfortunately no method has yet been devised for grinding the castellations themselves, and these, therefore, have to be lapped separately by hand—which is most unsatisfactory. While grinding the bore, the gear should be held in a collet-chuck from the top diameter—hence the truing of the top diameter with the pitch line in the gear-cutting process. Gears ground in this way should be perfectly true, and are now ready to be tested for center distance and true running.

The Drilling

It should be clearly understood that the web of the gear shown in Fig. 1 is now soft. This brings us to the final machining operation, that is, the drilling. There are many advantages gained in leaving this operation until the last. The bore is now the correct size, this being essential for locating the drilling jig. Furthermore, in the grinding operation, the bore is totally ignored, the top diameter being the most important. The hole has been ground true with the latter, so that if the holes had been drilled previous to the hardening, they would not be concentric with the bore, and would not match with the gear or center to which it has to be bolted. Another advantage is that the holes are now soft and can be reamed with the piece to which the gear is to be bolted, it being understood that these would also be left soft in the parts in which the holes are required. All these are important points, and this is the reason for leaving the drilling until last.

The "Running-in"

The gears should now be bolted to their respective parts and finally "run in" before being placed in the car. This should be performed in a special case, and the "running-in" done under belt power. The bearings, in these special cases, are set at the proper center distance, so as to accommodate the various gears of a train, thus wearing in the gears so that all those for similar parts are absolutely interchangeable. The case is made oil-tight, and a mixture of finely powdered emery and lubricating oil is forced through an opening in the top, so that this grinding material will come in contact with all the teeth in mesh in the train. The grinding is continued until each tooth has been worn perfectly smooth, and to an accurate fit with the teeth of the other gears with which it comes into mesh. As a further means of thoroughly running in the gears of the transmission to a perfect fit, the motor, transmission and driving shaft are installed in the chassis, and the motor is run while the various speeds of the transmission are thrown into mesh. During this run an electric dynamoter, by means of which a variable load may be applied, is connected to the end of the driving shaft. The gears should now be as perfect as, with the best practice yet known, it is possible to get them.

It may be objected here that the leaving of extra metal for heat-treatment is rather costly. This is a question upon which there is room for a considerable difference of opinion. The author is of the opinion that if the method of leaving extra metal is used with discretion, and only in the case of very intricate gears, the most satisfactory results should be produced.

* * *

VANADIUM IN HIGH-SPEED STEEL

When high-speed steel was first alloyed with vanadium the vanadium was used in no greater amounts than 0.2 to 0.3 per cent, but it has been found that greater percentages produce better results, and as much as 0.75 to 1 per cent is now generally used. The efficiency of a tool may be measured either by the cutting speed at which the tool will last for a specified time, or by the length of time it will last under the same speed and general conditions without resharpening. Tests have shown that a tool steel containing 0.3 per cent of vanadium will stand up under a ten per cent increase in speed as compared with the same steel containing no vanadium. If 0.6 per cent of vanadium is added, an increase of twenty per cent in the speed is possible, and with 0.9 per cent of vanadium the speed may be increased thirty per cent. As regards the effect on the time between grindings, the speed and other conditions being the same, 0.3 per cent vanadium in the steel doubles the time between grindings, 0.6 per cent quadruples the time, and 0.9 per cent octuples it, eight times as much metal being removed between grindings, if the same speed and feed are used as would be efficient with the same steel containing no vanadium. These figures are given in a recent publication issued by the American Vanadium Co., Pittsburg, Pa.

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TOO MANY SPEED CHANGES NOT AN ADVANTAGE

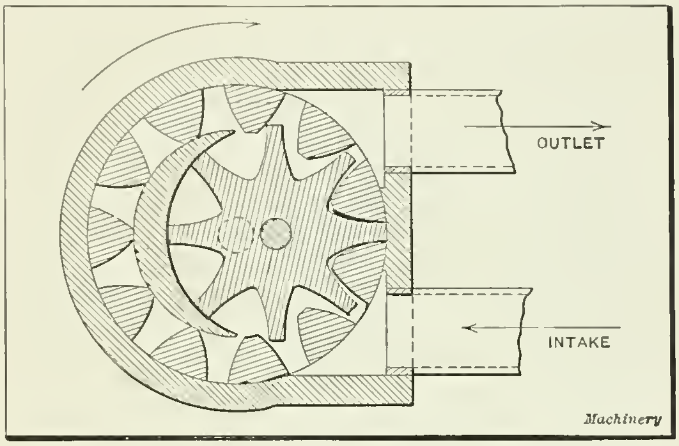
In an article on "Rational Machine Tool Design," by Prof. J. T. Nicolson, published in the *Machine Tool Engineer*, a supplement to the *Practical Engineer* (London), the author states with great emphasis that "the modern craze for large numbers of spindle speeds is not warranted by considerations of commercial economy; and it is to be distinctly condemned from the point of view of technical efficiency. The fewer the number of speeds, the broader, stronger, and more durable can be the gears, the smaller will be the power wasted in friction and the more compact and handy may be the headstock" of a machine tool. He says, further, that there is no money for the user, in a headstock with a large number of spindle speeds. and, even if there were, it is very doubtful whether the operator would use the speed changes intelligently. The added complication is a source of trouble in the working of the machine. A simple headstock with from eight to ten speeds, is, according to Prof. Nicolson, the best for every requirement. The great secret of economical cutting is not a complex headstock with many spindle speeds, but a lathe of moderately simple design which is kept constantly at work.

THE VIKING ROTARY PUMP

The accompanying illustration shows the principles of an interesting rotary pump, invented by Mr. Jens Nielsen of Cedar Falls, Iowa, which has recently been tested at the Engineering Experiment Station of the Iowa State College, and is described in the April number of the *Iowa Engineer*.

As will be seen in the illustration, the pump has but two moving parts—an outside annular gear, and an inside spur gear. The large gear has a shaft at the back which extends through the pump casing and carries the driving pulley. The spur gear is mounted on a stud extending from the opposite side of the casing, which also has a crescent shaped projection on one side, dividing the space between the two gears as shown. While, in the illustration, the lower pipe is shown as the intake pipe and the upper pipe as the outlet, either may be used for the intake, depending upon the direction of rotation. The action of the pump is evident. After the water enters the pump, it is carried around the pockets formed by the teeth in the large gear and the crescent-shaped projection. When the gears come into mesh on the upper side, all water is forced into the outlet port.

Tests have been made with heads varying from 30 to 150 feet of water and at speeds from 200 to 450 R. P. M. At 215 R. P. M., the efficiency was 48.6 per cent. At 400 R. P. M., the efficiency was 76.3 per cent. The average efficiency of all the tests was 64.8 per cent, the average speed being 360 R. P. M. At high velocities, the average efficiency was practically 70 per cent.



Diagrammatical Section of the Viking Rotary Pump

The comparatively positive action of the pump is shown by the discharge per revolution. At the lowest efficiency this discharge was 0.209 gallon, and at the highest, 0.235 gallon, which shows that even at the lowest efficiency the leakage was slight. The volume of water discharged per revolution, if there were no leakage, would be 0.259 gallon.

One advantage of the pump is that only one moving part requires packing—the main shaft where it enters through the back casing. The inventor has used one of these pumps in a stone quarry since 1906 pumping water mixed with mud and fine gravel. This pump is still working satisfactorily.

* * *

An interesting departure in advertising has been made by the American Woodworking Machinery Co., Rochester, N. Y., in a recent issue of *Vocational Education*. This firm offers to give, free, with a stereopticon. a series of slides showing in detail the construction of its No. 77 fast feed planer and matcher, from the foundry to the testing floor. The details which accompany each slide enable a teacher to prepare a talk before his class in connection with the exhibition of the views. What better method is there to acquaint a class in machine shop practice, for instance, with the mechanism and process of construction of a machine, than by showing the actual work? This, of course, can best be seen in the shops but if that is not practicable, the next best method is to show pictures of the operations. These few slides will convey more information on woodworking machinery to a class than pages of written matter or hours of unillustrated oral explanation. The value to the advertiser who thus makes known his tools is obvious.

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We solicit contributions from practical men on subjects pertaining to machine shop practice and machine design. All contributed matter published exclusively in MACHINERY is paid for at our regular space rates unless other terms are agreed on.

JULY, 1912

PAID CIRCULATION FOR JUNE, 1912, 24,674 COPIES

MACHINERY is published in four editions The practical work of the shop is thoroughly covered in the Shop Edition, $1.00 a year, which comprises approximately 700 reading pages. The Engineering Edition—$2.00 a year, coated paper, $2.50—contains all the matter in the Shop Edition, about 300 pages a year of additional matter and forty-eight 6 x 9 Data Sheets filled with condensed data on machine design, engineering practice and shop work. The Foreign Edition, $3.00 a year, comprises the same matter as the Engineering. The Railway Edition, $2.00 a year, is a special edition, including a variety of matter for railway shop work—same size as Engineering and same number of Data Sheets.

NOVELTY IN PATENTS

The communication from Mr. Shaw in another part of this number regarding an application of ball bearings to machine tools, raises an interesting question as to what constitutes novelty in patents. The requirements of construction for a drilling machine spindle as regards bearings are that thrust in the direction of the spindle shall be supported as well as the lateral thrusts due to belt pull and other forces acting against the sides of the spindle. This means that in the simplest form of spindle bearing, as ordinarily made, there shall be two radial bearings and two thrust bearings. Two thrust bearings must be provided, one to take the thrust of drilling, and the other to carry the weight of the spindle when not at work.

The designer of the drilling machine referred to by Mr. Shaw, took up the problem from a new point of view, however, and succeeded in providing a successful ball bearing construction consisting of two radial bearings only. The novelty lies in the elimination of separate thrust bearings by following a perfectly logical assumption. Radial bearings of the well-known annular types are rated as having a thrust bearing capacity of twenty-five per cent of the allowable radial load. Hence the requirements of drilling machine spindle bearings are perfectly satisfied by providing two radial bearings, one of which has a radial bearing capacity of at least four times the thrust bearing requirement. Suppose the maximum thrust to be provided for is 1000 pounds, then a bearing capable of carrying a radial load of 4000 pounds will safely carry the thrust load and, of course, be far above the lateral thrust requirements.

The question is: Does this design, embodying a simple construction found in hundreds of other machines not required to provide for endway thrusts on shafts but which in this case provides for thrusts by greatly increasing the radial bearing factor, constitute novelty? We believe that it does, and that the lucky discoverer of the principle is entitled to all the protection provided under patent laws. The best ideas are generally the simplest, and in this case machine construction has doubtless been improved and simplified at one stroke. This is the height of machine design accomplishment.

* * *

VALUE IN A GOOD NAME

A bill has been introduced in Congress providing that all products intended for interstate or foreign trade shall be stamped with the name and address of the makers. The penalty provided for violation of the proposed statute is a fine of one thousand dollars or imprisonment for six months, or both. The same penalty is provided for erasing or changing the stamp.

It is practically impossible to frame any drastic law that will not work hardship or injustice to a few, and probably this proposed legislation is no exception; but we believe that in the end it would confer material benefits on both manufacturers and consumers. A great step forward would be made for honesty in manufacturing and selling, and dishonest competition would be hard hit.

Every machine tool that carries the maker's name is not only a permanent advertisement for him, but an incentive to produce his best, and security that others shall not appropriate the prestige acquired through honest workmanship and effective design. There can be no objection to a dealer attaching his nameplates to machines sold; but we believe that the policy followed by some dealers of replacing the name of the manufacturer with their own is bad for the industry, because it relieves the maker of all responsibility for the character of his product and places a premium on poor workmanship. A good name and an established reputation are of the greatest help in selling machine tools, and the most successful dealers represent manufacturers who possess them. Their dealers can talk *quality*—the men who are selling tools without any reputation can only talk *price*.

* * *

FIXING RESALE PRICES

Many manufacturers fix the prices at which their products are sold by means of agreements as to resale prices, and by employing the principle of constructive infringement in the case of patented articles. Fixing resale prices has many advantages. The practice enables the manufacturer to advertise a product and the price, and to insure to the retailer a reasonable profit. It secures the retailer's position and prevents unfair competition so ruinous to the trade. Probably one of the most wholesome developments of the past twenty years of American trade has been the establishment of fair resale prices and the elimination of destructive competition.

But the principle of constructive patent infringement, of comparatively recent development, may be used for other purposes than the fixing of fair prices which insure reasonable profit to the retailer. Constructive patent infringement may be used as the means by which monopolistic control of manufactured products can be secured by groups of allied manufacturers. House bill 23417 has been drawn with the view of eliminating the danger arising from the power of the owners of patents to monopolize any manufacturing field, and this bill, it is hoped, will prevent patentees or owners of patents from attaching to the sale of goods unreasonable restrictions as to prices or methods of sale.

The matter of establishing resale prices presents many difficult and conflicting propositions. No one can deny that it is better for the manufacturer, jobber, retailer and consumer to have stable prices. Fluctuating prices mean uncertainty and demoralization. Fixed prices may insure a fair profit to all concerned in the distribution of the goods. The purchaser buys with the feeling that he is paying the market price and no more, and that he must pay the fixed price wherever he purchases the article. On the other hand fixed retail prices may enable groups of manufacturers to eliminate the law of supply and demand and impose monopolistic conditions which are intolerable.

We believe that whatever solution is found the result should not depend upon the provisions of the patent law, for that should not be used to enforce conditions of sale or use. The law should only secure to the inventor a reasonable reward for his ingenuity and labor.

WHAT TO STUDY

Sometimes we receive letters from young mechanics, saying, in substance: "I am a young man employed at the ——— Works, and I want you to recommend some books that I ought to study." The editor who must answer a question of that kind is in a worse plight than the doctor who is required to prescribe for a disease that he cannot diagnose; for the doctor can usually prescribe something harmless and "get away with it," but the editor cannot proceed along such easy lines. He is expected to give good, practical advice with but an indefinite knowledge of the needs of a young man whom he has never seen, and with whose previous education, ambitions and mental capacity, he is not familiar.

Some men should be advised to study anything and everything that would be useful to them in an executive position; while to others such advice, if followed, would mean simply disappointment and waste of time and effort. Some men do not possess the peculiar qualities that would enable them ever to rise to high executive positions; and those men should rather concentrate all their educational effort on practical study of the kind of work they are engaged on, so as to become proficient in that. Others, again, of a more energetic, more resourceful, or a more brilliant make-up, should pursue studies along entirely different lines—studies which may not benefit them within a year or two—perhaps not within five years; but which would ultimately prove useful to them when in positions of an entirely different character from those which they now occupy.

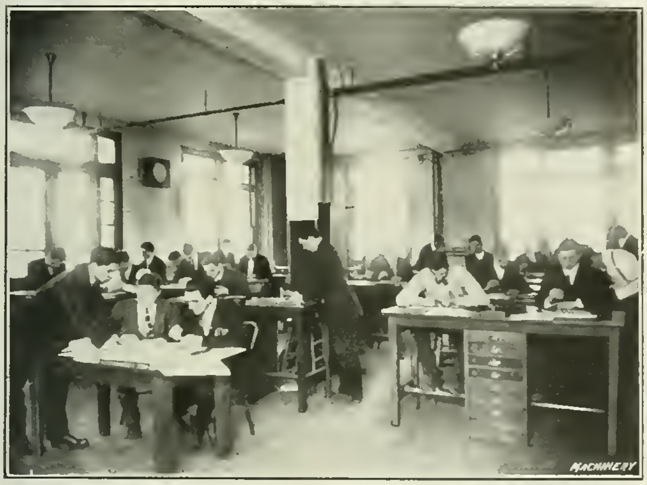

Fig. 1. One of the Drafting-rooms. All Work is designed here and Working Drawings are made for the Pattern and Machine Shop

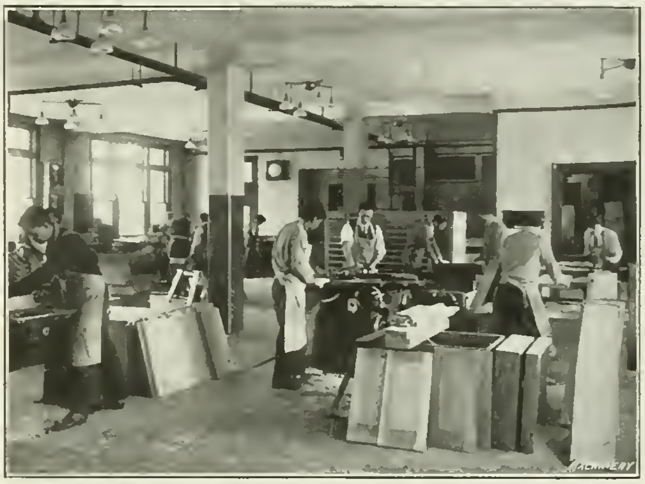

Fig. 2. Wood-working and Pattern Shop equipped with the Latest Machinery and Tools for this Class of Work

What a man should study is largely a question which he must decide for himself. It is difficult for anybody else to decide it for him. A man should increase his knowledge of the work in which he is most interested—it will make both his work and study easier. For example, if he is interested in drawing, and has a natural ability for working out ideas or designs of his own, we advise him to study drafting, machine design, mechanics and mathematics, so as to utilize his natural inclinations. The young man whose sole interest is centered upon the practical operations in the shop, different methods of grinding tools to obtain the best results, short cuts for obtaining increased production, etc., we advise to pursue studies along shop practice lines, because for him the shop proper undoubtedly offers the greatest possibilities. If he is familiar with shop practice and has acquired a knowledge of the use of the various machine tools and shop systems, and, in addition, has a personality which makes him capable of handling men, there is no reason why he should not rise to be a foreman or superintendent.

In choosing a course for study, however, do not be misled by the idea that immediate benefit will be derived from it. Many a man who has risen to a prominent position in the industrial field has spent years in studying subjects which have been of no immediate advantage to him. It may have been five or perhaps ten years, before he has found a direct application for his knowledge; but he would have been unable to fill the higher position satisfactorily had he not acquired a fund of knowledge during the years when he had the opportunity.

THE WENTWORTH INSTITUTE*

A TRADE SCHOOL FOR TRAINING SHOP-FOREMEN AND SUPERIOR WORKMEN

By CHARLES L. HUBBARD†

A day spent at the Wentworth Institute, Boston's new school for industrial training, described in the October, 1911, number of MACHINERY, so impressed the writer with the value of the methods employed and the results obtained in training foremen and skilled mechanics, that he believes some of the enthusiasm absorbed from this group of busy men and boys should be passed along so that others may profit by it. What is so important to the efficiency of the shop as a whole, and to the advancement of workmen individually, as enthusiasm? Let the young man of average ability become sufficiently filled with love and respect for his chosen work and appreciation of the principles that underlie it, and the other requisites for success will follow naturally.

The Wentworth Institute is giving its students just this kind of a start, not by way of advice, but in a practical way, which not only makes a greater immediate impression, but is far more lasting. The object of this article is to describe briefly the general scheme followed in bringing about this result, in the hope that it may be developed in other schools of similar character, and also that it may awaken greater interest in practical industrial education, both among mechanics and among manufacturers and employers of skilled labor.

A casual inspection of the catalogue of this institution fails to show any particular difference from the methods followed in other trade schools, but as soon as one steps inside the building, he catches the air of the genuine earnestness, efficiency, and system noticeable in the business and engineering offices of the highly organized concerns of the present day. Furthermore, the impression is lasting as one passes through the different departments and notes the interest and industry of the students in their work, their businesslike, intelligent and skillful way of attacking their tasks and overcoming their difficulties, and the complete absence of any action which would tend to detract from the seriousness of the work in hand.

The average boy leaves school at fifteen or sixteen years of age. He enters a shop as an apprentice under the usual conditions, has little to encourage him during his hours of work, and too often little to look forward to in the future. He is placed at some task where he will be of most value to his employer, with scant regard to his own advantage in the way of learning his trade. A desire on his part to find out the reason for doing things is not encouraged, and those above him have not time for answering questions. It is not the fault of the foreman; he is held responsible for turning out the greatest possible quantity of work with the men in his charge. The fault is really with the system, and to remedy this fault, schools like the "Wentworth" are being established. Mr. Dodge, past president of the American Society of Mechanical Engineers, in speaking upon this subject, says: "The apprentice boy who picks up a trade, learning it chiefly by imitation and with little or no instruction, enters a machine or wood-working shop at sixteen and earns an average wage of $3.00 per week. At twenty-two years he may be earning $13.50, but at twenty-four years he has reached his highest earning capacity, getting $15.80 per week."

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* The following articles on industrial schools, trade education and kindred subjects have previously been published in MACHINERY: "Features of Apprenticeship System at the General Electric Co.'s Lynn Works," April, 1912, engineering edition; "The Cincinnati Method of Industrial Education—A Friendly Criticism," March, 1912, engineering edition; "The Wentworth Institute," October, 1911; "T. R. Almond Mfg. Co.'s Evening School," July, 1911; "Training of Machinists in the Trade School," July, 1911, engineering edition. See also other information previously published, referred to in connection with the last-mentioned article.

† Address: 283 Central St., Auturudale, Mass.

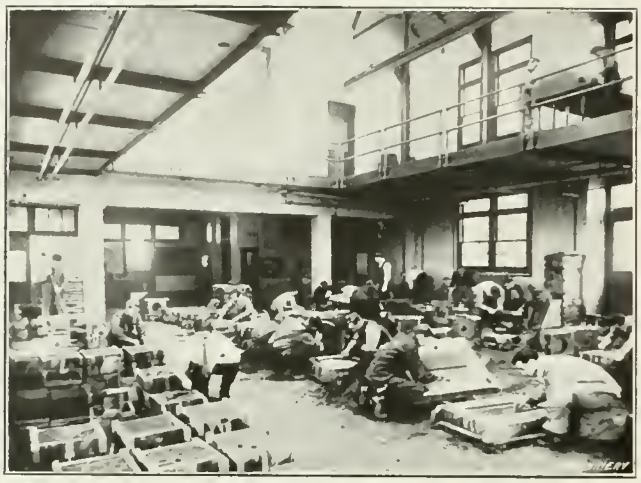
Fig. 3. Foundry in which the Men are trained to become Skilled Workmen and Foremen

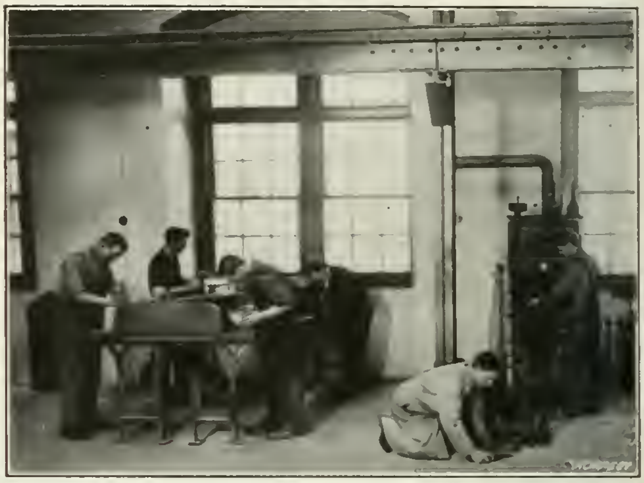
Fig. 4. Light and Spacious Core Department located on the Balcony in the Foundry

What is there to give a young man enthusiasm and draw out the best there is in him under such conditions? There may be a few special cases where young men have sufficient ability and endurance to win out under any condition, but the larger part usually drift from shop to shop, gradually losing hope of better things, and develop into "one-machine" men with practically no chance of further advancement. These statements are not intended to discourage men who are working under these conditions, but rather to encourage them by pointing out the opportunities that are open to them through the development of modern trade schools. Europe has long been aware of the advantages of this method of instruction, while America is only waking up to its possibilities. This is shown by an item which appeared in a recent number of the *Outlook*, and which states that in 1908 Prussia had 400,000 pupils, or nearly 14 per cent of its entire population, enrolled in its industrial schools, while only 2 per cent of the population of the United States were being trained in a similar manner. In some of the best shops, it is true, more care is taken in training apprentices than in others, and in certain cases private trade schools are now being carried on for the purpose of supplementing the training of the apprentices in the shop; but admirable as are some of these efforts to give the apprentice boys a chance, their number is still so small—and is certain to remain small in proportion to the demand—that there is genuine need for the public trade school in every industrial center.

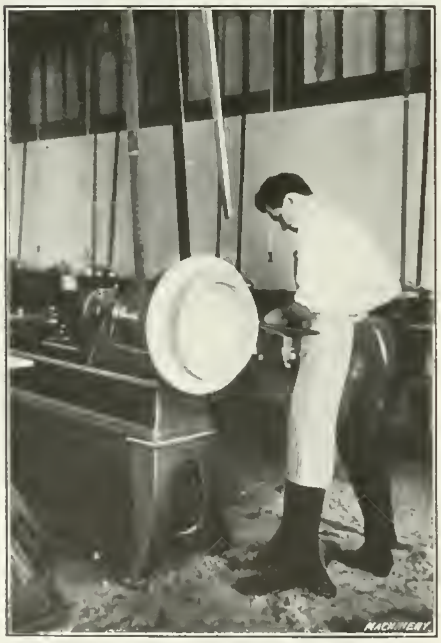

Fig. 5. A Student engaged in Pattern Making, which forms a Part of the Shop Course in General Machine Construction

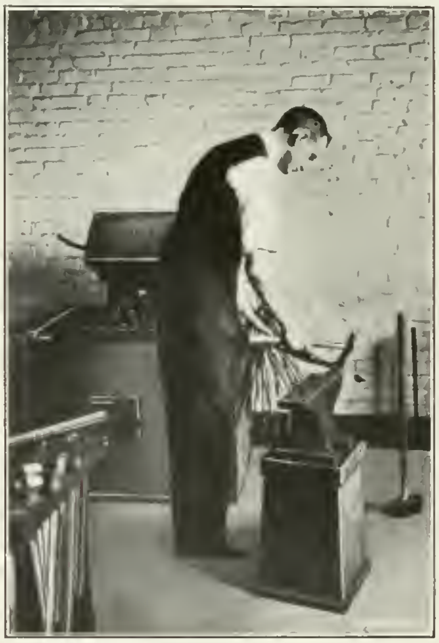
Fig 6. A Student at Work in the Forge Shop, a Course in Forging also being included in the General Shop Course

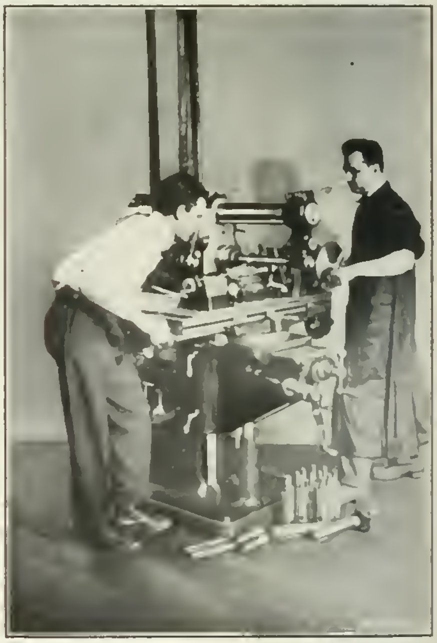
Fig. 7. Work in the Milling Machine Department, illustrating the Character of the Work being done

It has already been stated that one of the prime objects always kept in view in the training at the Wentworth Institute is to awaken in the student a thorough and lasting interest in his work. This is done, in a very simple and practical manner, largely by answering questions, both *asked* and *unasked*, and this really covers the whole field of teaching. Answering unasked questions gradually trains the student to ask them on his own account, and as his reasoning powers are developed, he reaches a point where he answers some of them himself. Now, when a man can both ask and answer his own questions he becomes original, and furthermore, an original man has ideas. Given a man with originality, and a training to properly discriminate between the practical and impractical, and he will neither lack interest in his work nor have a long wait for success. Such men are in demand in all the manufacturing plants of the country at wages that are only limited by their ability.

One or two illustrations will serve to show the general methods followed in accomplishing this result. For example, a student is given a piece of work to be done on a lathe. His instruction is not confined to this piece of work alone, but he also makes a study of the lathe itself. Every part which goes to make up this machine is examined, and its use and the principle upon which it operates, are carefully explained. He is taught to make computations in gearing so that the necessary changes for screw cutting, etc., may be made without the use of tables. Tests are made upon the strength and friction of gears, belts, lubrication, etc., until he has thoroughly mastered the machine itself, and has become proficient in its use. This same general scheme is carried out in a similar way upon all of the various machines in the shop. Thus the student not only becomes familiar with the use of machine tools, but is also able to detect and correct faults in their operation, and make proper adjustments. All of this forms a part of the necessary qualifications of a foreman, and adds greatly to the chances of future promotion.

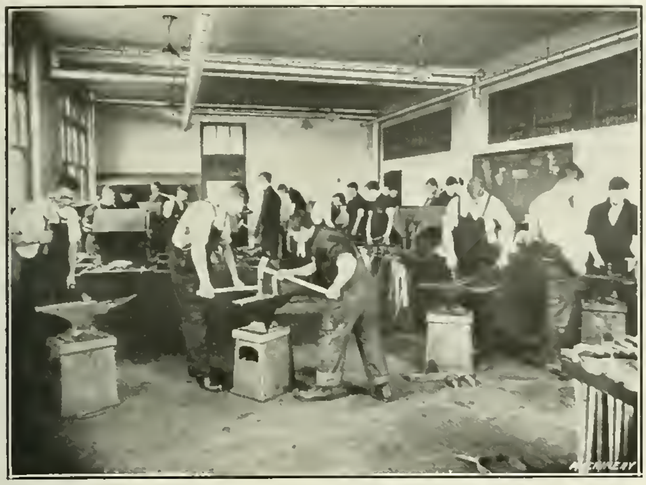
Fig. 8. General View in the Forge Shop

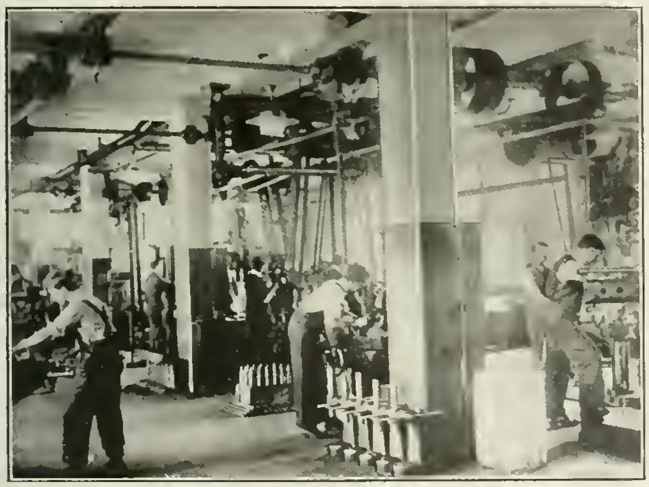
Fig. 9. General View in the Machine Shop

Various methods are employed for awakening and holding the ambition of the student besides the regular routine work. One scheme is to incite a friendly spirit of competition in the several departments, which is illustrated by the following incident connected with the foundry practice. One feature of this course is to learn the art of shoveling sand properly, which, of itself, is not an especially interesting operation. To add zest to this exercise, and awaken a suitable amount of interest, and to test the mettle of the men, the class was divided into gangs working in competition, both as to speed and quality of work done. To avoid monotony, this work was carried on in connection with subjects requiring equal time in the class rooms, drawing rooms or laboratories, so that each type of work seemed by contrast a form of recreation when compared with the other. This was kept up every school day for nearly two weeks, at the end of which time the class had not only become proficient in the shoveling and tempering of sand without thinking of it as drudgery, but was also thoroughly drilled in team work. Each student had had opportunity to act as gang foreman and had learned how to take orders from his fellows, and had also learned from the records of successive days that there was a "science" even in shoveling sand. These are items of much value in the handling of men and are requisites in the training of a successful foreman. Compare this with the same work as done by the average apprentice, and note the difference in spirit and in the mental effect upon the two sets of boys. In like manner, time and efficiency tests are made in molding standard patterns, and records are established which every member of the class strives to excel. These methods of stimulation are only employed for first arousing an interest in the work, after which a natural desire for knowledge is developed which is sufficient to maintain the necessary degree of enthusiasm without artificial means.

Another important point in the general scheme of instruction is to make the men feel that they are doing *real work* with tools and machines of latest design, and that all knowledge gained is of actual practical value. This is well illustrated in the machine department, where, as elsewhere, work is carried through with the same order and system which would be employed in the most up-to-date shops. The article or machine to be built is first designed in the drafting-room, the patterns made in the pattern shop, and the castings in the foundry. The bench-work and machine-work are then given out to different men in the shop and the work is carried on to completion. In order to give a well balanced course, the men are shifted from machine to machine as fast as they become proficient in their use, and in this way they have an opportunity to work upon the different parts of any article or machine which is being built in the shop.

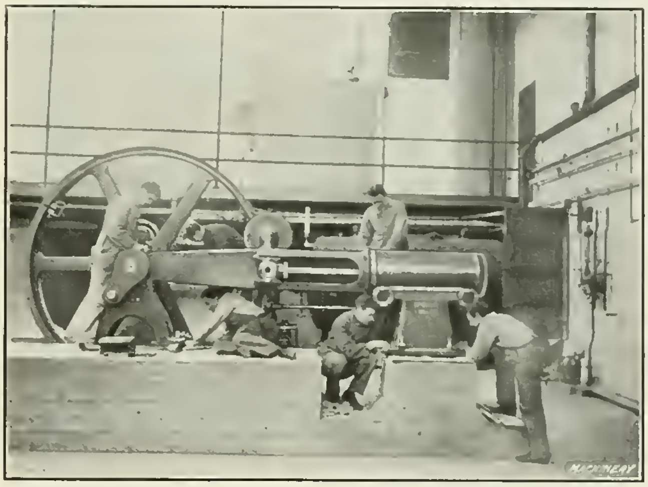
Fig. 10. Students assembling an Experimental Engine in the Steam Engine Laboratory. All Work of this Kind is done by the Students under the Direction of a Foreman

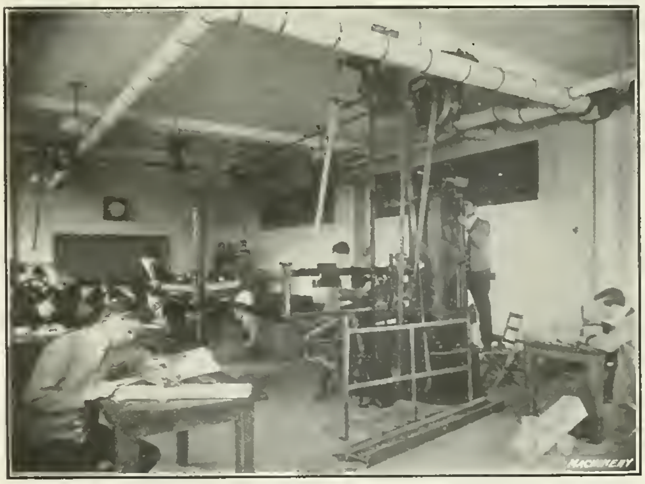
Fig 11. The Testing Laboratory where Materials entering into the Construction of Buildings and Machinery are tested for Strength

No man is held back in his work by another, promotion being dependent upon individual proficiency in each case. Nor is a man kept from using a valuable machine for fear he will damage it, as is often the case with an apprentice in a shop. He is given instruction in the use of each machine with an opportunity to put it in practice. Until he become thoroughly familiar with it, his work is kept simple. In this way the risk of damage is small.

Another feature of interest is the testing of work after it is finished, to see how it may be improved in design. For example, one of the exercises consisted of the design and construction of an arbor press. After completion, one of these was taken to the testing laboratory and each part tested to the breaking point under the kind of stress to which it would be subjected in actual use. The main casting was broken and the weakest section ascertained; the teeth on the rack of the ram were tested and compared with the teeth on the pinion and the maximum strength of the handle was found. In this way the design of the machine may be revised, strengthening some parts and lightening others, to make the whole of uniform strength throughout. It is a noticeable fact that the men, as a rule, get a better grasp of theoretical problems of this kind when they can see their practical application to their particular line of work. The variety introduced into each day's work contributes greatly to its success. The school day is divided into four hours of drawing-room, class-room, laboratory or other theoretical work, and the same length of time is given to practical applications in shops or foundry.

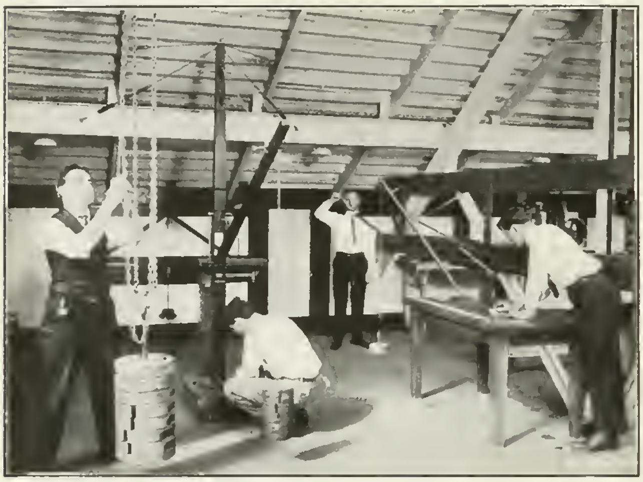

Fig. 12. Determining the Distribution of Load in Derricks and Cranes, using Specially Designed Apparatus

In much that has been described there may appear to be a similarity with other trade schools, but the essential fact which seems to differentiate the Wentworth Institute from others with which the writer is familiar is the perfect blending of the spirit of investigation and open-mindedness of the best schools of science with the spirit of industry and production of the best commercial shops. In every course, theory and practice are carried on together in all the work, and theory is only taught so far as its practical application can be demonstrated.

The objection may be raised that this will have a narrowing effect upon the student, and that the instruction should be more general in its character. It must be remembered, however, that these young men are not university students to whom time and money are not of prime consideration, and who are simply laying a foundation for some special work later. The short length of the course is of the greatest importance to the type of men who enter the Wentworth Institute, and the sacrifice which they make for it is such that it must show practical results in higher wages as soon as it is finished. For these men, later success must come from practical experience obtained in passing upward through the different stages of their chosen trades, and not by passing over it, or dipping into it from the top, as a university student might do. The primary aim of the Wentworth Institute is to so equip its graduates, that with the later experience to be obtained in actual work, they may become superior workmen, foremen, and superintendents. The work done in the school is not intended to take the place of shop experience later on, but is expected to shorten this period at least one-third, and make advancement more rapid and more sure.

In addition to this, if a man develops superior ability as his work progresses, he can broaden his knowledge by further study to better advantage than at an earlier period. While a foundation, if sufficiently broad and deep, will support almost any structure, it is well in this short and busy life not to spend too large a share of it on the foundation alone, before finding out what it may be called upon to carry. The man who avails himself of the advantages of the Wentworth Institute, and subsequently works his way upward to better things, has constructed a foundation of sufficient depth to support almost anything he may wish to place upon it. If he desires to broaden this foundation, it is easily added to without tearing down that which he has already built. When a man has reached the point in his career above alluded to, he knows pretty accurately what his foundation is to support and can finish its construction without waste of time or material.

An advantage of the location of the school is its nearness to the manufacturing district of Roxbury, where various shops and factories are open to the students, thus permitting them to see in practical operation many of the machines and methods employed in the various courses of instruction at the school. A great number of courses are given, in order to meet the requirements of different classes of men. They are briefly outlined below. The one-year day courses include instruction in carpentry, electric wiring, plumbing, machine work, patternmaking, and foundry work. These one year courses are designed especially for apprentices, and aim to give a more thorough foundation than can be obtained in the commercial shop. It is not expected in this short time to turn out finished workmen, but to give the students a thorough understanding of the principles involved, together with sufficient manual skill, so as to enable them to gain a full mastery of their trade in a much shorter time than would otherwise be possible.

The two-year day courses have for their object the training of men to become superior workmen, foremen, and master mechanics. They include instruction in machine construction and tool design, and electrical construction and operation. The general methods of instruction are similar to those already outlined, except that the increased length of time makes it possible to teach the scientific principles in a more thorough manner. It also makes it possible for the student to obtain a greater degree of skill in the use of both hand and machine tools. Evening courses in seventeen practical trades are offered to young men who are employed in mechanical trades or industries during the day.

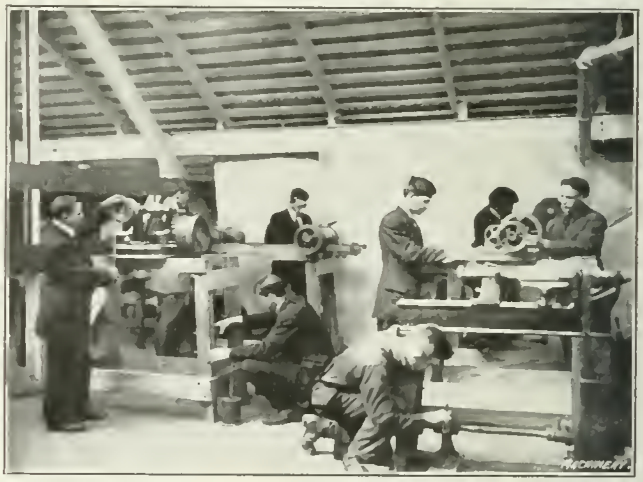

Fig. 13. Another View of the Mechanical Laboratory showing Students making Friction Tests on Pulleys and Gears

The directors have also inaugurated part-time courses in addition to those noted above. These require the students to attend their classes at the institute every other week, but give them an opportunity to work at some regular employment during the alternate weeks.

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The ribs of a gear should never be made flush with the rim or hub, but should come from $\frac{1}{8}$ to $\frac{1}{4}$ inch below the rim or hub face; otherwise the rim and hub cannot be finished without making an unsightly appearance.

INDUSTRIAL ADMINISTRATION AND SCIENTIFIC MANAGEMENT[*]—1

WHAT CONSTITUTES SCIENTIFIC MANAGEMENT

By FORREST E. CARDULLO[†]

The work of the engineer may be divided into three great departments, since it has to do with the design of machinery, the methods of constructing and operating it, and the administration of the plants in which it is constructed and operated. The first two departments (namely the design of machinery, and its construction and operation) have received the careful attention of trained specialists for more than a century. Even at the beginning of the nineteenth century when engineers first began to apply the resources of modern science to their work, the arts of machine design and construction were in an advanced state, owing to the efforts of many generations of skilled mechanics. The third department of engineering work, however, has lagged far behind the other two, since comparatively little attention has been bestowed upon it. It is doubtful if any substantial advance in industrial administration was made in the thirty centuries preceding the year 1880, and even at the present time only a few men are devoting serious attention to the fundamental problems of management.

Importance of Industrial Administration

At the present time, industrial administration is the most important of the three departments of engineering work. It is not, of course, confined to purely engineering projects, but is an essential part of all commerce and manufacturing. Since the greater part of our working population is engaged in some kind of industrial work, the proper supervision of their efforts is a matter of prime importance to the well-being of the country. Most of the readers of MACHINERY are, or ought to be, interested in the proper administration of the mechanical industries. Hence, this series of articles will discuss more particularly the management of shops and factories engaged in the metal trades.

As has already been intimated, the art of industrial administration was stationary for a long period of time. In spite of tremendous changes in our social, economic and industrial systems, we have been content to adapt or modify methods which originated thousands of years ago. I may liken the system of administration which obtains in most industrial plants to one of those "old homesteads" which dot our New England landscape. They started as a log cabin, to which was successively added a lean-to, a barn, a shed, an ell, an upper story, and other "modern conveniences." As a result, they are roomy—and also inconvenient. The common system of industrial administration is constructed of the surviving remains of Greek slavery, Roman militarism, Saxon serfdom, the medieval guilds, and various other historical oddities, slightly altered to adapt them to the twentieth century conditions, and engrafted on one another in very much the same way as the additions to the old house. This system of management has been a growth in which each manager appropriated those developments of the past which appealed to him. Sometimes methods were adopted as a result of a carefully and properly conducted investigation, but nine times out of ten they were adopted because the manager "guessed" they were the best ones.

Conventional Management

We will designate the system of management described in the preceding paragraph as "conventional management."[‡] It must not be inferred from the description the writer has given that conventional management is always and utterly objectionable. When the manager is a good guesser, he will usually choose good methods of work. If his lieutenants are able and energetic, these methods will be well carried out. Of course the system is not perfect, and in many cases it is not even satisfactory. Nevertheless conventional management can be made to work, and to work well, when it is in the hands of capable administrators. Different men will, of course, adopt different methods, and in different shops we will find that the work of administration is carried out in very different ways. In every case, however, the distinguishing feature of conventional management is the acceptance of something already in existence and the choosing, by guess, between methods which have been developed by someone else.

Systematic Management

Within the past thirty years, however, two other systems of management have arisen. One of these may be called "systematic management," while the other has been named by its originators, "scientific management." The systematic system of management is the development of the clerk and the bookkeeper. It aims at the keeping of careful records and the collecting and classification of information. It aims to proceed by continually bettering existing records. It aims to inform the management as to the preferable one of two alternative methods of work, each of which must be tried out in practice. Systematic management is, then, simply the keeping and comparison of records in order to determine the relative value of methods of work.

Scientific Management

Scientific management, on the other hand, has been developed by the engineer. Scientific management aims at the careful investigation of every problem of the industrial world in order to determine its best solution. It is not content to rely upon records, or upon the judgment of the most experienced workman. It brings to its aid all the resources of science. Every possible method of performing a piece of work is carefully analyzed and the best elements of all of the methods combined in order to form a new method. Having established the best methods of work, scientific management then instructs the workman how best to perform his task, and offers an incentive to do it in the prescribed manner. Scientific management is often called the "Taylor System" in honor of its foremost exponent.

Scientific management is not an invention but a discovery. It is the application of the scientific method of research to the problems of the industrial world. Insofar as it is concerned with the investigation of these problems, it is science and nothing else. Insofar as it is concerned with the proper application of the results of these investigations, it is management and nothing else. The combination is therefore correctly termed "scientific management."

Just as in the old days, certain types of machinery reached a very high state of development without the aid of the scientifically trained engineer, so in these days, the administration of certain of our industries has been very highly developed without the aid of scientific management. In some kinds of work, as for instance, watch making, the problems of administration are simple on account of the limited character of the product and the extensive use of automatic machinery. In industries of this class reasonable piece-rates have been established by a series of cuts and after prolonged labor troubles. Such industries have arrived at an efficient system of management by a very strenuous and unpleasant process, and the adoption of scientific management would not always bring notable advantages. On the other hand, most industries are not in this class. The character of the labor employed, the quantity and character of the output, the kind of machinery used, and the kind of material supplied, is continually changing. In the first class of industries a process of evolution extending over two or three generations has established the best methods of management. In the second class of industries the best methods are continually changing as conditions change.

In most industries, the introduction of scientific management promises to effect great gains, and to greatly increase the efficiency of our whole industrial system. Scientific management has been applied to many different kinds of work, and seems to be almost if not quite universal in its application. It has brought to light many problems in connection with industrial administration of whose very existence we were previously ignorant. Every time it is applied to a new set of conditions, even in the same industry, new problems are presented. If, in the near future, it is extensively applied to all industries or even to any one industry, it will give rise to very serious political, social and economic problems as well as intensify a great many of the problems that are now pressing for a solution. It will be seen, then, that the application of scientific management in industrial administration is not only important to the factory owner, the superintendent, and the workman, but to the law maker, the citizen and, in fact, to every man, woman and child in the country. The field of industrial administration is a very great one, but we cannot appreciate the importance of a right understanding of the problems which will be raised by the extensive introduction of scientific management until we realize how this field is interrelated with our entire political and social system.

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[*] For articles relating to scientific management previously published in MACHINERY, see "Scientific Management from a Social and Economic Standpoint," June, 1912; "Industrial Efficiency," May, 1912; "Helping a Man to find his Place," May, 1912; "The Efficiency Engineer," February, 1912; "Saving Time in Machine Work," February, 1912; "Scientific Management in the Seventies," January, 1912; "Scientific Management of Arsenals," December, 1911; "Task Work—The Basis of Proper Management," December, 1911; "Scientific Management of Railway Shops," September, 1911; "Scientific Management and Economic Problems," July, 1911; "The Art of Cutting Metals," August, 1907; "The Utilization of Labor," April, 1907; "One Thing at a Time," January, 1907, and the series, "On the Art of Cutting Metals," from January, 1907, to August, 1907.

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[‡] Mr. Gilbreth has designated this form by the term "traditional".

An Example of Efficient Management

It is a fact which cannot be controverted, that very few shops in this country produce more than sixty per cent of the work which it would be possible for them to produce with the same wage roll and the same physical equipment. A few of the best managed shops produce probably eighty per cent of the work which it would be possible for them to produce, and occasionally departments in well managed shops reach an efficiency of over ninety-five per cent. On the other hand, there are numerous shops in this country which, without any considerable change in their equipment or increase in their wage roll, could produce from three to five times as much work as they put out at present. This statement, extraordinary as it may seem, is not the result of a wild guess, but may easily be verified by any one who will make a study of conditions in these shops. Some two years ago, the writer made a trip through southern New England inspecting some of the representative industries. The most efficient department that I ever saw was the grinding department of the Norton Grinding Co., Worcester, Mass. I do not know that the engineer, Mr. Norton, made a conscious attempt to install the system developed by Mr. Taylor, but I do know that by a careful study of the work of this department he has raised the standard of efficiency so that every man that I saw was employed continuously in producing a very high class of work with a rapidity that was astonishing, and by methods which the average shop foreman would say were impossible. In conversation, Mr. Norton emphasized the necessity of a careful study of shop problems and stated that such problems were worthy of attention from the most highly trained engineers. Although he never once used the term "scientific," it was quite evident that his study was scientific in the best sense of that term, and that no single problem which had presented itself in his grinding department ever escaped a most thorough and searching investigation. I shall always remember this department of Mr. Norton's works as one of the finest examples I have ever seen of excellent management, and also I shall always remember the type of employe which I saw in that department as a representative of the very finest type of the American mechanic. Every man seemed to be a man of unusual intelligence and skill and seemed to be putting into his work that indefinable something, which for lack of a better term we designate as "brains."

A third matter which attracted my attention was the fact that Mr. Norton seemed to be personally acquainted with every man working in that department; seemed to know their especial abilities and the work for which they were best fitted, and seemed to take great interest in seeing that each man was doing the kind of work for which he could realize the highest pay. So far from adopting the attitude of the average employer, who is inclined to think it a matter of good business policy if he can drive a sharp bargain with his men, and obtain a day's work for a minimum wage, Mr. Norton spoke with pride of the unusual earnings of several of his men who were working under a premium system.

An Example of Inefficient Management

At another time I visited a concern in which it seemed to me that the majority of the men were doing absolutely nothing that was useful. This concern was one of the largest ship building yards of the Atlantic coast. I had no opportunity to talk with any of those responsible for its management and therefore cannot say what attitude they adopted toward various questions of administration. There did, however, seem to be a dearth of foremen, and as in the time of the Judges in Israel, "every man did that which was right in the sight of his own eyes." I remember seeing one man who was engaged in chipping a plate with a pneumatic hammer, and he had two assistants whose duty seemed to be to drag the air hose after them and carry his hammer as he went from place to place. At another place I saw a man measuring a plate and marking upon it an opening which was to be made in a bulkhead, with five or six workmen lounging around him doing nothing. Most of the work of the establishment seemed to be conducted in that manner, and altogether, it was the most disgusting exhibition of shiftless management that I have ever seen in my life. The matter was so apparent that several students who were with me at the time called my attention to it, although they were men unaccustomed to shop administration and most of them were men totally unfamiliar with methods of shop work.

Administration of Average American Shop

The administration of the average American shop is a mean between the slipshod methods of the shipyard and the careful and efficient methods of the Norton Grinding Co. In such a shop, such obvious inefficiency as I have described in the case of the shipyard, would be promptly squelched. On the other hand, in such a shop, careful investigation will usually show very great inefficiency in many departments although such inefficiency is not at first obvious. This inefficiency is due to a variety of causes. It may be that work is slack and the workmen are "nursing their jobs" in order to avoid discharge. It may be that they are prolonging an easy and agreeable task in order to avoid being assigned to a more difficult and disagreeable one. It may be that illness or unsanitary shop conditions have deprived the workman of a measure of his usual energy and ability. In many shops, inefficiency has nothing to do with the workmen, but is entirely chargeable to the management. All of the men appear to be busily employed and the work to be carefully conducted, but at the same time, the type of machines used, the sequence of operations employed, the conduct of the toolroom, or any one of a dozen different things for which the management is or should be directly responsible, greatly reduces the efficiency of the shop.

The writer was once employed by a firm that manufactured small steam engines for the oil trade. Each of these engines was equipped with two flywheels weighing about 600 pounds apiece and the only machine work done upon the wheels consisted in boring the hub, reaming it, and cutting the keyway. I was employed to bore the hubs, which was done upon a homemade machine having a stationary spindle and a revolving table. There was a crane which was used to place the wheels upon the table, but before the wheels could be lifted by the crane, they had to be brought about 500 feet from that part of the yard in which they were stored after being cast. I was instructed to get another apprentice who was named Gus, to help me roll them from the storage yard to a point under the crane. During this time, both my machine and Gus's machine were idle, since they were of a character which required constant attention. This job had to be done several times a day, and I doubt if those two machines were running more than half the time.

As I remember conditions in that shop, I can see that there were endless possibilities of increasing the output by improving the methods of management. Nevertheless, to one who is not in the habit of thinking about the possibilities in this line, the shop appeared to be busy and well managed. It was conducted by a foreman who had an excellent reputation and who was supposed to know "how to get out the work." He was a man of considerable experience and knew about how much time certain work would take when done by the average machinist in the average way. Most shops would have considered him a valuable acquisition, and in a great many shops he would have introduced notable improvements. The ship building company I have already described would have been fortunate had he taken their affairs in hand, but any department managed by him would have made a sorry showing alongside of the grinding department of the Norton Grinding Co. He employed the usual methods of conventional management, that is, he allowed his men to choose their own methods of doing work, and then eliminated those men or those methods which were obviously incompetent or inefficient. He was not at all versed in the scientific plan of finding the methods of greatest efficiency, and of applying them in the administration of his department.

Misapprehension of Principles of Scientific Management

I have heard a good many men say, in regard to scientific management, that they have managed their affairs scientifically without knowing that they were scientific. However, when I have come to talk over the matter at length with them, I find that what they mean is that some of the inefficiencies not usually obvious had become apparent to them, and that they had adopted some of the methods of scientific management in attempting to eliminate the inefficiences which had come to their attention. This is a very different matter from installing a system of scientific management, although the efficiency of a good many plants has been greatly increased in this manner. However, the men of whom I speak do not understand what scientific management is. They think that scientific management is a collection of best methods, that it necessarily involves the use of certain kinds of blanks and records, or that it is a form of organization, a method of wage payment, or something of that kind. Of course such things are employed in scientific management, but they are only the tools which it uses, and just as a carpenter will change his tools for different kinds of work, so scientific management will adopt different methods, different forms, or different plans of organization, as conditions change.

A great deal of harm is likely to come from the unintelligent employment of some of the methods of scientific management by such men, even when they are acting in the best of faith. The introduction of some of the methods will often cause antagonism among workmen, and they will sometimes prove inefficient under new conditions. In either case scientific management is blamed for the failure, when, as a matter of fact, scientific management would probably have employed other methods under the given conditions. *Scientific management must not be confounded with its forms or its methods*, just as a man must not be confounded with his clothes, or a religious creed with its form of church organization.

Methods under Different Types of Management

It will help us in our consideration of different types of management, if we take a concrete example and note the differences of the several types, as they appear in the example. Let us suppose that a piece of lathe work is to be done, such, for instance, as the turning of a crankshaft. In the conventional type of management the foreman will assign such a job as this to the first man having a vacant machine in which it can be conveniently performed. Systematic management will usually do the same thing. Scientific management, on the other hand, will assign the piece of work to that machine in which it can best be performed.

Having received the work, under conventional management, the workman will determine the plan of procedure, will choose and grind his own tools, and will proceed to work, using those feeds, cuts, and speeds which he thinks will be the most satisfactory. In case the workman is receiving day wages, the pace of the work will depend upon the foreman. As the foreman goes about the shop, he will occasionally take notice of the condition of the work and the way in which it is being performed. If the workman is obviously incompetent or inefficient, the foreman will instruct, reprimand, or discharge him, as his judgment will warrant. On the other hand, if the work appears to the foreman to be going forward at a reasonable pace, nothing will be done.

In case the workman is being paid by some piece-work or premium plan, he will be anxious to earn as large a wage as possible and therefore will attempt to determine the best cuts, feeds, and speeds for the work in hand. There are two methods open to him for doing this. One is to guess at the best conditions and the other is to experiment until he has determined them. The first method, of course, leaves much to be desired. The second method is open to the objection that it takes a considerable number of experiments to determine the best conditions of work, even when the experiments are confined to the performance of a certain job on a certain machine. The workman is rarely, if ever, able to devote the necessary time to such experiments, and he has not the training which would enable him to properly perform and record them. With the facilities which he usually has at hand, it is impossible for the average workman to do any more than gradually improve his performance by careful attention to his methods of work.

Conventional management determines the time required to do a piece of work, or the piece-rate to be paid for it by one of two methods. The first method is for the foreman or some other experienced person to guess at the time required to do the work. The other is to put a capable and conscientious workman at the work and see how long it will take him to do it. Of course the guess of the foreman is about as good as the guess of the average drummer would be if he tried to estimate the population of a village while he was riding through it on a train. The other method of allowing a pace maker to determine the piece-rate is a better one. Since, however, the pace maker usually does not have the opportunity of making a careful study of the best methods of performing the work, his time allowance will usually be too large.

Systematic management, like conventional management, leaves the method of performing the work entirely to the workmen. It does not, however, leave the question of the proper pace to the foreman. The records of previous performances have established a pace and the management can readily determine whether or not the work is being conducted at the best pace of which there is previous record. If it is not, the foreman is notified and the workman is obliged to increase his pace. He may do this in one of two ways. He may experiment in order to determine the possibilities of the work, or he may go to someone who knows more about it than he does for assistance and instructions in regard to feed, cuts, speeds, and methods. In either case he is nagged into bringing up his pace to that of the previous man, and in this way the production is kept up to the best previous record.

Under scientific management, the sequence of operations, the cuts, feeds, and speeds, the tools and appliances, and the methods of work are determined by the management and not by the workman. Before the work is commenced, a specialist considers all the possible methods of doing the work and after carefully analyzing them determines which of these methods are the best. Having fixed upon the methods of work, a time allowance is then established for each operation. A typewritten or blueprinted instruction sheet is then prepared which informs the workman exactly what he must do, and how long it should take him to do it. Instead of grinding his own tools, he receives a supply of properly formed and ground tools. Instead of depending upon the foreman or upon previous records for establishing the pace of work, the time required to perform each of the several operations is exactly known. The whole series of operations has been subjected to a careful analysis, every possible variation has been considered, and the methods developed are not only good ones, but are the best possible ones, considering the limitations of that particular shop.

In order to accomplish the best results, not only must the workman receive an instruction sheet, but he must be shown how to perform many operations. One of the officers of administration is, therefore, the teaching foreman, who makes it his business to instruct the men in the proper ways of doing work and who is always ready to come to the aid of those men who are unable to perform their tasks in the allotted time.

In order to encourage the workman to follow the proper methods of work and to perform his task in the allotted time, a piece-work, premium, or bonus plan is adopted for the payment of wages. The plan which seems to give the most satisfaction is known as the Gantt bonus plan. This consists in paying the man a certain definite percentage of his daily wages as a premium whenever he performs his task within the allotted time. If his task, for instance, consists of ten pieces a day, and he succeeds in making ten or more pieces, he will receive from twenty to sixty per cent additional wages as a premium. In case he produces less than ten pieces, he receives the regular day wages, but no premium. A man's earnings are computed each day and he knows on the morning of the following day whether or not he has earned the premium. If he has not, it is the duty of the teaching foreman to go over his work with him and instruct him in those points in which he may be deficient. In order to make sure that this teaching is thorough and effective the teacher receives as a bonus a fraction of the bonus earned by his workmen and in case all of his workmen earn bonuses, the teacher receives an extra bonus. It will readily be seen that with such a system of wage payment, thorough instruction and cooperation are the invariable order of the day, and that the foreman as well as the workmen are always on the lookout to see that the tools, machines and stock, are all in perfect condition.

Not only does the man receive adequate instructions, and a reward for obeying these instructions, but he is offered every reasonable facility for doing his work quickly and well. He does not have to spend his time hanging around the smithy or the toolroom getting the things that may be needed for his work. He spends no time repairing his machine, taking up the belts, or fixing the tools supplied to him. The management makes it its duty to see that nothing hinders him in his work so that his entire time and attention may be devoted to the performance of, and not to the preparation for, that work. This requires that certain assistants shall perform tasks which conventional management usually delegates to the workman himself.

Collecting Data Necessary for Scientific Management

It will be apparent from the foregoing, that instead of depending upon judgment, scientific management depends upon knowledge, in its task of administration. Judgment is the instinctive and subconscious association of impressions derived from previous experience. When a man's experiences are wide, his impressions of them are correct, and his memory is good, his judgment will be good. But even the best judgment falls far short of knowledge, and any system of administration based on judgment alone must fall short of scientific management. Judgment will always have its place in any system of administration for two reasons, firstly because knowledge cannot always be obtained, and secondly because it may sometimes cost more to obtain it than the knowledge is worth. In either case judgment is valuable, if not absolutely necessary. But at the best, judgment is only a guess and not to be relied upon if accurate information is available. Not only does scientific management depend upon knowledge, but this knowledge is carefully and systematically collected and the data so obtained are classified and digested until the knowledge is instantly available whenever a problem is presented to the management. Back of the form of organization is a knowledge of the needs and the work of the plant. Back of the plan of wage payment is a knowledge of psychology and sociology. Back of the instruction sheet is a knowledge of the sciences of cutting metals and of handling work. As examples of the way in which such knowledge is obtained, let us take the two subjects last mentioned, and see what scientific management has done to develop the sciences of cutting metals and of handling work.

Most readers of these articles are doubtless familiar with the paper of Mr. F. W. Taylor on the art of cutting metals, which was published in abstract in many of the technical magazines shortly after it was delivered, in 1906. The work described in this paper is probably the best example of the scientific study of methods of manufacture which has ever been made. Mr. Taylor and his associates at the Midvale and Bethlehem steel companies were engaged in the work for nearly twenty-six years, and during that time made many notable discoveries in the line of their work. One of the most important of these was the discovery of high-speed steel; which is, at a very conservative estimate, worth fifty million dollars per year to the machine industry of this country. Other no less important but less spectacular results were the discovery of the best forms for cutting tools, the invention of a slide-rule for the determination of proper cutting speeds, and the resulting developments in the form, rigidity, and power of machine tools.

In making this investigation suitable machines were prepared and after establishing certain standards in regard to the kind of material to be cut, the form and chemical composition of the cutting tools, and the length of time which the tools must run without regrinding, a very elaborate series of tests was made. The object of these tests was to determine the maximum permissible speed of cutting with different feeds, depths of cut, kinds of tool steel, forms of tools, classes of material, and conditions of work. There were in all twelve conditions affecting the cutting speed, each of which could be varied. Some of these could be varied over a very wide range, and every time one of the conditions was altered a large number of experiments was necessary in order to determine the permissible cutting speed. It is obvious that in such a complicated problem as this, thousands of experiments were necessary before it could be solved. As fast as experimental data were collected, the results were worked up in order to determine the mathematical laws governing the cutting of metals. Since these laws were found to be extremely complicated, and since, if the work was to be practical, quick and simple methods of solution had to be devised, a great deal of time and effort was spent in devising methods for determining the proper cutting speeds for any given conditions. Finally after many years of work, a slide-rule was invented which gave a quick and accurate solution of the problem.

This investigation was probably the most important investigation of the kind ever attempted. It was very thorough, requiring a period of twenty-six years for its completion. The total cost is stated to have been $800,000. The results, in which every metal working shop in the country has shared, are unquestionably worth one hundred million dollars a year. Hardly one manager out of one hundred, probably not one mechanic out of a thousand, realizes the immense value and scope of the improvements resulting from this investigation. They rank in importance with the development of the steam engine, the railroad and the printing press. There are equally great opportunities for a dozen, possible one hundred investigations of like character in other industries. It is to be hoped that they will be soon commenced and that they will be prosecuted with the same energy, tenacity and intelligence with which this investigation was so greatly marked.

Motion Study and Analysis

The method employed in determining the best way to handle work is known as "motion study." Motion study is almost a science in itself, and is really a branch of applied psychology. Motion study is not peculiar to scientific management, but has long been utilized by athletes in their endeavor to improve athletic records. A high jumper, for instance, will carefully train himself to do his work in a certain way, taking a certain number of steps in running up to the bar, throwing his limbs and body in a certain position as he jumps over the bar, and endeavoring in every way to develop that smoothness and machine-like precision of action which characterizes what he terms "form." The hurdler does the same thing, day after day making trial of different methods of running and jumping, timing himself by the stop watch, in order to achieve the most perfect form.

The same sort of study can be employed to advantage in training workmen to perform their tasks, when the tasks are repetitive in character. There is, however, one very great difference between motion study for the athlete and for the workman. Whereas the athlete strives to perform a task which taxes his strength and endurance to the limit, the workman strives to develop that form which will enable him to perform his task quickly and with a minimum of fatigue. In the case of the athlete, he is striving to excel for one supreme moment. The workman, on the other hand, must be trained to repeat his task, day after day, month after month, year after year, without injury to his strength or his health, because only in that manner can the industry in which he is engaged reach its maximum prosperity. It takes a more carefully trained observer and a far better understanding of men and their physical capabilities to train a workman to do a task quickly and well without over-exertion, than it does to train an athlete to perform his task quickly and well, where the question of over-exertion does not come in.

Any one who has ever had anything to do with athletics understands how impossible it is for a man without training to compete with the trained athlete. Just as it would be impossible for the average healthy and vigorous man to enter an athletic contest and do creditable work in competition with trained athletes, so it is impossible for the average workman to go into a shop and accomplish a creditable amount of work, in competition with a workman who has been properly trained after a motion study has been made of his task. In the same way, just as it is impossible for the average man who likes to look at the stars, to predict the time of an eclipse or the future configuration of the heavens, so it is impossible for the average machinist to compete with the trained engineer who has at hand a slide-rule which will tell him exactly the cuts, feeds and speeds, which it is possible to employ with a given class of material and a given machine. We find it advisable to employ designing engineers who have spent years in studying the strength of materials and the sciences upon which engineering depends. It is equally advisable to employ another class of engineers who will study the principles of management, and methods of doing work.

So far we have only touched on two points in regard to the turning of our crankshaft, namely motion study and the science of cutting metals. There are a dozen other branches of science involved in the direction of the shop, all of which are used by scientific management in furthering administration. When we consider these things, it becomes apparent that in many industries the introduction of scientific management will completely revolutionize methods of work, methods of administration, and even methods of selling the product and of financing the industry.

It will be seen from what has just been said that scientific management is by no means a simple matter, that it requires forethought and care in its application, and that, above all things, it requires the scientific spirit in order to make it successful. It will also be apparent to every one, that while scientific management will very probably greatly increase the output per man or per machine, the staff which it requires for the planning of the work, for the conducting of experiments, and for keeping workmen supplied with material and tools, will be quite an expensive one. The question of whether or not scientific management is profitable, and therefore practicable, will hinge upon the question of whether the savings which scientific management will effect, will pay for the staff which it is necessary to maintain. In my opinion, the savings will usually be more than sufficient to pay for the extra cost of scientific management, although sometimes they will not. The application of all of the methods and machinery of scientific management to the pattern-shop, where every job is different and where the principal part of the work consists in planning rather than in executing, will not usually be a success. On the other hand, where scientific management is applied to repetitive work, there is no question but what the cost of maintaining the staff will be but a very small fraction of the savings which will result.

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During the past year 29,353 applications for patents were filed in Great Britain. Of the foreign applications those from Germany and the United States were most numerous; 3304 applications were of German origin, while 2670 were received from residents of the United States. The United Kingdom, of course, contributed the largest number, or 19,579 applications. During the year, five applications were filed for the revocation of patents not worked to an adequate extent in the United Kingdom. Two of these applications were granted; in one case the application was dismissed; in one the patent expired during the proceedings; and the fifth case is pending.

A BALL RACE GAGE

The accompanying illustrations (Figs. 1 and 2) show a ball race gage, which is used in the works of the Cadillac Motor Car Co., Detroit, Mich., for gaging the diameter of the ball race in a ball retaining ring. Two of these rings form a thrust bearing to reduce the thrust on the main drive shaft of an automobile. As shown in Fig. 2, this gage consists of a cast-iron stand *A* in which a hardened and ground steel ring *B* is retained. The top portion of this ring is made a good fit for the inside diameter of the ball-retaining ring *C*, which when being gaged is simply slipped over the top portion of ring *B*. A stud *D* held to the base by a nut, as shown, is slotted to receive the gage frame *E*. Stud *D* is hardened and ground, and the plate *E* has a reinforced piece *F* held to it by rivets, the latter being hardened and ground and made a good fit in the slot in the stud. The fulcrum of the pointer or needle *G* is so disposed that any variation in the work is magnified twenty-five times at the point where the reading is taken. A knurled handle *H* is fastened to the gage for convenience in holding it.

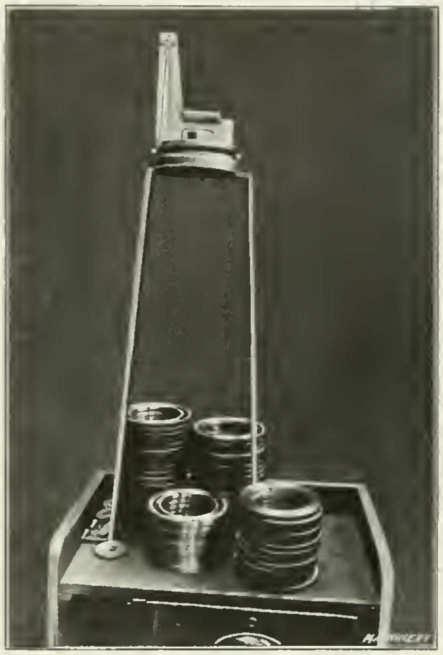

Fig. 1. Ball Race Gage in Use

In operation, the work is slipped over the ring *B* of the gage as shown in Fig. 2; then the gage frame *E* is placed in the slot in stud *D* and the gaging knife-edge rollers *I*, which in this case do not rotate but are held rigidly to the frame, are placed in the ball race. The position of the measuring point of the needle is then noted to see if the race is of the required diameter. A limit of 0.001 inch is allowed on the diameter of the ball race, the latter being 4.125 inches in diameter. The race is ground on a Brown & Sharpe generating grinder. As shown in Fig. 1, the base of the gage is fastened to a frame which is of sufficient height to bring the ring to be gaged in line with the operator's vision.

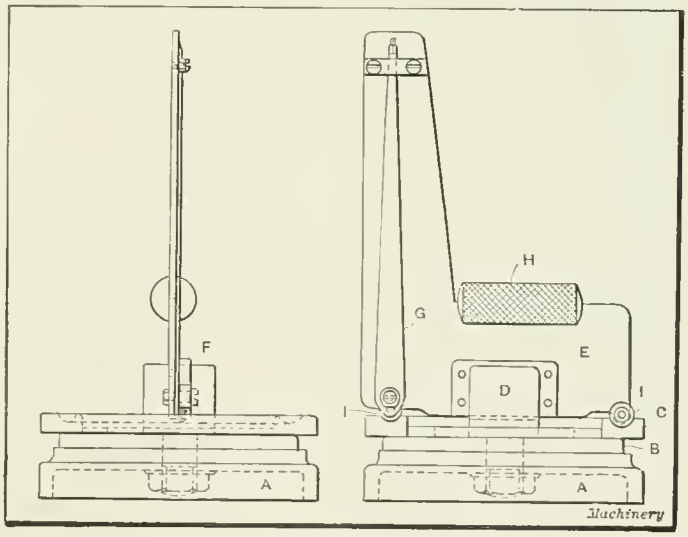

Fig. 2. Construction of the Ball Race Gage shown in Fig. 1

* * *

Bolts, cap-screws, or nuts, when used in connection with cored holes, should be supplied with washers for providing sufficient bearing surface for the nut or head.

THE EXTRUSION OF PLASTIC METALS*†

Although it had been found possible as early as 1850 to extrude such metals as lead and tin and thus form pipes and bars, the extrusion process had not, at that time, been successfully applied to the shaping, by means of extrusion, of such metals as copper, delta-metal, etc. It was when Alexander Dick, the inventor of the delta-metal, made some experiments with this material under high pressure and at high temperature, during the latter part of the eighties, that it was first shown that this material could be extruded in a heated state. There were, however, several difficulties to overcome. The extrusion process, as is well known, consists of hot plastic metal being pressed through a form or die at high pressure, so that a continuous bar or pipe of the cross-section of the die or form is produced. Lead and tin can be extruded at comparatively low temperatures (250 degrees F.), but copper and similar metals require temperatures all the way up to 1750 or 1800 degrees F.

The main difficulties to be overcome are to maintain the high temperature and plasticity of the metals during the extrusion, and to make press cylinders and dies which will be able to withstand the effect of the high temperatures and pressures. The first condition was met by Dick by filling the press cylinder with molten metal and by surrounding it with heat insulating material, such as ground granite. In order to prevent the heated metal from forcing itself between the plunger and the cylinder, when the pressure was applied, a spherical steel piston was employed which spread when the pressure was applied, and in this way effectively closed the cylinder behind the metal.

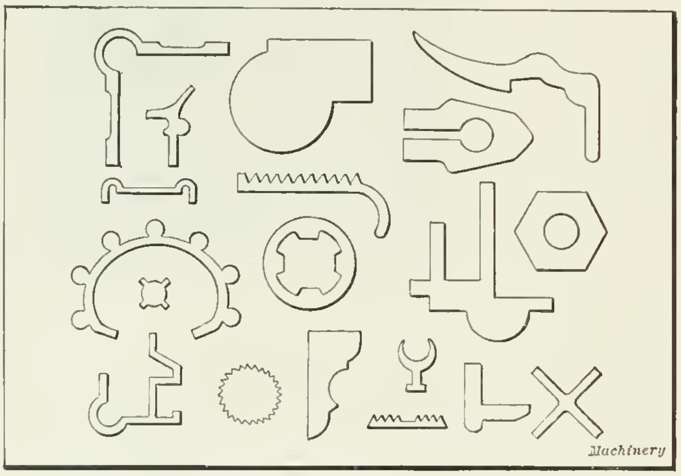

Fig. 1. Some Interesting German Products of the Extrusion Press

The advantages of the extrusion process, as compared with the ordinary rolling and drawing process, soon became apparent. The extrusion process permitted parts of unusual cross-section to be produced in great quantities. In fact, sections could be extruded which could not be rolled under any circumstances. In Fig. 1 is shown a number of special sections which have been produced by extrusion. On account of the high pressure under which the metal is extruded it becomes more compact and its strength is increased. The extruded shapes, therefore, possess those qualities which make them especially useful in machine design. The surfaces are smooth, and free from flaws and other defects. The dimensions of the extruded shapes can be gaged with great accuracy, so that they may be used either directly or with very little additional finishing. After the advantages of the new method had become known, it was soon adopted and further developed by many different individuals and concerns.

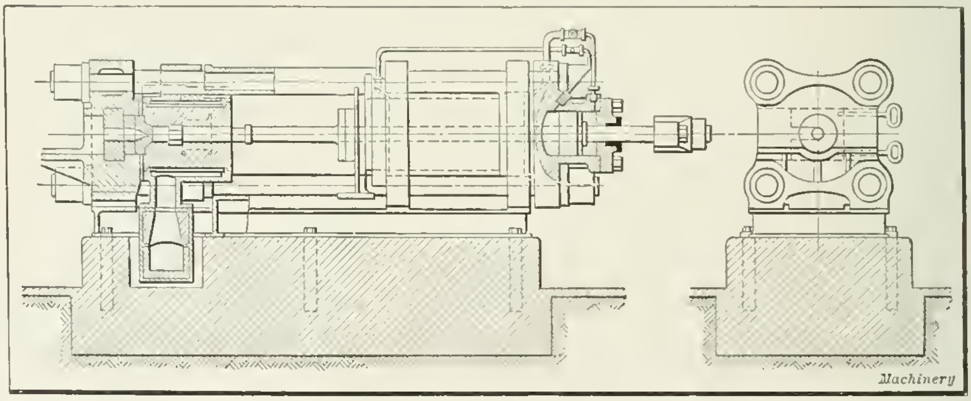

Fig. 3. General Arrangement of Krupp Extrusion Press

Instead of pouring the molten metal into the press cylinder, it was found to be better to have it cast into blocks which were heated to a white heat and inserted in the press. In this way the time required for the setting of the metal in the press cylinder was saved, and the efficiency of the machine considerably increased. Further developments resulted in the perfecting of the press, and the metals used for the cylinders and the dies. In order to retain the heat within the cylinder it was surrounded by a jacket and heated by special means. Several new presses were brought out, and besides the Dick press, those best known in Germany were built by the firm of Friedr. Krupp A.G., Grusonwerk in Magdeburg-Buckau. The object of this article is to describe the methods and processes used in connection with the machine. The complete installation consists of a foundry for producing the metal blocks, a heating furnace, and a hydraulic press and pumping arrangement.

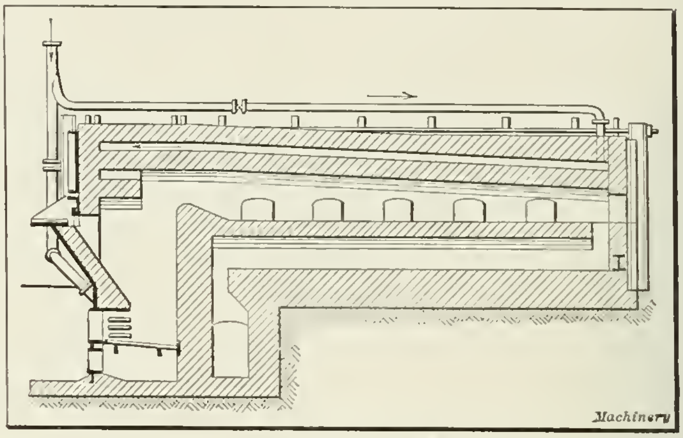

Fig. 2. Section through the Heating Furnace

The Casting of the Metal Blocks

The metal blocks are cast in long sections and are afterwards cut up into pieces of suitable size for the presses. The blocks are cast in permanent molds, and in order that as smooth a surface as possible may be obtained, it is necessary that the inside of the mold be of a close-grained metal, free from flaws. In order to still further insure against blow-holes or porous parts in the cast blocks, the molds are covered on the inside with a preparation, the same as is done in the casting of copper and brass in general.

After the blocks are cast and cut into parts, they are inspected for defects, and any burrs or fins that may be present are removed by chisels or scraping. Special care must be used in producing hollow parts for pipe. In this case, it is especially important that the core be central with the outside, in order that homogeneous walls of uniform thickness may be obtained in the extruded pipe.

Heating the Metal Blocks

The metal blocks are heated in a special furnace which should be placed close to the extrusion press. The important feature about the heating is that the block must be heated clear through to the center, and not be brought to the press when merely the surface has been brought to the required temperature. A furnace used for heating the blocks is illustrated in Fig. 2. The blocks are inserted at the end opposite the grate, and roll by gravity down the somewhat inclined surface toward the fire-box. When the required temperature is obtained, they are pulled out through an opening at the side. In order that good results may be obtained in the extrusion process, it is important that the blocks do not come in contact with the brickwork of the furnace. The surface on which the blocks rest is, therefore, covered with a cast-iron plate. The length of the furnace is made to suit the capacity and speed of the action of the press. The width is usually made about three feet. The heated blocks are most conveniently transferred from the furnace to the press by means of an overhead trolley.

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* Abstract from an article by Friedr. W. Siepke, of Magdeburg, Germany, in *Werkstattstechnik*, April 15, 1912.

† See also "An Experiment in Extrusion," MACHINERY, June, 1912, engineering edition, and other articles there referred to.

The Hydraulic Extrusion Press

The hydraulic extrusion press shown in Fig. 3 is of the horizontal type. The press consists mainly of the hydraulic cylinder, the dies, the pressure chamber or extrusion cylinder, and a head which holds the dies. Four heavy connecting bars tie this head to the hydraulic cylinder. The pressure chamber is located between the head and the hydraulic cylinder and moves on four guide bars.

These presses are built in two sizes, the main dimensions of which are given in Table I. The output of the presses varies according to the size and form of the cross-section of the different extruded shapes. With trained operators and simple cross-sectional shapes, it is possible to extrude about 20,000 pounds of metal in ten hours in the small-size press and 35,000 pounds in the larger press. This output cannot be obtained, however, when tubing of difficult sections is being extruded. The figures given above correspond to two hundred press operations in ten hours. In order to be able to maintain this efficiency the press chamber must be sufficiently heated at the beginning of the work and there must be no interruption in the operation. For the complete installation required for one press, four men are necessary, one of whom works at the furnace.

Details of the Hydraulic Press

The hydraulic cylinder is made of steel casting and lined on the inside with a copper bushing. The pressure chamber is made of so-called "Krupp special" steel which even when heated has a high tensional strength. This chamber or cylinder is forged and is provided with a jacket of steel casting. Between the pressure chamber and jacket an open space is provided through which the heated gases from the fire-place arranged beneath the pressure chamber can pass. By this means the chamber is heated to the required temperature, the gases from the combustion escaping through a pipe above the pressure chamber into the chimney. The required temperature to which the pressure chamber should be heated by external means is about 600 degrees F. This heat is required so that the metal blocks which are heated to some 1650 or 1800 degrees F. may not be suddenly cooled. Should sudden cooling take place, the surface of the metal block may lose its plasticity and the extrusion may either be unduly delayed or be made entirely impossible. The high temperature of the walls of the pressure chamber, while the extrusion takes place, requires an especially high quality of metal, and it has been proved in a number of instances that forged Krupp special steel answers the requirements better than any other known material.

TABLE I. GENERAL DIMENSIONS OF EXTRUSION PRESSES

Dimensions	Smaller Size	Larger Size
Total pressure, pounds	1,430,000	2,200,000
Maximum pressure, pounds per sq. in	3770	4125
Diam. of hydraulic cyl., inches	22	26
Stroke, inches	27½	31½
Diam. of extrusion cyl., inches	4⅗	5½
Max. diam. of extruded bars, inches	2	2¾
Required horsepower	100–150	175–225

In order to prevent too high a pressure in the hydraulic cylinder, a safety valve is provided on the pump which opens at a pressure of about 4500 pounds per square inch. In order to instantly relieve the pressure in the hydraulic cylinder, a releasing valve is inserted between the pump and the controlling valve on the machine.

The dies containing the shape for the extruded form are held in the head. This latter takes the pressure during the extrusion process. One of the greatest difficulties in the past with machines of this type has been to remove the remainder of the metal block in the pressure chamber when operations are suspended or when practically all the metal has been extruded. Part of the metal would usually be pressed in between the joints, solidify and make the removal of the various parts difficult. In the Krupp press this difficulty is taken care of as follows: As already mentioned the pressure chamber is placed between the head and the hydraulic cylinder, but is movable on four guide rods. A tapered hole is provided in the pressure chamber in the end towards the head, and the dies are formed with a corresponding taper. An auxiliary hydraulic cylinder is provided at the right-hand end of the press in Fig. 3, and the pressure chamber is connected with the piston of the auxiliary cylinder by means of a cross-head and two connecting-rods. By this means the pressure chamber can be operated. Before the beginning of the extrusion, the pressure chamber is forced against the die by means of this auxiliary cylinder, and due to the tapered hole and the tapered end of the die a very close-fitting joint is provided, so that the metal, during the extrusion process, cannot enter between the two surfaces. At the end of the extrusion, the auxiliary cylinder operates the pressure chamber in the opposite direction, thus opening up a space between the die and the pressure chamber and making it possible to easily remove the remaining metal from the top of the die.

TABLE II. INFLUENCE OF THE EXTRUSION PROCESS ON THE PROPERTIES OF METALS

Metal	Cast		Extruded	
	Tensile Strength, Pounds per Square Inch	Elongation, Per Cent	Tensile Strength, Pounds per Square Inch	Elongation, Per Cent
Copper	28,500	35	34,000	38–40
Zinc	27,000*	12	35,000	38
Magnalium	43,000–64,000	5	53,000–71,000	10
Aluminum	14,000–17,000	3	33,000–38,000	4.3
Delta-metal	83,000	11	98,000	21.8
Durana-metal	58,000–74,000	35	60,000–81,000	38

[* The tensile strength of cast zinc is given by several authorities at about 3500 pounds per square inch, and that of rolled zinc at about 16,000 pounds. The strength of cast zinc given in the table is 70 per cent greater than for rolled zinc, which seems to be a very high and doubtful value.—EDITOR.]

The press can be operated with considerable rapidity. For simple shapes, it is possible to go through the complete cycle of operations for one metal block in three minutes, this time being divided as follows: Putting the metal block into the pressure chamber, 1 minute 25 seconds; extrusion, 50 seconds; opening up the space between the pressure chamber and die, 10 seconds; removing the remaining metal, 15 seconds; and returning to the original position, 20 seconds. The effect of the extrusion process on the tensile strength of various metals is indicated by Table II.

* * *

Franklin H. Wentworth, secretary of the National Fire Protection Association, stated at the meeting of the New England Foundrymen's Association, April 10, that out of more than 11,000 fires under automatic sprinklers, of which the association had records during the past fifteen years, there was not a single instance where the automatic sprinkler, when of standard approved make and installation, had failed to put out or hold in check a fire under it, except in cases where the system had been tampered with, or crippled by an explosion.

* * *

Undoubtedly many (accident) prevention appliances in use in Germany might well be adopted here, but the real and important difference is not in the prevention apparatus—it is in the prevention spirit. In Europe, and especially in Germany, accident prevention is kept constantly before the public, before the legislatures, before the employers, and before the workers.—*F. C. Schwedtman in "Accident Prevention and Relief."*

DETAILING CRANE GIRDERS WITH CURVED LOWER CHORDS*†

By CHARLES B. GILBERT‡

The detailing of crane girders with curved lower chords—that is, of the fish-belly type—sometimes involves considerable labor. The tables given in the accompanying Data Sheet Supplement were, therefore, compiled by the writer about three years ago, and have been used by the structural detailers of the Niles Crane Works, of Philadelphia, Pa. The tables have been carefully checked and have been in use so long that it is assumed that all errors have been eliminated. The tables have proved of great value as time savers when figuring the depth of curved girders, half the span being divided, for convenience, into five or ten equal spaces for spans of different lengths. A glance at the accompanying engraving Fig. 1, will explain the use of the tables, a crane girder having a span of 61 feet 3 inches having been assumed as an example. The curved part has a span of 60 feet; one-half of this distance, or 30 feet, is divided for the convenience of the templet makers into ten spaces of 3 feet each. The end ordinate, assumed here to be 1 foot, will be found at the extreme left of the tables under the heading *H*. The lengths of the remaining nine ordinates follow in order.

For short spans, say about 30 feet, it is most convenient to divide the base of the curve into five spaces, as it is the usual practice to give ordinates about every 3 feet. In this case we would use only every other ordinate in the tables, or, beginning with the left-hand column, the ordinates would be as found in the columns headed *H*, 8, 6, 4, and 2.

The construction of the parabolic curve, while familiar to every student of geometry, may be of interest in this connection. In Fig. 2, divide the base *BO* and the height *H* into the same number of equal parts (ten in the illustration); draw straight lines from *O* to points 1, 2, 3, etc., on line *AB*; then draw vertical lines from points 1, 2, 3, etc., on line *BO*. The points of intersection between the lines 1 and 1, 2 and 2, etc., are points on the curve of the parabola. When the curve is slight, as is frequently the case in plain girder design, it is sufficient, on the drawing, to join the points by straight lines.

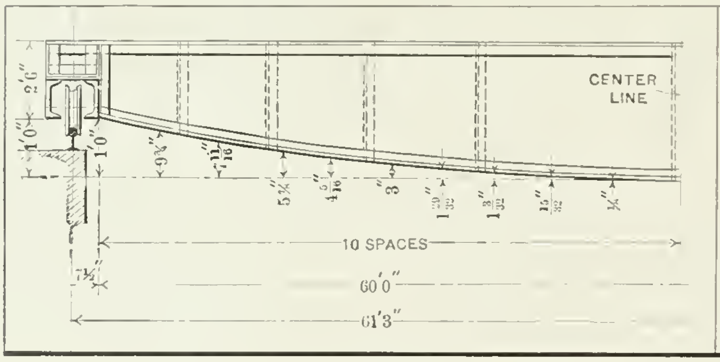

Fig. 1. General Lay-out of Typical Crane Girder

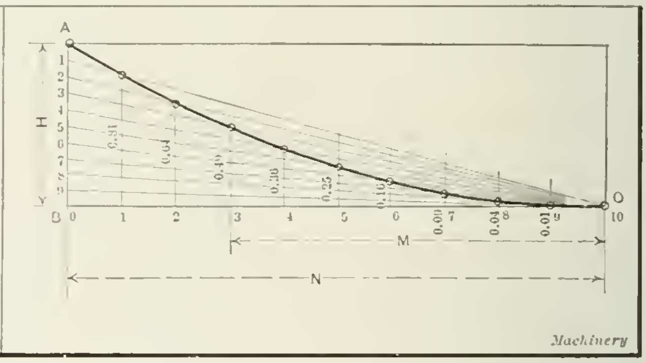

Fig. 2. Lay-out of Parabolic Curve, and Method of Calculating Tables

The tables in the Data Sheet Supplement are calculated as follows. In Fig. 2, let

H = end ordinate,

X = required ordinate,

N = number of equal spaces into which base BO is divided,

M = number of spaces from O to required ordinate.

Then,

$$X = H \times \frac{M^2}{N^2}$$

When $N = 10$, as in the case for which the tables are calculated, $N^2 = 100$, and

$$X = H \times 0.01\,M^2$$

Hence, ordinate No. 2 equals $H \times 0.01 \times 64 = 0.64\,H$. Ordinate No. 6 equals $H \times 0.01 \times 16 = 0.16\,H$, and so forth.

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* With Data Sheet Supplement.

† See also MACHINERY, January, 1912, engineering edition, "Points in Crane Construction and Design," and the articles there referred to.

‡ Address: 1809 N. 16th St., Philadelphia, Pa.

MAKING THE "UNIVERSAL" HACK-SAW BLADE

By CHESTER L. LUCAS*

The steel from which hack-saw blades are made is almost invariably a special grade of crucible steel, each maker having a preference for his own particular brand, the content of which he considers best for hack-saw blades. In making the "Universal" hack-saw blade at the West Haven Mfg. Co., New Haven, Conn., the steel comes to the factory in large sheets, and the first operation consists in cutting these sheets to smaller sections, each of which is wide enough to be cut into blades of standard lengths, eight, ten or twelve inches. These sections are then cut into blanks for the individual saw-blades. The thickness of the stock and the width of the blank vary, of course, with the different lengths of blades being made. All of this cutting is done on square shears and it is essential that the shear-blades be kept in excellent condition so that the edges of the blanks will be square and free from burrs.

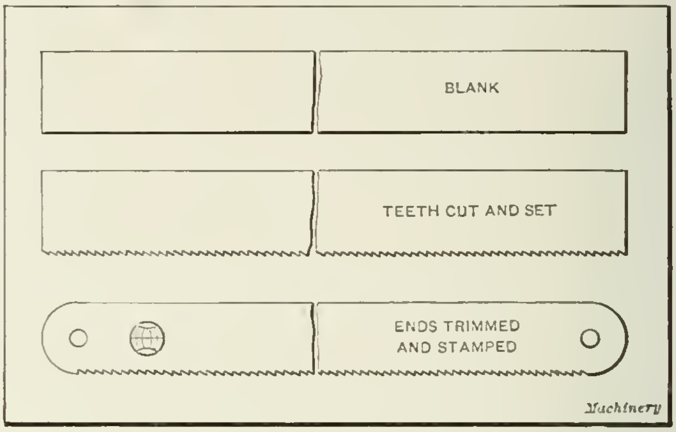

Fig. 1. Order of Operations in Hack-saw Blade Making

Cutting the Teeth

The blanks for the hack-saw blades are now in the condition shown in the upper view of Fig. 1, being merely blocked to size. Next in order comes the operation of cutting the teeth. Among hack-saw blades makers there are two distinct methods of cutting the teeth; by punching and by milling. The milled tooth is superior to the punched tooth, because milling leaves the sides and faces of the teeth perfectly sharp, while punching rounds one side of the tooth, thus impairing its cutting qualities.

Fig. 2 shows the operation of milling the teeth of "Universal" hack-saw blades. The work is done in plain milling machines, fitted with special vises for holding the thin blades, having "hold-downs" for the front jaws. The vise on the machine shown at the right is but partly filled with blanks, while the one at the left is completely full, and a cut is being taken across the work. The mirror-like appearance of the work is caused by the flooding of the oil over the work. The gang cutters used are made of high-speed steel, and it requires twelve or fourteen of them to make up the width necessary for the average cut. It will be noticed that in mounting the cutters on the arbor, they are set one a little ahead of the preceding one, thus effecting a helical arrangement of the faces, the object being to distribute the cut.

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* Associate Editor of MACHINERY.

These cutters are, of course, made for milling the various sizes of teeth. The number of teeth per inch varies from 14 to 32. Blades intended for cutting solids in iron and steel are usually cut with from 14 to 16 teeth; for general all-around work it is considered advisable to use 20 teeth. For soft brass, 24 teeth has been found better than a smaller number per inch, because there is less tendency to "hog in" and for thin tubing and sheet metal 32 teeth per inch is very satisfactory.

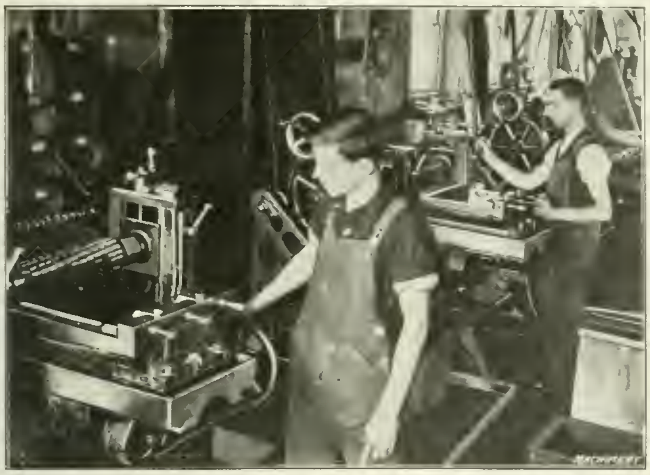
Fig. 2. Milling the Teeth

Setting the Teeth

The semi-completed hack-saw blade now appears as shown in the middle view of Fig. 1, and in this condition is ready for the setting operation. There are two recognized methods of setting the teeth of hack-saw blades: one is by flat dies having a reciprocating motion, and the other, by rolls having a rotary motion. The machine shown in Fig. 3 is of the rotary type, and as the blades pass between the rolls, projections press the teeth alternately slightly upward and downward, thus giving the teeth the required "set." From the setting machines, the blades are passed to presses that clip the ends, punch the holes, and imprint the trademark upon one end. One of these presses may be seen in the foreground of Fig. 4, and in the background of the same illustration may be seen a battery of the milling machines that cut the teeth.

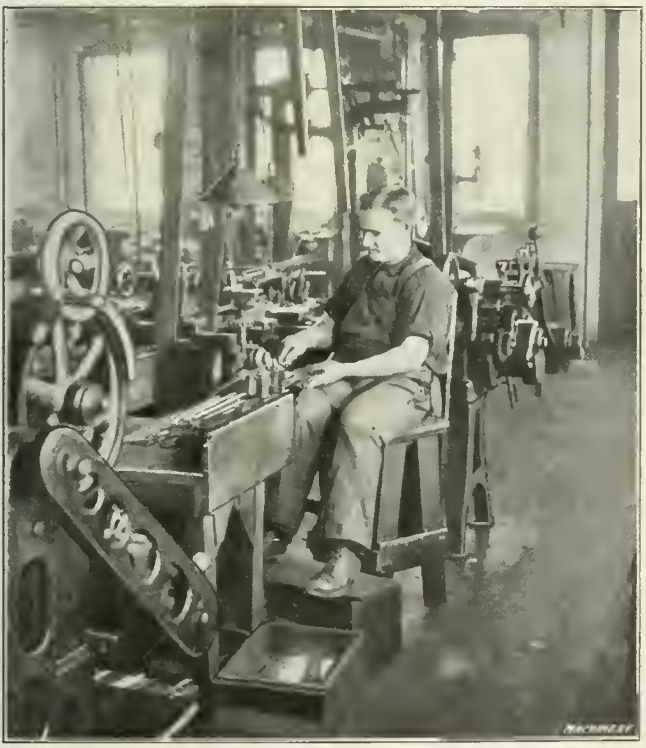
Fig. 3. Setting the Teeth

Hardening and Tempering

The hardening department of the West Haven Mfg Co. is located in a brick addition to the main factory and is exceptionally light and roomy for a department of this kind. The blades are treated by a special process that leaves them as hard as glass, and of extremely uniform hardness throughout.

In order to give them the required toughness, the blades are next tempered by immersing them in hot oil. Previous to this, however, they are packed loosely in an iron frame, similar to the vise used in milling the teeth. This frame has set-screws for applying pressure to the blades, against both the sides and edges. After placing the blades in the frame, and immersing frame and blades in the oil, they are allowed to remain there until the mass of blades has been brought to the temperature of the oil. After this, the screws of the frame are tightened upon the blades, thus bringing any that are bent or warped back into shape. It should be remembered that this is done while the blades are very hot and still dripping with oil, in which condition they yield readily to the pressure from the clamping screws. The hack-saw blades are allowed to remain in the frame until they are cold, at which time those that were warped will have regained their original straight condition.

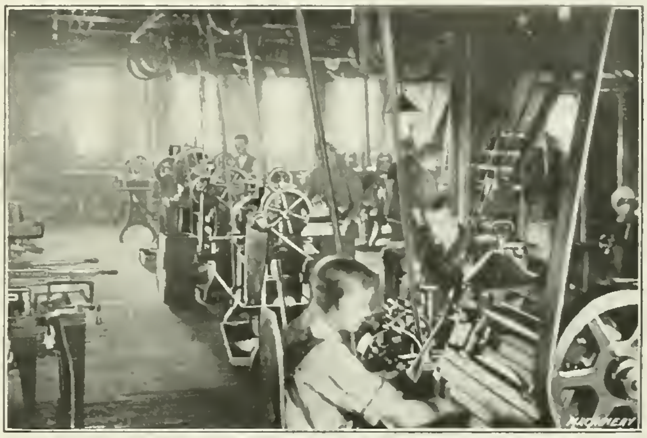
Fig. 4. Milling and Punching Operations

In order to reduce the brittleness of the pierced ends of the blades, the ends are dipped into a pot of molten lead. The lead in the pot is of the right depth so that when the bottom is touched, the ends of the blades will be immersed to the right distance. After this operation, the blades are cleaned and brushed free from scale and dirt, at which time they are ready for inspecting and packing.

Inspecting and Packing

Fig. 6 gives a general idea of the way in which "Universal" hack-saw blades are inspected and packed. The inspectors sit at well-lighted benches and successively try each saw for temper, at the same time inspecting them for poorly cut teeth and for soft spots that may be present. They are then wrapped in packages of twelve each, labeled and boxed for shipment.

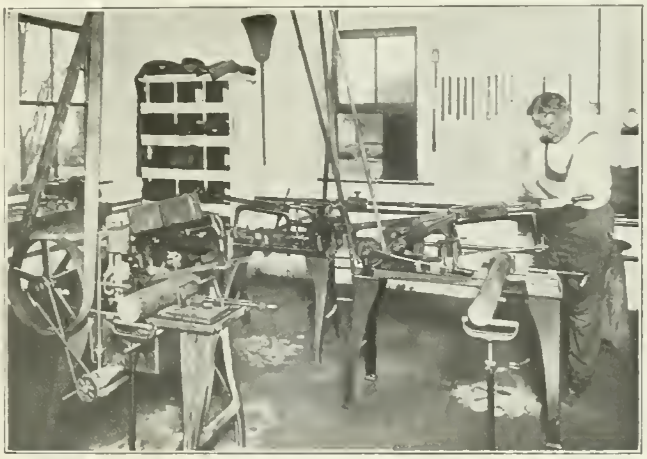
Fig. 5. The Testing Room

From time to time, blades are selected at random from the different lots and tested for cutting qualities, after the manner shown in Fig. 5. They are tested for duration, for speed in cutting and for performances on various hard metals. The results of these tests are carefully recorded and thus the high standard aimed at in making "Universal" hack-saw blades is maintained.

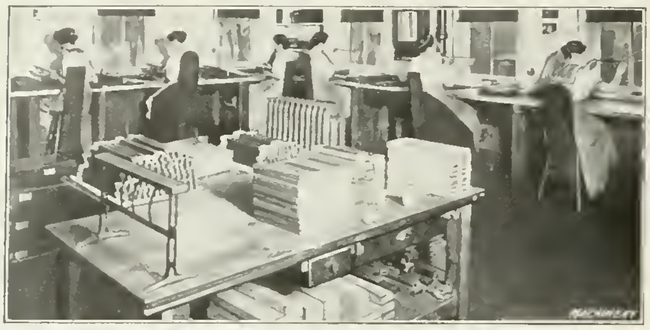

Fig. 6. Inspecting and Packing

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INDUSTRIAL ADVANTAGES OF THE UNITED STATES

In the United States—a young, growing country—there has been, and still is, an unlimited demand for more highly developed industries. New manufacturing establishments are constantly under construction, and are usually equipped in the most modern manner. In Europe it is, with few exceptions, merely a case of remodeling old establishments. It is very easily understood that an old remodeled factory can never come up to the same standard or offer the same possibilities for manufacturing, as an establishment which from the beginning is planned after modern ideas. The familiarity with old established ways also tends to make difficult departing from old ideas and moving into new fields. The expense account is also a very important factor and should not be overlooked. Whereas a new shop will cost almost as much with an equipment partly copied after old ideas, as it would equipped in the most modern way, the old shop, modernized to the same extent, would have to stand the expense not only of the modern equipment, but of the old superseded one also. New buildings would in most cases have to precede the new equipment, as the facilities offered by old buildings are often so inferior as to make only half a success of the new departure.

The extent and population of the country makes the home market offered in the United States very large, as compared with the market available to the manufacturer in an average European country. This, in turn, makes possible a greater sub-division of labor. Even the smallest article can be manufactured on a large scale without looking for a market outside of the boundaries of the home country. In Europe, on the other hand, most firms of any importance have been, at least until a very recent date, compelled to go into a number of different lines of manufacture, as each line alone has an insufficient market to make the business pay the desired returns. This is a consideration of more than ordinary importance. Not only can an establishment manufacturing one article or one line of articles, secure a greater prestige in this certain line, and enable its responsible heads to gain a much greater experience in the particular line of work they have to direct, but a systematic arrangement of the work can be established, which is not possible in an establishment manufacturing many varied articles. This sub-division of labor, in the whole industrial field, as well as in the individual shops, has been the great cause of the systematic organization peculiar to American factories. This systematic arrangement, again, has made it possible for American shops to turn out, with the same number of men, a much greater amount of work in a given time than is usually turned out by the average European shop.—*From an address by Mr. A. L. Valentine, of Hartford, Conn., before the American Society of Swedish Engineers, Brooklyn, N. Y.*

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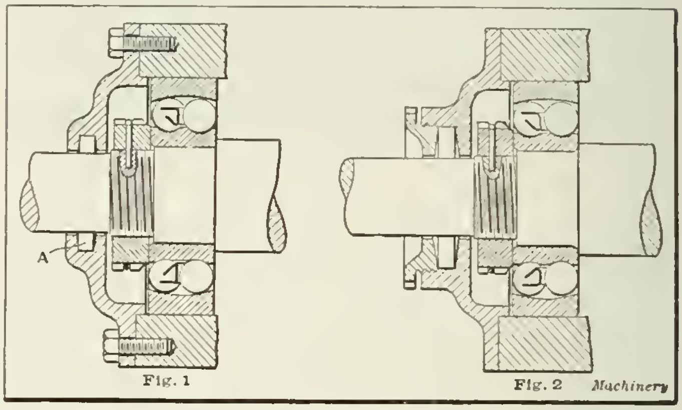
There is a distinction that makes a big difference between a smooth cutting file and a slick one.

THE MOUNTING OF BALL BEARINGS[*]

By F. H. POOR[†]

The method used for housing a ball bearing depends largely upon the nature of the machine to which the bearing is applied and the load and speed under which it is operated. One essential should always be kept in mind—ball bearings should in every case be kept clean, in order to give the best service. The selection of bearing caps for any given machine, therefore resolves itself practically into providing for sufficient protection of the bearings against grit or liquids which may be injurious to the bearing, and preventing the escape of the lubricant. The forms of end caps illustrated in the accompanying engravings have been designed for use in connection with the S. K. F. radial ball bearings and have been found satisfactory for general application.

The use of a single groove at *A*, as shown in Fig. 1, is generally sufficient. The grooves are cored to a depth of not less than 3/8 inch and the edges of the lips are bored approximately 1/64 inch larger than the shaft. The width of the grooves and the lips must be determined with a view of providing sufficient strength and protection against abuse when installed. The use of a second groove in the end cap, as shown in Fig. 3, and sometimes a third groove, is recommended where machines are subjected to a great deal of dust, fine grit, moisture, etc. In this case it is customary to pack the outer groove with a felt washer or with a heavy grease, which will provide a frictionless packing. The groove for the felt should be machine-finished. The groove adjacent to the bearing may be drained at the bottom to more effectually provide against leakage of the bearing lubricant. The return drain serves to keep the lubricant in circulation behind the sealing groove.



Figs. 1 and 2. Cap Designs for Ball Bearings with Single Groove

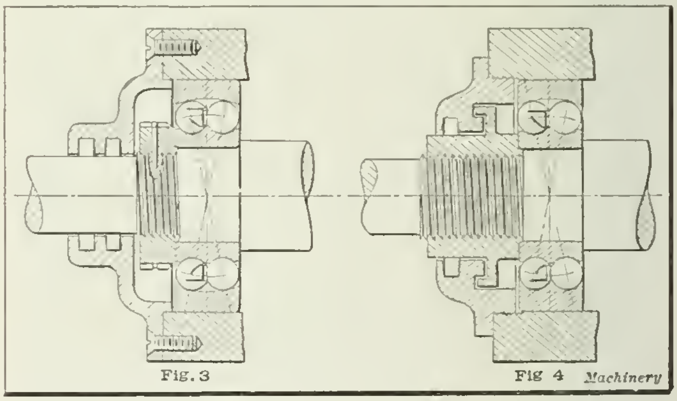


Fig. 3. Cap with Two Grooves. Fig. 4. Cap Design used where Bearing is exposed to Fine Dust

Caps of the type shown in Fig. 4 are too expensive to be considered except for extreme conditions, such as are found in high-speed grinders, cement machinery, etc., where protection against exceedingly fine dust is of importance. Fig. 2 shows a type of end cap, providing for a felt washer only, but having a tightening device to insure a tight fit of the washer on the shaft. This arrangement is applicable to low-speed bearings and is frequently used in automobile transmissions. In Fig. 5 is shown a plain end cap. Numerous means are used for securing the caps to the housings, and also for locking the retaining nut for the inner races. The G-shaped wire shown applied in the engravings, however, is generally considered the simplest form of locking device.

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[*] For further information on ball bearings, see the following articles previously published in MACHINERY: "Some Notes on Ball Bearings," May, 1909, engineering edition, and also the articles there referred to. See also MACHINERY'S Reference Book No. 56, "Ball Bearings."

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The fitting of bearings to shafts seldom presents any great difficulties. Inasmuch as the bearings are ground to very close limits, the shafts to which they are to be fitted should also be accurately finished to present a smooth uniform seat for the bearing. The inner race should be a tight fit on the shaft and should be permanently seated in a fixed position against a shoulder on the shaft by means of a lock-nut or a distance piece. A driving fit alone should not be depended upon to properly retain the inner race in position, as the continued action of the load on the bearing will tend to peen down the shaft. A positive means for holding the inner race in position prevents creeping on the shaft and materially increases the actual bearing length on the shaft.

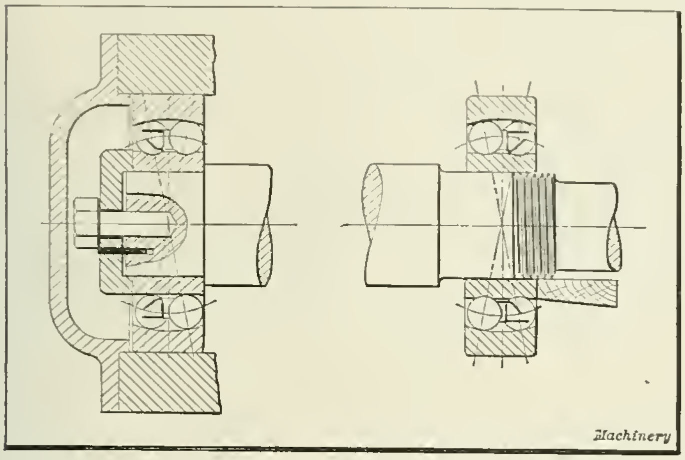

Fig. 5. Plain End Cap. Fig. 6. Using a Piece of Wood to drive Bearing into Place

In order to obtain a proper light drive fit on the shaft, this should be finished slightly larger than the bore of the bearing, preferably within a maximum limit of 0.001 inch and a minimum limit of 0.0004 inch above the actual size of the hole in the bearing. If the shaft is made smaller, the bearing race will tend to creep and cut into the shaft, and if larger limits than indicated above are allowed, too great a force will be required to properly seat the bearing, with the added danger of cracking the inner race. It is easy to drive the race in place by heating it in oil to about 170 degrees F. and driving it into position by light blows of a soft metal hammer. A piece of copper tubing, or a piece of wood in conjunction with an ordinary hammer can also be used for the same purpose, as indicated in Fig. 6. The outer race must under no circumstances be given a blow when fitting the bearing onto the shaft.

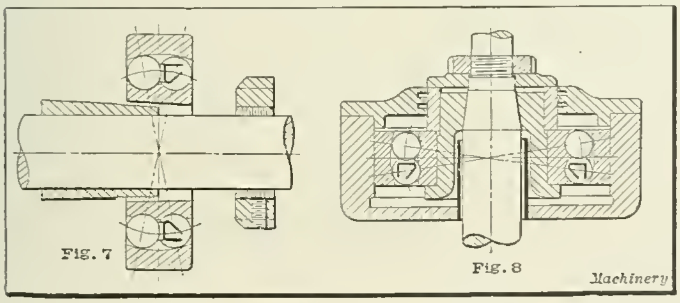

Fig. 7. Adapter Type of Bearing. Fig. 8. Method for Retaining Lubricant in Vertical Bearing Shaft

The outer race should have a very close sliding fit, but should never be securely fixed in the housing. A slow creeping of the race should at all times be possible under the vibration of the load. This slow intermittent creeping insures a proper distribution of the load over the whole surface of the outer race. Even when it is desired to prevent end motion of the shaft, a slight clearance of 0.010 inch should be provided on each side. Without this lateral clearance—*i. e.*, if the race is securely fixed in the housing—the load will always bear on one position in the race. When there are several radial bearings on the same shaft, one bearing only should be used to hold the shaft against end motion; the outer races of the other bearings should be free to locate themselves.

In cases where it is impossible to make the inner ball race a driving fit on the shaft or to secure it by means of a lock-nut or distance piece, the adapter type of bearing shown in Fig. 7 should be used. This bearing is provided with a conical split sleeve and lock-nut which clamps the bearing on the shaft in any desired position.

The shaft and housing should be turned as true as possible to insure concentric running of the races, and in case split housings are found desirable, great care should be taken to see that the housing sections do not bind the outer races and distort them. The application of radial bearings to vertical shafts occasionally makes lubrication difficult. A practical method of meeting these conditions—as they are sometimes to be found in the upper bearings of sugar centrifugals, vacuum cleaners, side cutters on wood planers, vertical pumps, etc.—is shown in Fig. 8, the retention of the lubricant being amply provided for by the tubular cup between the shaft and the seat for the inner race. This mounting is also made in a modified form with a lock-nut below the bearing, in which case the upper face of the inner race is held against a shoulder on the bearing support.

When it is necessary to use a thrust bearing to take the weight of a vertical shaft, a combination of radial and thrust bearings, as shown in Fig. 9, provides an ideal method of mounting. The center of the radial bearing coincides here with the center of the spherical surface of the thrust disk. This provides a combination which is self-aligning about one point.

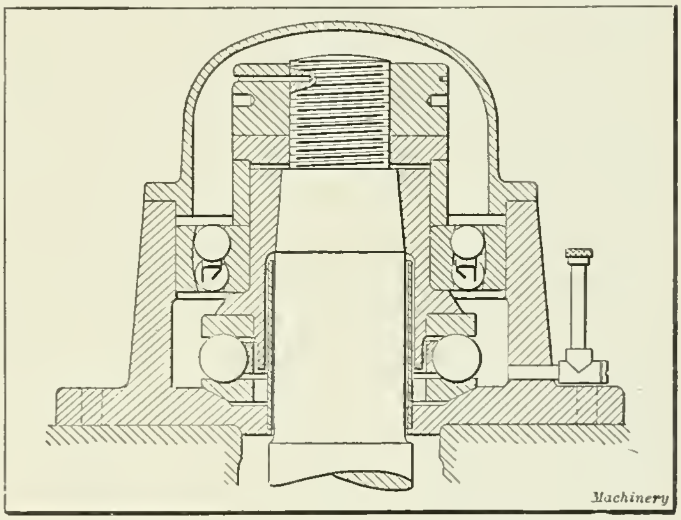

Fig. 9. Combined Radial and Thrust Bearing

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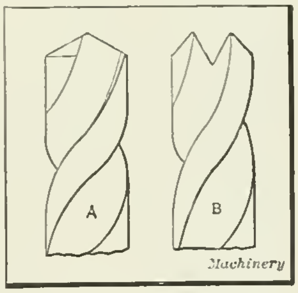
THE DRILLING OF MARBLE OR SLATE SLABS

Anyone who has had to drill marble or slate knows of the difficulties met with. Frequently holes are produced by drilling through with a small diameter drill, following with one of the full diameter of the hole required. A better method, says the *Practical Engineer* (London), is to mark out the center of the hole required and start it with an ordinary ¼ inch twist drill, as shown at *A* in the accompanying illustration, replacing this tool by a special tool, as shown at *B* (of the same diameter as that at *A*), as soon as the cavity is deep enough to permit of changing with safety. Then, to obtain the full diameter hole, a drill of the full size required is used as before. This method is more rapid than to drill a small hole right through the marble by an ordinary twist drill.



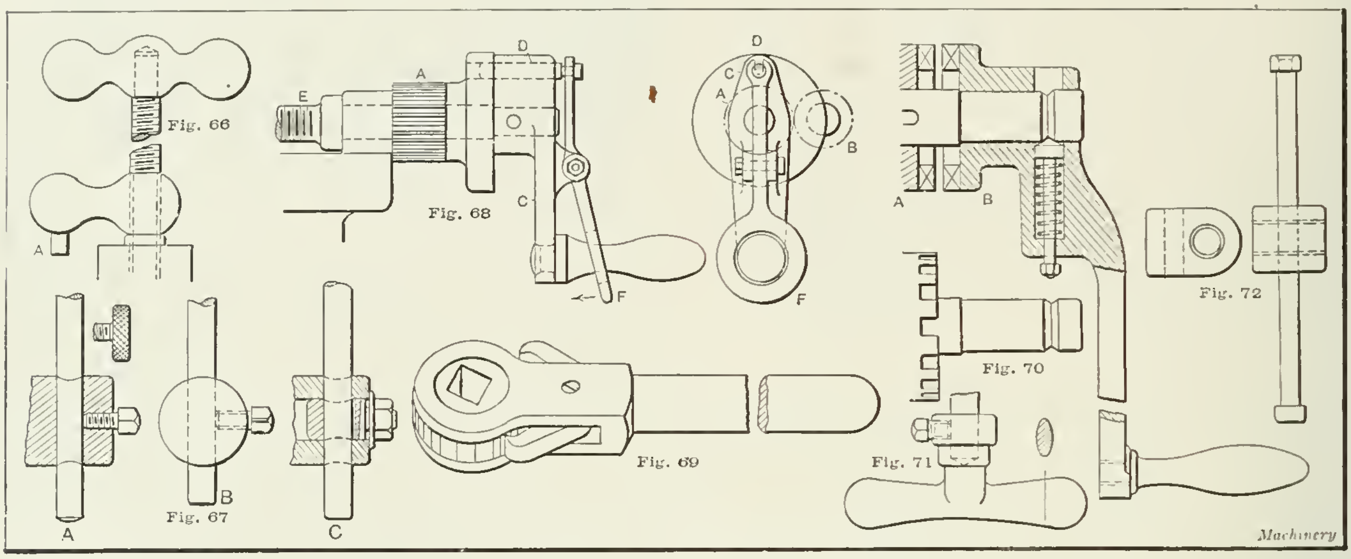
Drills for Marble or Slate

MACHINE HANDLES—2

A STUDY OF THE VARIOUS TYPES OF HANDLES AND HANDWHEELS USED ON MACHINE TOOLS

By FRED HORNER

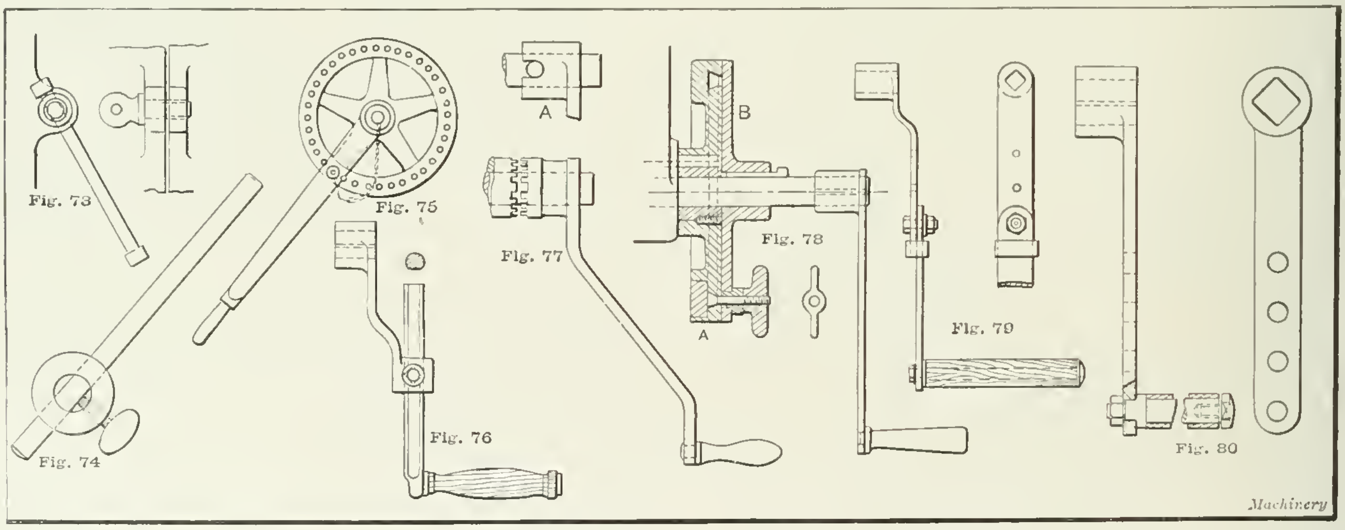
The handles and handwheels illustrated and described in the previous installment of this article were, in general, of a simple nature. In the present installment some of the handles and mechanisms described will be of a more complicated nature, including combinations of handles, handwheels, ratchets, indexes, and other similar mechanisms.



Figs. 66 to 72. Types of Handles used in Machine Tool Construction

In Fig. 66 is shown an example of a handle combining the double and single types, one being used for adjusting the raising screw and the other for locking it. The latter has a small pin *A* which catches against the bearing cap and prevents the handle from swinging into contact with the revolving spur gears on the other side of the cap. A handle attached to the end of a spindle for operating a belt-shifting mechanism for a small countershaft, is shown in Fig. 71. This handle is made of cast iron.

In a few instances, it is not desirable or may be impracticable to permit the handle to project out on one side or the other of its boss. In such a case, a sliding handle of the type shown in Fig. 73 is used; the same kind of handle, passing through a nut on one side of the threaded hole, is shown in Fig. 72. This example is taken from a brass finisher's lathe and is used for tightening the screw of the hand-rest underneath the bed.



Figs. 73 to 80. Types of Handles used in Machine Tool Construction

Handles provided with clutches, apart from the friction devices already described in the previous installment, are sometimes required to prevent their being operated when the power feed is in and the shaft is rotating. Teeth are cut on the boss or hub of the handle and on the sleeve of the spindle, as shown in Fig. 77, thus permitting of disengagement when desired. Ratchet teeth are occasionally required. As an alternative design, a pin may be driven through the spindle and the hub of the handle may be provided with slots on either side as shown in the detail view at *A* in Fig. 77. Often the handle is kept out of engagement by a weak spring. A washer may be held on the end of the spindle by a set-screw to prevent the handle from falling off, while, in other instances, the washer is omitted in order that the handle may be slipped off and placed on another adjacent screw or spindle. An example of this type of handle is shown in Fig. 70, where two screws or spindles on a boring mill are shown placed close together, and one handle serves for both. The clutch arrangement, in this case, differs somewhat from the ordinary type. The clutch *A* is double-ended, one end only being shown in the engraving, and slides along a feather key on the spindle. When moved to the left it engages with a power-driven clutch gear, but when moved to the right it meshes with the teeth of handle *B*, and the turning of the latter rotates the spindle when an adjustment is desired. The spring plunger in the handle engages with the V-groove in the spindle and prevents the handle from falling off endwise. The spring, however, is not strong enough to prevent the pulling off of the handle when it is desired to remove it.

Pilot or star handles, of the types shown in the previous installment, are generally so designed that they can be disconnected so that when the power feed is in action the star handle does not rotate. Some form of friction clutch is usually provided, or a spring plunger is fitted to the hub of the star wheel handle, the plunger passing through into a hole in the sleeve which rotates with the operating spindle or shaft. The friction-disk device is also a favored type of connecting medium for many mechanisms of this description. The Lang disk device was one of the first to be applied extensively in turret lathes. One of these applications is seen in Fig. 78, in which the power-driven plate *A* is coupled to the disk *B* on the shaft when the wing-nut is tightened. Two of these nuts are used when the drive is heavy. Many variations in the details are found in different designs.

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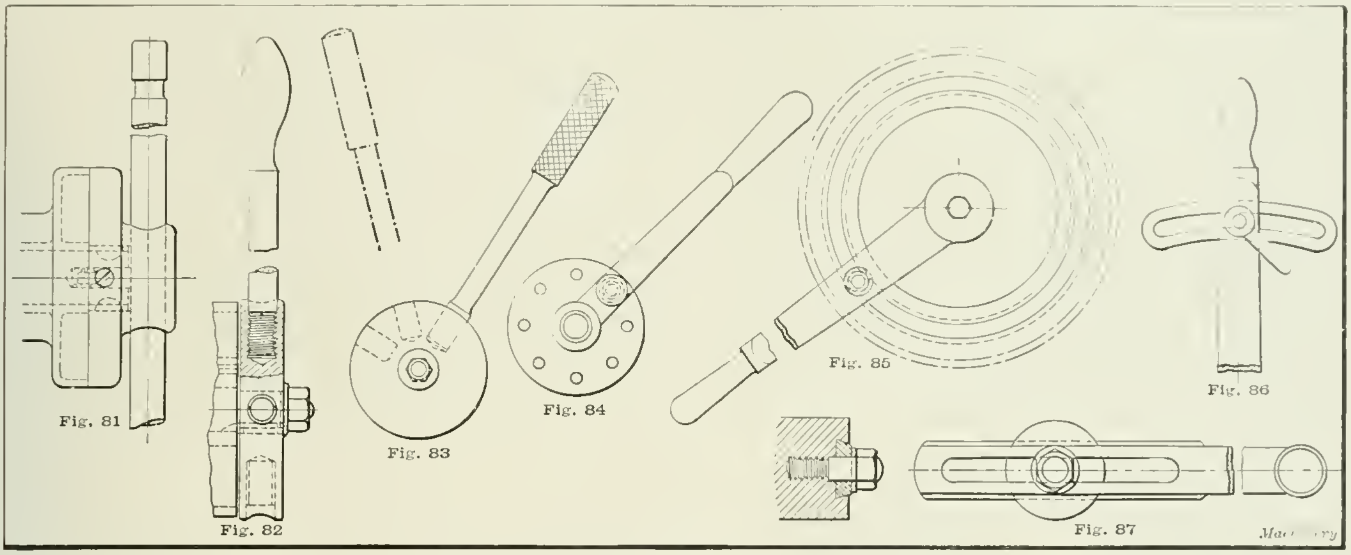
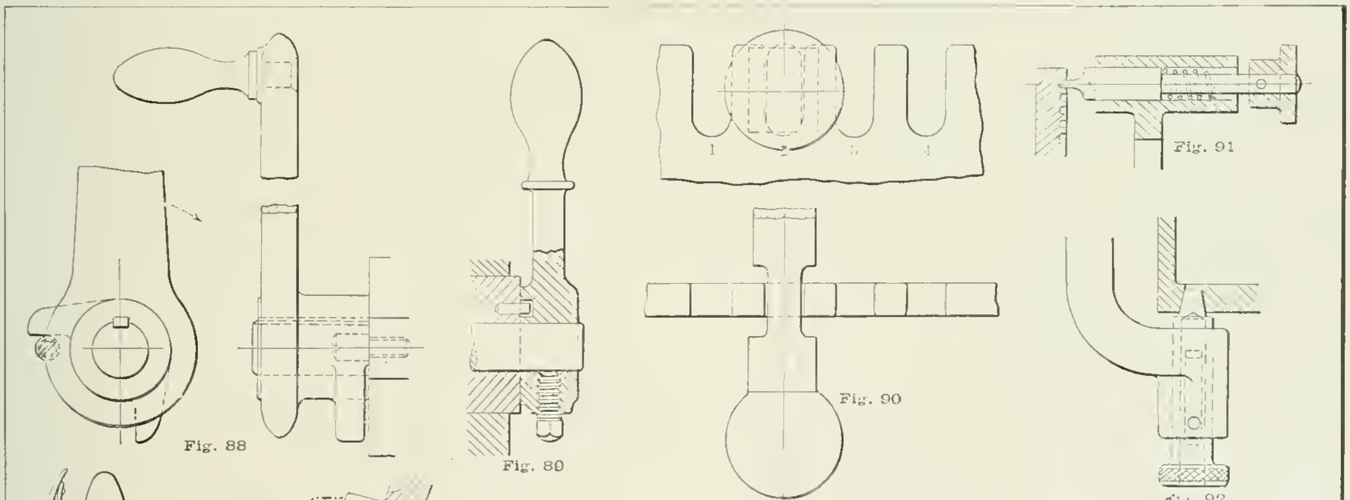


Figs. 81 to 87. Types of Handles used in Machine Tool Construction

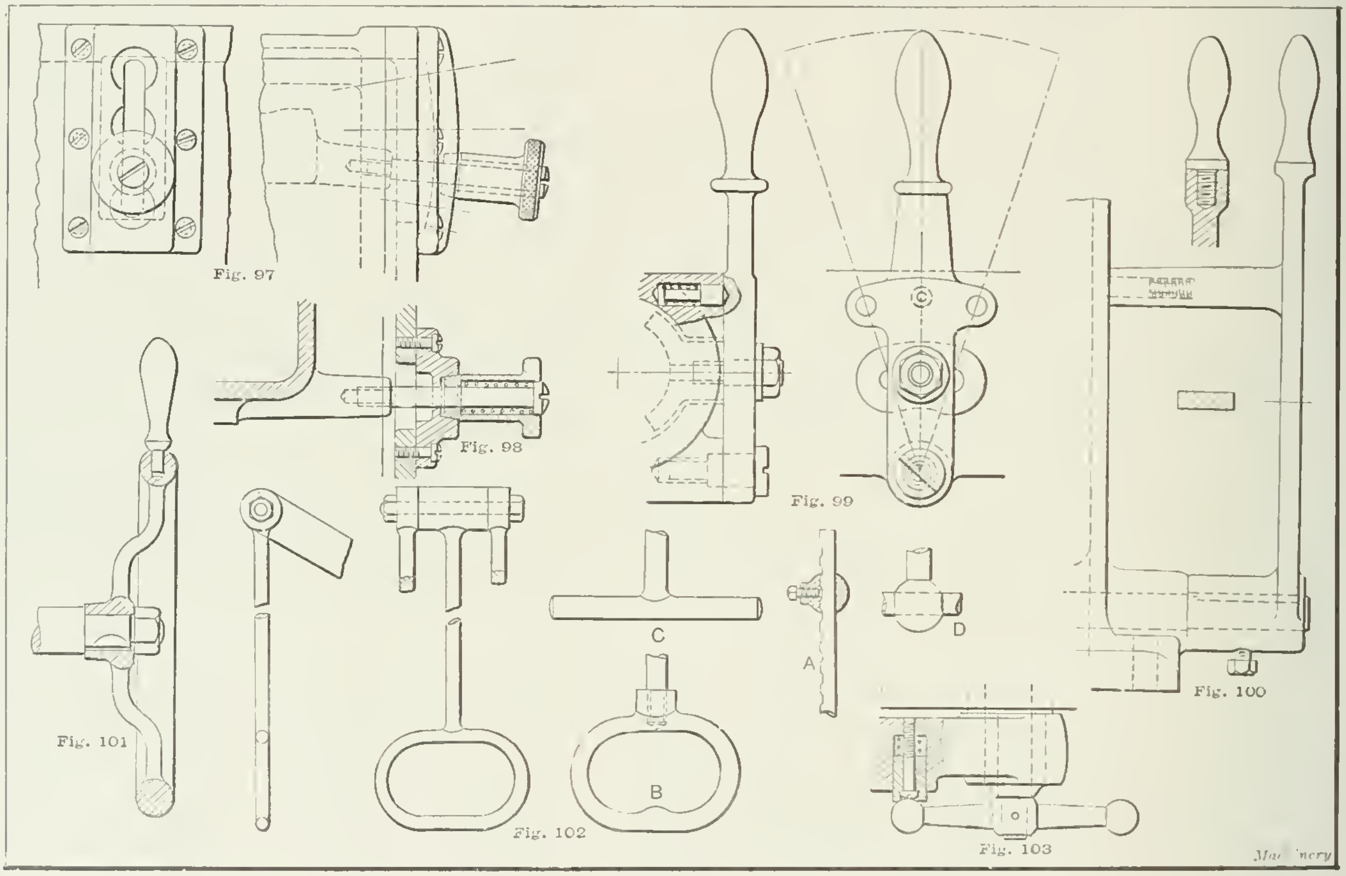
Ratchet handles are employed principally for two reasons: either because there is insufficient space for a complete turn of the handle, or because the power required cannot be conveniently applied by a full circular motion of the hand. Most cases of this kind relate to movements where only occasional adjustments are required, such as the adjustment of a slide at infrequent intervals, etc. Such cases occur when the setting lasts for a long period of machining, or when a power feed is usually applied, and the handle is required only to give a small adjustment for exact position. Heavy lathe carriages, for instances, are sometimes operated in this manner and also the saddles and slides for heavy boring and drilling machines. The ratchet is usually double-acting, as shown in Fig. 69, so as to admit of adjustment in either direction without removing it from the square on the end of the screw or spindle.



Figs. 88 to 96. Types of Handles used in Machine Tool Construction

Another class of handles is designed to enable two or more rates of speed to be obtained, this being accomplished by the withdrawal of a pin or other means of coupling. Many feeds on drilling machines are constructed in this manner so that by a slight movement of a pivoted handle the rapid lever movement is changed into a slow one, by means of a worm or other mechanism for fine adjustment or feed. The application of this device is illustrated in Fig. 68, this being applied to a shaper and actuating the saddle screw. When the parts are in the position indicated, gear *A*, driven by gear *B*, is coupled to the handle *C* by means of the plunger *D*, and screw *E* is rotated by power; but when the hand is applied to the handle, pushing the pivoted lever *F* in the direction of the arrow, the pin *D* is withdrawn and screw *E* may be revolved rapidly by hand.

Certain types of machines, especially for tapping, are provided with a simple means for obtaining two speeds, by having two squared spindles for receiving the operating handle. When the handle is applied to one, the drive is at a rapid rate, but when operating upon the other, the drive is through two spur gears at the slow speed. Then there is another common type, that adjustable for radius to suit different powers and speeds. Hand screw machines are very commonly provided with adjustable handles, and so are certain types of portable machines for drilling, planing, shaping, etc. Adjustment for radius is necessary in many handles for feed motions, principally in drilling machines, where a light pressure is more easily applied with a short handle, and a heavy pressure when the handle is drawn out to its full length. The lengths of handles are varied in different ways. A common method is to slide a loose handle through the socket portion which fits on the shaft, as indicated in Fig. 76. This loose portion is then tightened with a set-screw. Occasionally, a split hub is employed instead, and clamped with a set-screw. Another way is that shown in Fig. 79, where flat arms are used, provided with holes for the reception of a tightening bolt. The two parts are also kept together by a loop as indicated. Instead of the separate holes, a slot is sometimes made so that the readjustment may be effected without removing the bolt. In Fig. 87 is shown an instance of an adjustable handle applied to a keyway cutter of the portable type. The dovetail section of the lever prevents it from falling out when the nut is loosened. The handle in Fig. 80, from a portable cylinder boring machine, shows a case where the handle proper is adjusted along the web by a series of holes drilled at different radii. A continuous slot forms an alternative to the separate holes, if more rapid changes are desirable.



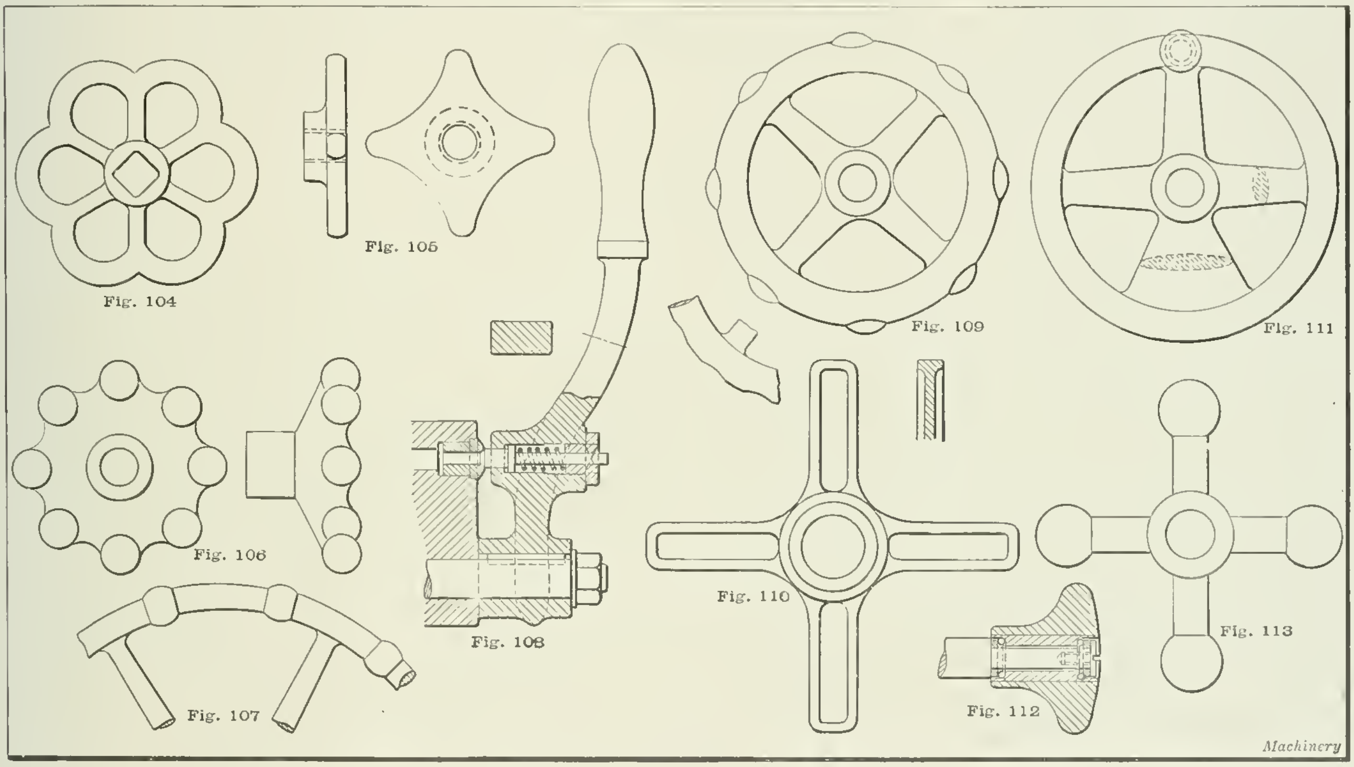
Figs. 97 to 103. Types of Handles used in Machine Tool Construction

The handles for feeding spindles of small drilling machines, etc., are usually of plain bar section and can slide through the boss of the rack spindle. The method of clamping these handles and the means for adjustment are shown in Fig. 67. At *A* and *B* are shown arrangements with set-screws, with either square or knurled heads, and at *C* a grip-bolt design. A wing-screw, as shown in Fig. 74, is also often used. In some sensitive drilling machines the lever is self-locking in any position, through the medium of a spring plunger, as indicated in Fig. 81. The plunger presses against the handle with sufficient force to hold it by friction.

Another class of designs requires that a lever may be adjusted for radial direction so as to bring it in the most convenient angle for the operator's hand. Handles with split hubs, as already described, are used for this purpose in certain instances, but are not always desirable. A type suitable for small drills is that shown in Fig. 82, where the handle can be screwed into either one of three or four holes in the disk on the pinion spindle. Sometimes the handles fit into a tapered hole, as shown in Fig. 83. Among other methods for obtaining the same ends may be mentioned a circle of holes in a disk, into one of which the spring plunger of the pivoted handle can enter, as shown in Fig. 84. A similar method is adopted in the design shown in Fig. 75, where a large wheel is provided with holes for receiving the locking pin of the handle in any position which happens to be most convenient for feeding the spindle. This design is applied to a special vertical hole grinder. An alternative design is that in Fig. 85, where a T-groove is cut in a circular disk so that the handle can be locked in any position by means of a T-bolt and nut. This design is applied to a multi-spindle drilling machine in which each spindle is fed down independently with its own lever, or, if desired, simultaneously by a shaft (common to all) on one end of which is the wheel seen in Fig. 85. The ratchet lever is used on many drilling machines, the engagement of the pawl with any particular tooth governing the radial setting of the lever.

In many cases it is important that means be provided for locking or retaining the handle in a certain position after the movement has been made, so as to keep the adjustment unaltered until a change is again made. This requirement is present in nearly all machine tools. Sometimes the range of movement of the lever is small, and, in such a case, the arrangement shown in Fig. 86 may be used, where the handle is clamped to a quadrant with a wing-nut after the handle is adjusted. A stop arrangement is shown in Fig. 96, where two stop-pins are used to arrest the motion of the small handle at each extreme of its movements. In Fig. 88 is shown another example of preventing a movement beyond a certain point. Here two lugs are provided which come in contact with the head of a screw. Still a different arrangement is shown in Fig. 89, where an annular groove is provided, fitting over the stop-pin, so that the latter arrests the motion of the handle at each end of the slot. Another means of control is indicated in Fig. 90, where the heavy knob end of a lever is raised, moved to one side and brought into the next notch of the disk.

By far the greater majority of locked handles, however, are retained by some form of spring catch. The spring is combined with a plunger which either acts automatically or is pulled out by hand when making changes, and which maintains the handle steadily in one place and eliminates the vibration which is liable to occur in a locking device without spring action. An example of a hand-operated plunger is shown in Fig. 91, this design being frequently met with on the indexing arm of milling machine dividing heads. Another example, from a milling machine gear-box, is shown in Fig. 92. Here the plunger has a tapered end dropping into a series of holes in the edge of the gear-box. A plunger is often withdrawn by a lever arrangement as shown in Fig. 93. A great many handles are also modeled after the steam-engine reversing lever, with a plunger fitting into notches on the rim of a quadrant or into ratchet teeth on the side of a disk. In Fig. 94 is shown an arrangement used for changing the gears in a gear-box, a pivoted clasp lever being used for withdrawing the plunger, and in Fig. 95 is another example of a handle used for operating gear-box change gears. In Figs. 97 and 98 are shown the elevation, end view and section, respectively, of a handle, the stem of which is screwed into the lug of a tumbler bracket carrying the change gears, and which is locked by the tapered end of the spring handle which enters into the counterbored recesses indicated. The same principle is applied to cases when gears have to be moved laterally, in which case the handles are attached to a forked piece embracing the gear.



Figs 104 to 113. Types of Handwheels and Handles used in Machine Tool Construction

The trouble of pulling back the plunger at each change is avoided in a great many handles, by making the plunger end of a pointed or slightly rounded shape, so that it will easily slide out of the countersink provided for it. In Fig. 99 an example of this kind is shown, where a handle can be locked in three positions by a spring plunger. A variation of the design, with the plunger placed in the handle, is shown in Fig. 108. The plunger here slides into a series of hardened steel bushings forced into the casting of the bed of the machine.

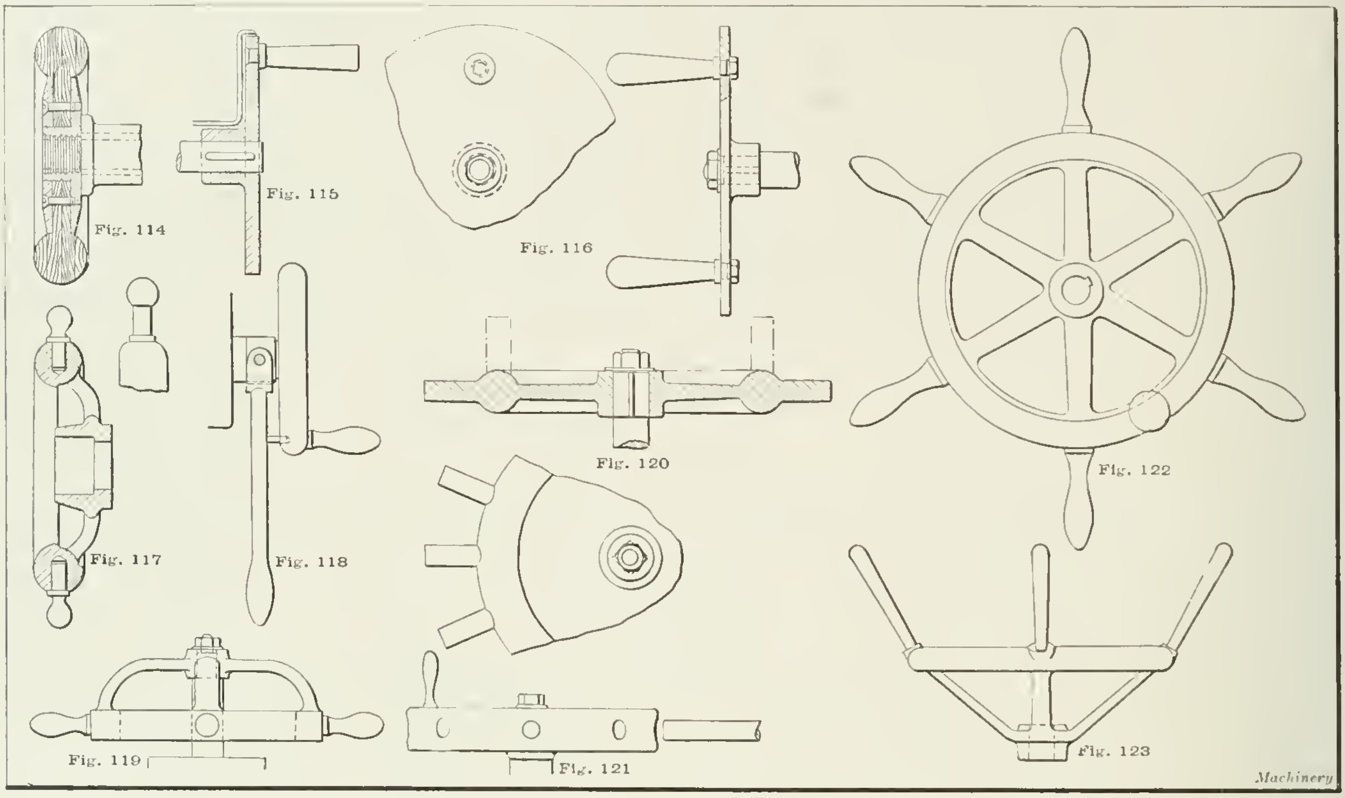
If two levers happen to come close to each other, as in the front of a drilling machine gear-box, it is often the practice to carry one handle out further than the other, in order to prevent the handle ends from interfering. The boss of one handle is then lengthened, as shown in Fig. 100, this requiring also the lengthening of the boss that receives the spring plunger. In some cases, the convenience of being able to machine the shaped handle portion separately prompts a design as illustrated in the detail in Fig. 100, where the handle is screwed into the main forged lever. Provision is sometimes incorporated for holding a spring plunger out of engagement with the locking holes, this being usually accomplished by a partial twist which engages a pin in a slot and prevents the forward movement of the plunger. A method of locking a handle in two positions is illustrated in Fig. 103. This method is applied to some milling machine back-gears. The ball ends of the handle are prevented from moving by the hollow spring plunger shown.

Mechanisms which cannot be easily reached by the attendant standing on the ground are either operated by long shafts or chains, or, if circumstances permit, a hanging pull-rod is used, the rod being provided with a loop or handle for the hand. Fig. 102 shows some details used on designs of this kind. The pull-rod is usually made with a boss fitting on the bolt or pin at the end of the levers to which it is attached, and is either of fixed length or adjustable, as indicated at *A*, in which the rod has a series of flats to receive the point of the clamping screw. The handle ends may be designed as shown at *B*, *C* and *D*. If there are two pull-rods close together they are often connected by a loose horizontal link to prevent their clashing with each other, and if a pull-rod comes close to a bearing or spindle, a light bracket is often carried out from the frame to embrace the rod and prevent it from coming into contact with the moving parts.

Handwheels

Handwheels are merely a special design of handles; on modern designs the use of handwheels is undoubtedly increasing. The continuous rim of the wheel possesses some advantages which are not present in handles even when made of the star or spider types. The continuous rim always presents something for the operator to grasp without feeling blindly for it in the air, as is often necessary when he has to keep his eye on the work or tools. It also permits of a more delicate feed motion. Micrometer graduations can be placed on a large diameter of the rim. The weight of the rim and its flywheel action are of great advantage when rapidly rotating the wheel for quick adjustments. It is well balanced and does not have a tendency to alter adjustments because of vibration. It can be provided with special fittings, such as dogs, ratchet teeth, feeding devices, and other details. The principal objection to a handwheel is that it takes up more room than a handle and may, therefore, be in the way. In such cases, it either must be made removable or be discarded for some other design.

On the boundary line between star wheels and handwheels are a number of knobs, cross-handles or disks used chiefly for tightening or clamping where no great power is to be exerted. In Fig. 110 is shown a good example of a cross-handle, and in Fig. 113 another of the ball type. The plain star-shaped knob is often used as shown in Fig. 105, or a small disk with a series of knobs on its periphery, to give a firm grasp, as shown in Fig. 106. The looped type of wheel shown in Fig. 104 is also very popular. Fig. 112 shows a special type of knob fitted with ball-bearings, its function being to control and feed endwise the grinding-wheel spindle of a small grinder. When it is desired to increase the grip of the hands on a handwheel, knobs or projections are often cast on it, as shown in Fig. 109, or the rim may be hollowed out with a series of transverse grooves, as in the small detail shown in the same illustration. Large handwheels are often cast with the rim as shown in Fig. 107. A wooden wheel made in segments as shown in Fig. 114 is very suitable for operating the draw-in chucks on bench and other small lathes.



Figs. 114 to 123. Types of Handwheels used in Machine Tool Construction

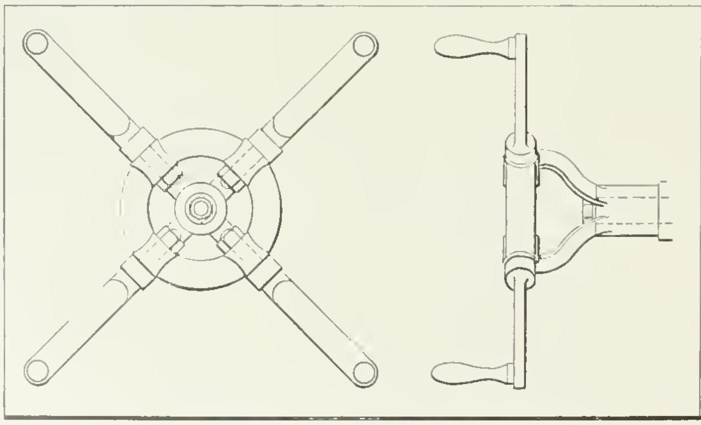


Fig. 124. Handwheel with Radial and Lateral Handles

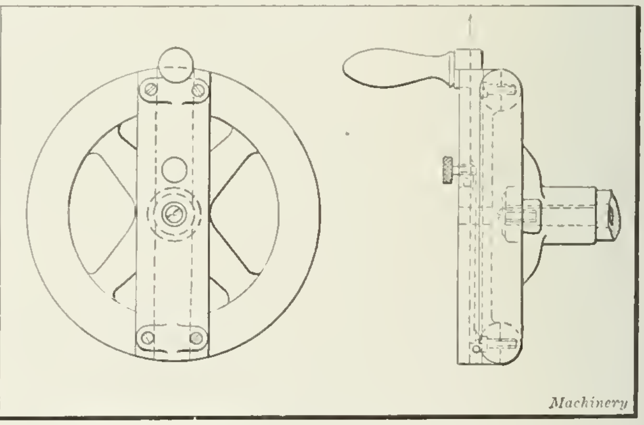


Fig. 125. Handwheel with Handle Adjustable Radially

Handwheels are divisible into two main classes, those which are grasped by the rim only, and those that are fitted with one or more handles projecting either radially or laterally from them. The lateral extending handle is used for rapid rotation, and the radial handle chiefly to enable increased power to be exerted. An example of a wheel provided with a single handle is shown in Fig. 101. The accurate balancing of a handwheel with one handle is often neglected, but sometimes the arm opposite the handle is increased in size so as to balance the wheel properly, as shown in Fig. 111. Wheels of solid disk type, with one or two handles, as shown in Figs. 115 and 116. are easily manufactured and very convenient for certain applications; the edge is often graduated. An increase in the number of radial handles is often necessitated for reasons of convenience, because when provided with two or more handles, one will always be within easy reach. In Fig. 122 is shown a wheel with six radial handles, and one transverse handle on the rim. A peculiar specimen from a German turret lathe is shown in Fig. 124, in which a comparatively small handwheel has handles bolted into it and these handles again have lateral handles riveted to them.

A compromise between the radial and the transverse positions of the handles has sometimes been made, when the conditions prevent a strictly radial setting. Fig. 123 shows an extreme case of this. This wheel is placed horizontally on the bed of a cold-sawing machine so that the operator would have to bend down to reach it. For this reason, the rim is carried upwards by the arms, and handles inserted into it in an angular direction. Another arrangement, with the rim and the handles in a different plane from the boss, is shown in Fig. 119, this being the operating wheel for a vertical forming-slide, where the inside of the wheel can pass over the outside of the slide. Sometimes small knobs are fitted to the rim of the handwheel as shown in Fig. 117.

In some cases a considerable increase of power over that ordinarily required may be necessary at intervals. This condition is met in a German turret lathe by the arrangement shown in Fig. 118, where a lever pivoted on a boss adjacent to the hub on the handwheel is provided. This lever can be moved up against the handwheel so that a pin in it engages with the wheel, and a more powerful turning moment is thus obtained at the end of the lever than would be possible at the handle of the wheel.

Certain classes of handwheels made with solid webs instead of arms are provided with a set of holes around the periphery for the insertion of bars for turning them, as shown in Fig. 121. Another method of attaining the same object is to forge the wheel with a series of short pins or arms extending out from the rim and slip a piece of pipe on either of these for getting the increased leverage. A design of this kind is shown in Fig. 120. Sometimes the pins project out in the direction indicated by the dotted lines, in which case a bar can be laid across the wheel to engage with these pins. Fig. 125 illustrates a more complicated method of design for increasing the leverage of the handwheel, this being applied to certain milling machine table handwheels and cam-cutting attachments. The handle is formed with a sliding piece moving in ways screwed onto the wheel, and is pulled out when required.

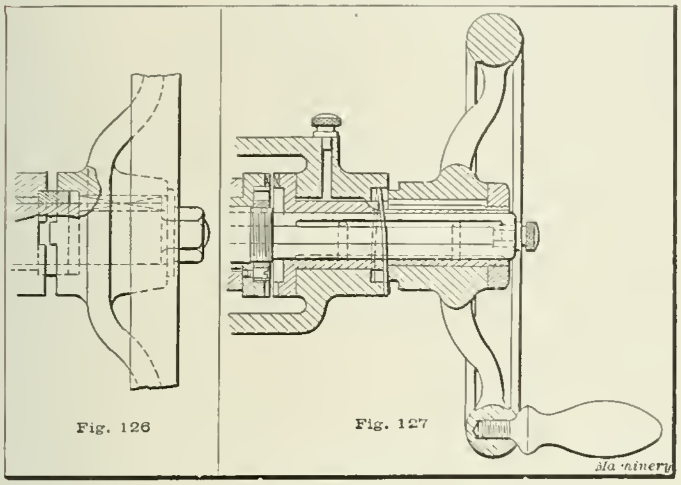


Fig. 126 Fig. 127

Figs. 126 and 127. Handwheels with Clutch Arrangement

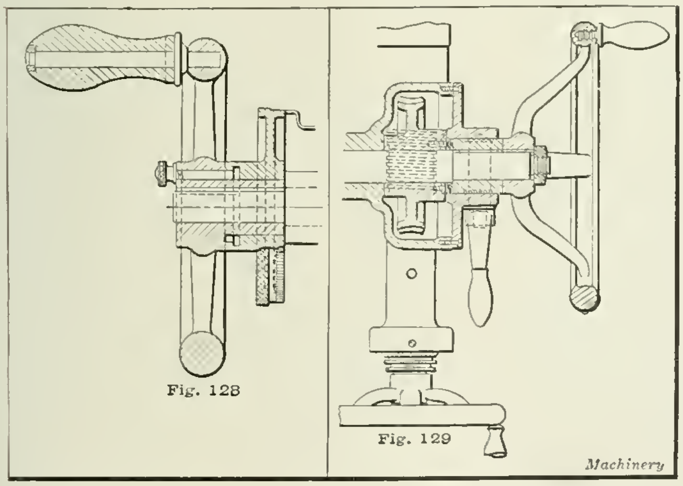


Fig. 128 Fig. 129

Figs. 128 and 129. Means for Connecting and Disconnecting Handwheels

A great number of devices for coupling and disconnecting handwheels have been designed. A plain clutch hub, as shown in Fig. 126, may have only a couple of teeth on opposite sides of the periphery, although it is more convenient if a greater number of teeth are used, so that the wheel may be slipped into engagement at almost any point. A spring may or may not be incorporated to keep the wheel out of mesh. In Fig. 127 the spring is placed in front of the boss and the resistance of this has to be overcome when the wheel is pushed forward to engage the teeth inside of the casing. Sometimes clutch teeth are provided in both faces of the hub so as to engage different mechanisms when moved toward the right or left.

Friction locks frequently are used in connection with micrometer dials when the dial must be released to turn it to the zero position for a new setting. This is accomplished, as shown in Fig. 128, by a bolt working in a circular T-slot by means of which the micrometer disk can be clamped to the wheel hub. Another method is to use a central threaded pin and let this force a transverse pin upward against the bore of the disk.

In the case of many handle mechanisms, it is necessary to provide for rapid and slow feeds or adjustments, which cannot be done by a single handle or handwheel. The most commonly used method is to use a worm and worm-wheel, the wheel being on the shaft of the rapid handwheel and the worm being turned by another handwheel at right angles to the first, as shown in Fig. 129. Some kind of clutch is incorporated to connect or disconnect the two movements. In the example shown, the rapid handwheel has a clutch moved along by a circular rack in order to engage the worm-wheel.

* * *

PATTERNS FOR THE FOUNDRY

In an address before the Superintendents' and Foremen's Club at Oakley, Cincinnati, Ohio, Mr. H. M. Ramp, superintendent of the Modern Foundry Co., called attention to the difficulties the foundryman has to meet because of the fact that patterns are poorly made or in poor condition. In the course of his address he said that many concerns have inspectors who check up every piece of work done in the factory; some have inspectors who check up every gage and templet at stated periods to discover errors and prevent mistakes; but he knew of no concern that employed an inspector to periodically check up the patterns to find out if they were true. Usually such checking is first done after a lot of castings have been rejected, and only then is the pattern found to be at fault. There seems to be a tendency today to save on pattern cost, although a great deal of money is spent for improved machinery in the machine shop to improve the quality and cheapen the cost of the finished product. The average patterns in the average foundry today are not made as well as they were ten years ago, and still there is a reason why the foundry ought to be supplied with better patterns than formerly. The trend of the times is to reduce the skill of the workers by putting more dependence on improved machinery; hence, the molders of today are not as skilled as they were years ago, and, for that reason, better patterns rather than poorer ought to be the rule.

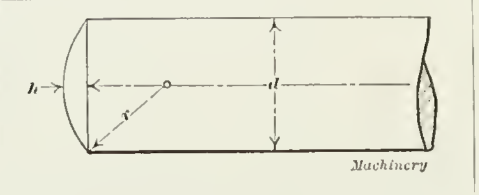
Mr. Ramp also called attention to the lack of understanding of the requirements of the foundry on the part of many machine designers. The castings designed may be perfectly fitted for the purpose for which they are made, but the design is such that the molder cannot make a perfect casting on account of the excessive strains produced by the unequal proportions of the different parts, and it is impossible to prevent these castings from cracking or warping. It is easy enough to say that no more metal is required at this or that point; it may be very creditable to be able to design a machine with a maximum of utility and a minimum of weight, but, nevertheless, there are unalterable laws in the shrinkage or contraction of cast iron that the designer cannot be permitted to overlook. Many castings are designed with a view to saving metal, which, as a matter of fact, will have a higher ultimate cost than if no specific effort to save metal had been made. The extra labor cost in the foundry in such cases outweighs the saving in the cost of the metal.

* * *

Fernand Forest is credited in France as being the first mechanic to construct a multiple-cylinder explosion motor. Forest claims that he built the first four-cylinder motor in 1889, and the first gasoline launch in 1885. He developed magneto ignition in 1883, thirteen years before it was adopted by any automobile manufacturer. A movement is on foot in France to reward Forest for his inventions which are the foundation of the modern internal combustion motor, and for which he received little or no financial benefit.

TABLE OF RADII FOR TOOLS TO TURN SPHERICAL ENDS

(h) in 64ths	Diameter (d) in 32nds																														
	1/16	3/32	1/8	5/32	3/16	7/32	1/4	9/32	5/16	11/32	3/8	13/32	7/16	15/32	1/2	17/32	9/16	19/32	5/8	21/32	11/16	23/32	3/4	25/32	13/16	27/32	7/8	29/32	15/16	31/32	1
	Radius (r)																														
1/64	0.039	5/64	0.133																												
1/32	1/32	0.051	5/64	0.113	5/32	0.207	17/64	0.332	13/32	0.488	37/64	0.676	25/32	0.894	1 1/64	1.144	1 19/32	1.426	1 37/64	1.738	1 29/32	2.082	2 17/64	2.457	2 21/32	2.863	3 5/64	3.301	3 17/32	3.769	4 1/64
3/64		3/64	0.065	0.089	0.117	0.151	0.190	15/64	0.284	0.339	0.398	0.464	0.534	39/64	0.690	0.776	0.867	0.964	1.065	1 11/64	1.284	1.401	1.523	1.651	1.784	1 59/64	2.065	2.214	2.367	2.526	2.690
1/16			1/16	0.080	0.102	0.127	5/32	0.189	0.227	0.268	5/16	0.361	0.414	0.471	17/32	0.596	0.664	0.736	13/16	0.893	0.977	1.064	1 5/32	1.252	1.352	1.455	1 9/16	1.674	1.789	1.908	2 1/32
5/64				5/64	0.095	0.116	0.139	0.166	0.195	0.228	0.264	0.303	0.345	25/64	0.439	0.491	0.545	0.603	0.664	0.728	0.795	0.866	0.939	1 1/64	1.095	1.178	1.234	1.353	1.445	1.541	1.639
3/32					3/32	0.111	0.130	0.152	0.177	0.204	15/64	0.267	0.302	0.340	0.380	0.423	15/32	0.517	0.568	0.621	0.677	0.736	51/64	0.861	0.927	0.996	1.068	1.142	1 7/32	1.298	1.380
7/64						7/64	0.126	0.145	0.166	0.190	0.215	0.243	0.273	0.306	0.340	0.377	0.417	0.458	0.501	35/64	0.595	0.645	0.698	0.752	0.809	0.868	0.930	0.993	1.059	1.127	1.180
1/8							1/8	0.142	0.160	0.181	13/64	0.227	0.254	0.282	5/16	0.345	0.379	0.415	29/64	0.493	0.535	0.579	5/8	0.673	0.723	0.774	53/64	0.884	0.941	1.001	1 1/16
9/64								9/64	0.157	0.175	0.195	0.217	0.240	17/64	0.292	0.321	0.352	0.384	0.417	29/64	0.490	0.529	0.570	0.613	0.657	45/64	0.751	0.800	0.852	0.904	0.959
5/32									5/32	0.173	0.191	0.210	0.231	0.254	0.278	0.304	0.331	0.360	25/64	0.423	0.456	0.491	0.528	0.566	0.606	0.648	0.691	0.735	25/32	0.829	0.878
11/64										11/64	0.188	0.206	0.225	0.246	0.268	0.291	0.316	0.342	0.370	0.399	0.430	0.462	0.495	0.530	0.566	0.604	0.643	0.683	0.725	0.768	0.813
3/16											3/16	0.204	0.221	0.240	0.260	0.282	0.305	0.329	0.354	0.381	0.409	0.438	15/32	0.501	0.534	0.568	0.604	0.641	0.680	0.719	0.770
13/64												13/64	0.219	0.237	0.255	0.275	0.296	0.318	0.342	0.367	0.392	0.419	0.448	0.477	0.508	0.540	0.573	0.607	0.642	0.679	0.717
7/32													7/32	0.235	0.252	0.271	0.290	0.311	0.333	0.355	0.379	0.405	0.431	0.458	0.487	0.516	35/64	0.579	0.612	0.646	0.681
15/64														15/64	1/4	0.268	0.286	0.305	0.325	0.347	0.369	0.393	0.417	0.443	0.469	0.497	0.525	0.555	0.586	0.618	0.651
1/4															1/4	0.266	0.283	0.301	0.320	0.340	0.361	0.383	13/32	0.430	0.455	0.481	0.508	0.536	0.564	0.594	5/8
17/64																17/64	0.282	0.299	0.317	0.335	0.355	0.376	0.397	0.420	0.443	0.468	0.493	0.519	0.546	0.574	0.603
9/32																	9/32	0.297	0.314	0.332	0.351	0.370	25/64	0.412	0.434	0.457	0.481	0.506	17/32	0.558	0.585
19/64																		19/64	0.313	0.330	0.347	0.366	0.385	0.405	0.421	0.448	0.471	0.494	0.518	0.544	0.569
5/16																			5/16	0.328	0.345	0.363	0.381	0.400	0.420	0.441	0.463	0.485	0.508	0.532	0.556
21/64																				21/64	0.344	0.361	0.378	0.397	0.416	0.435	0.456	0.477	0.499	0.522	0.545
11/32																					11/32	0.360	0.376	0.394	0.412	0.431	0.450	0.470	0.491	0.513	0.536
23/64																						23/64	3/8	0.392	0.409	0.427	0.446	0.465	0.485	0.506	0.527
3/8																							3/8	0.390	0.407	0.425	0.443	0.461	0.480	1/2	0.521
25/64																								25/64	0.406	0.423	0.440	0.458	0.477	0.496	0.515
13/32																									13/32	0.422	0.439	0.456	0.473	0.492	0.510
27/64																										27/64	0.438	0.454	0.471	0.489	0.507
7/16																											7/16	0.453	0.470	0.487	0.504
29/64																												29/64	0.469	0.485	0.502
15/32																													15/32	0.485	0.501
31/64																														31/64	1/2
1/2																															1/2



RADII FOR TOOLS TO TURN SPHERICAL ENDS

By WILLIAM W. JOHNSON[*]

The method of arriving at the results given in the accompanying table of radii may be of interest. The work was reduced to a minimum in the following manner. The general formula for r in terms of h and d is

$$r = \frac{1}{2}\left(\frac{d^2}{4h} + h\right) \qquad (1)$$

Let $d = \frac{m}{32}$, and $h = \frac{n}{64}$; where

m = the number of 32nds in d, and
n = the number of 64ths in h.

Then,

$$r = \frac{m^2 + n^2}{128\,n} \text{ or } r = \frac{n}{128} + \frac{1}{n}\left(\frac{m^2}{128}\right) \qquad (2)$$

By means of a table of 1/128ths of an inch, and a table of squares, each column of figures is calculated as follows:

Take for example the column for $\frac{3}{8}$ inch diameter.

$\frac{3}{8} = \frac{12}{32}$, then $m = 12$ and $m^2 = 144$.

Giving n the values 2, 3, 4, 5 and so on, in (2), we have

$$\frac{2}{128} + \frac{1}{2}\left(\frac{144}{128}\right) = \frac{74}{128} = \frac{37}{64} = r$$

$$\frac{3}{128} + \frac{1}{3}\left(\frac{144}{128}\right) = \frac{51}{128} = 0.3985 = r.$$

$$\frac{4}{128} + \frac{1}{4}\left(\frac{144}{128}\right) = \frac{40}{128} = \frac{5}{16} = r.$$

$$\frac{5}{128} + \frac{1}{5}\left(\frac{144}{128}\right) = 0.0391 + \tfrac{1}{5}\,(1.1250) = 0.0391 + 0.2250 = 0.2641 = r$$

and so on, until $n = 11$.

Then $n = m$, $h = \frac{d}{2} = r$.

* * *

One good way to spend some of your stray **thinking moments** is in digesting the question of just exactly what it is you are aiming at in the world anyway.

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ELECTRIC CONTROLLING DEVICES

By G. J. KIRCHGASSER*

Electric controlling devices for electric motors include such apparatus as starting rheostats, speed regulating or controlling rheostats (referred to as speed regulators and controllers), and such devices as compensator or auto-transformer types of motor starting apparatus, which are used for alternating current motors. Besides these, there are special types of switches, such as float and tank switches, magnetically operated switches, star-delta switches used with squirrel cage induction motors, and various other styles used for controlling the motor or the circuit to it. Automatically operated motor starters, regulators and controllers are also included under this heading.

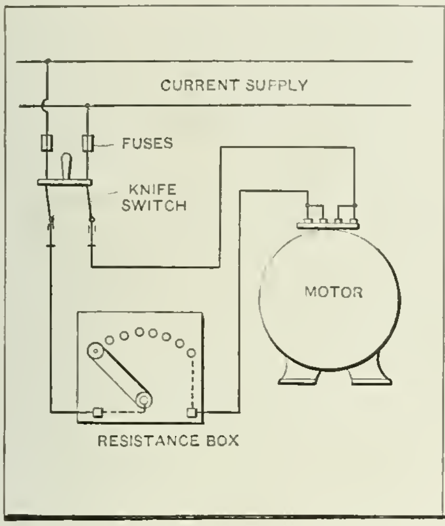

Fig. 1. Resistance Box in Armature Circuit arranged to be cut out by moving Lever over Successive Contact Button Terminals

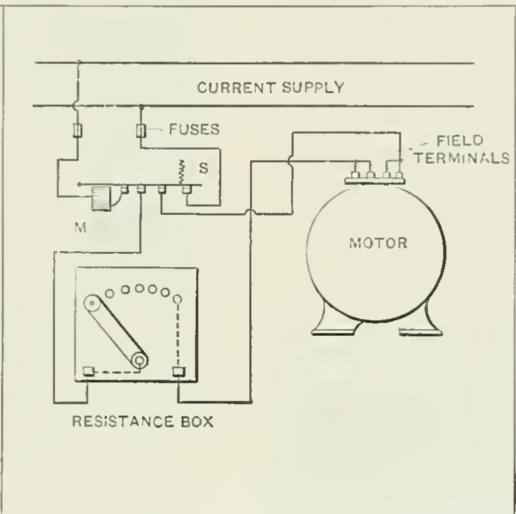

Fig. 2. Diagrammatic View of the Main Features of Shepardson's Patent Magnetically closed Main Line Switch

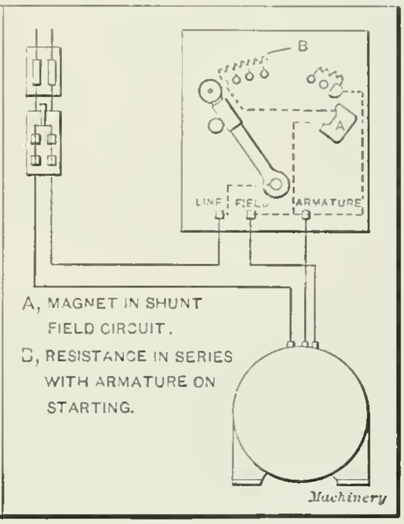
B
A
LINE
FIELD
ARMATURE
A, MAGNET IN SHUNT FIELD CIRCUIT.
B, RESISTANCE IN SERIES WITH ARMATURE ON STARTING.
Machinery

Fig. 3. Blades' Patent Controlling Device having Magnet incorporated with Starting Device and connected in Shunt-field Circuit

The motor with its controlling device can be compared to the human body. The muscles, representing the power, correspond to the motor, and the brain which controls or regulates the working of the muscles, corresponds to the controlling device. Work done by the muscles can be disastrous unless properly controlled, and an electric motor supplied with power is also very apt to cause trouble unless provided with a controlling device of some kind. The wires connecting the controlling device and motor are comparable to the nerves emanating from the brain and passing to the muscles.

A motor of very small power can be started without the need of a starting rheostat, but for most motors used in manufacturing or industrial plants starting or regulating devices of some kind are required.

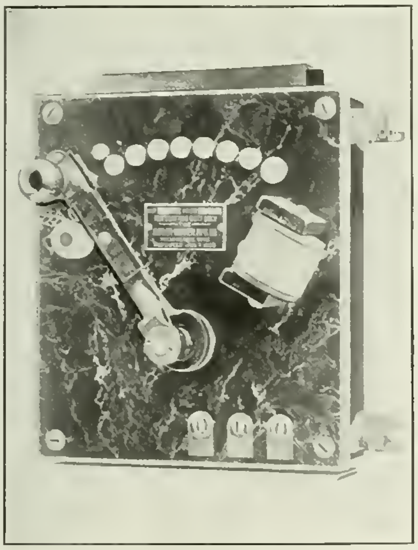

Fig. 4. Simple Hand-operated Motor Starting Rheostat with No-voltage Release

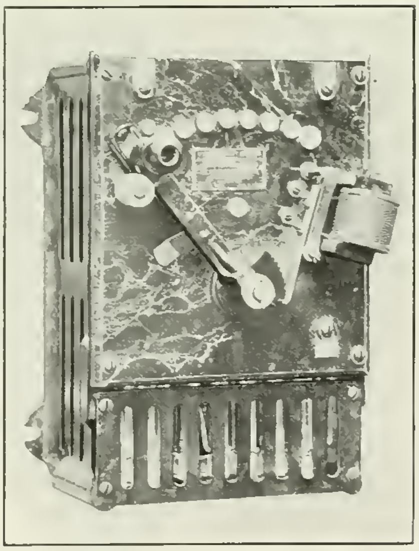

Fig. 5. Small Hand-operated Speed Regulator

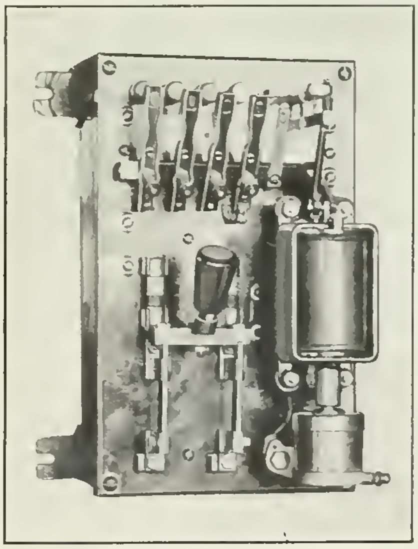

Fig. 6. Simple Automatic Motor Starter, Single Solenoid Type

Action of Motors

Current is passed through the armature conductors of a motor (which are parallel to the shaft) at right angles to the magnetic lines which pass from the motor field poles. The electrical energy transmitted to a motor meets with several losses in changing to mechanical action. If the resistance of the armature conductors is high, there will be a correspondingly high loss in this part of the motor. As the motor armature revolves in a magnetic field, a current is set up in the armature conductors just as in the case of a dynamo. This flows in a direction opposite to the current being fed to the motor and is greater at full speed than at half speed, while at a standstill, of course, no counter current is generated, because the conductors are not moving through a magnetic field. Because of the absence of this counter current or counter electromotive force when a motor is being started, there is nothing to check the inrush of current.

The necessity for controlling devices (of which the motor starter is the pioneer) for use with motors was recognized even before the first commercially efficient motors were put on the market for industrial purposes, which was about 1885. Early motors caused trouble, becasue it was found that when the switch connecting them to the line was closed, a very large current inrush took place. Controlling devices were not made then, so the armature was built with a high resistance, which served to retard the current inrush during starting; but as this high resistance was in circuit at all times, it resulted in the motor being very inefficient during normal running, and its speed varied considerably under varying load conditions.

One of the chief advantages of the shunt-wound motor is its ability to run at about constant speed even though it be driving two lathes or five, for instance, but the high resistance armature destroys this self-regulating feature, and, therefore, early electrical men tried to invent and design devices or methods for regulating the high resistance armature motor.

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No commercially practicable results followed until the armature with low resistance was developed. To avoid the large inrush of current mentioned, a resistance connected so as to be inserted during the starting period and cut out when running was employed. This was set up outside of the motor itself and really was the first controlling device of any value. The low resistance armature motor runs at practically constant speed, and with the arrangement of an outside starting resistance for cutting down the current, it put the high resistance armature motor and the various regulating devices into the scrap heap at one sweep. The diagrammatic sketch, Fig. 1, illustrates the method of inserting the resistance by means of a now obsolete type of starting-box. The lever for cutting out the resistance or returning it to the "off" position had to be moved by hand.

Motor manufacturers began using the shunt motor and this starting-box in which the starting arm was moved from the "off" to the "on," and *vice versa*, by hand. This arrangement, which marked the highest type that the most capable men in the electrical industry at that time were able to devise and place on the market, involved several great dangers: first, due to accidental breaking of the shunt field circuit, resulting in running away and destruction of motor and excessive current in the armature caused by the decreased counter electromotive force generated; second, due to the contact lever not being returned to the "off" position when shutting down, resulting in destructive current when the main switch was thrown in again and in sudden jerk instead of gradual acceleration (just as though no starting rheostat were installed); and third, due to leaving the contact arm on intermediate contacts, resulting in burning out the resistance of the starter.

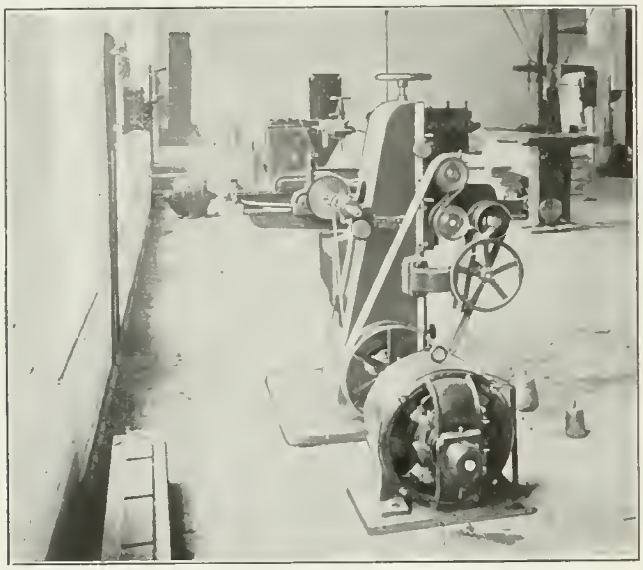


Fig. 7. Motor Starting-box, mounted on Wall for Starting Motor installed on Floor

Besides this, the blowing of the fuse, the cutting off of the current supply, the sudden drop of voltage—all left the motor unprotected, no starting resistance being in circuit when the current was again supplied. It meant that every motor would have to have an attendant to push the operating lever to the starting position when trouble arose, and it should be remembered that in the early days interruptions in current supply, drops in voltage, etc., were of more frequent occurrence than now. The dangers arising from the re-establishment of the current supply after the same had been cut off were a serious menace to the commercial operation of the electric motor. There was a crying need for a controlling device to overcome these dangers.

Shepardson's Main Line Magnetic Switch

Shepardson's main line magnetic switch was an effort to solve the problem, but it did not take care of all requirements. The switch lever *S*, Fig. 2, is held back by a spring so that when the current supply is cut off the magnet *M* is demagnetized, and the switch springs up and opens the circuit to the motor. The motor was not left connected to the line, but an attendant was just as necessary to push the starting lever back, and nothing prevented leaving the lever on an intermediate contact. Also, if the connection to the shunt field opened, there was no provision for opening the circuit automatically to prevent destruction of the motor.

Blades' Controlling Device

The device required, however, was finally invented. It marked the greatest step in the commercial application and operation of the electric motor. The invention, application for patent on which was filed Nov. 30, 1888, by Mr. Harry H. Blades, comprised a shunt motor connected to a constant potential circuit; a starting-box consisting of a series of resistance steps; a contact arm adapted to be moved by hand over the terminals of the resistance associated with the motor, whereby the resistance may be included in series with the armature of the motor when the contact arm is in the "off" position, and may be removed entirely from the circuit when the contact arm is in the "on" position; and a magnet which is adapted to grasp and hold the contact arm in the "on" position after it has been moved to the "on" position by hand. This magnet is connected in the shunt field circuit so that it

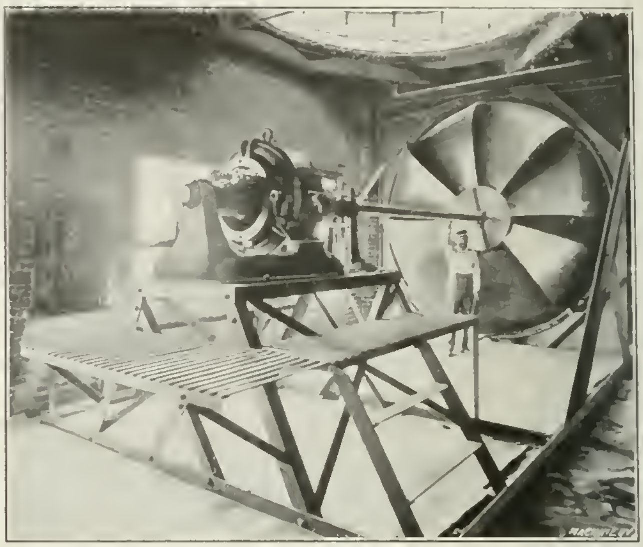


Fig. 8. Ten-foot Fan driven by a 25 H. P., C & C. Direct-current Motor regulated by a Cutler-Hammer Speed Regulator

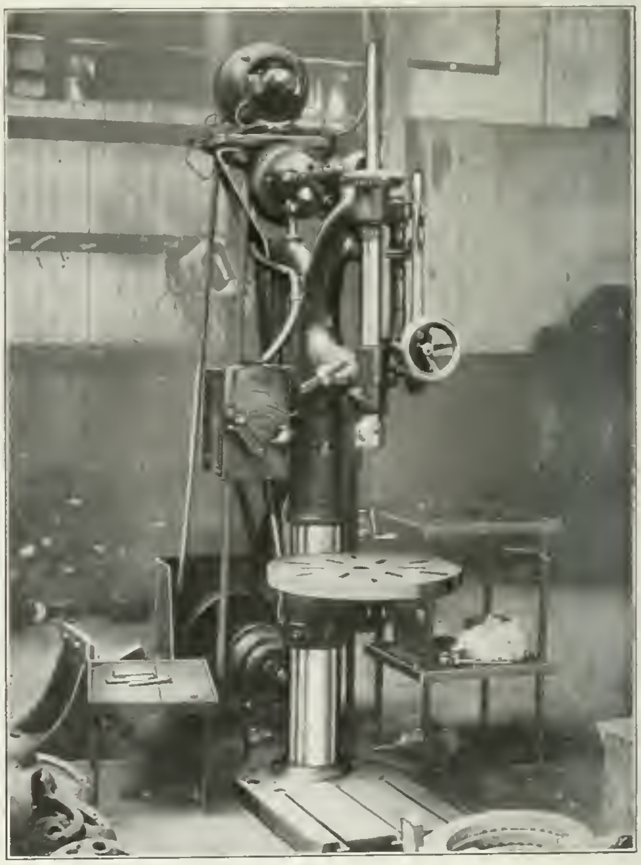


Fig. 8A. Drill Press equipped with Combination Starting and Regulating Rheostat

will not be influenced by varying currents flowing through the armature, but will be influenced only by the current flowing through the shunt field circuit. Fig. 3 illustrates Blades' original structure, patent for which was issued January 7, 1890. Mr. Blades was at that time electrical engineer for the Detroit Motor Co., which company has long since been out of business.

Blades had produced a novel combination for overcoming the dangers incident to the employment of the shunt motor and hand starting-box. If the shunt field were broken, the current supply interrupted or the fuse blown, the motor would shut down with the lever of the starting-box in position for starting properly; if the voltage dropped a trifle and only temporarily, the motor would not be disconnected, but if the drop were prolonged, the motor would be shut down and the rheostat lever returned to the starting position automatically. As there are only two rest positions of the starting lever, "off" and "on," and a strong spring is provided, the danger incident to leaving the lever on an intermediate contact was obviated. About 1892 and 1893 the Blades patent began to be used to a great extent, and by 1896 the use of the automatic release of the operating lever was considered essential to the successful operation of motors.

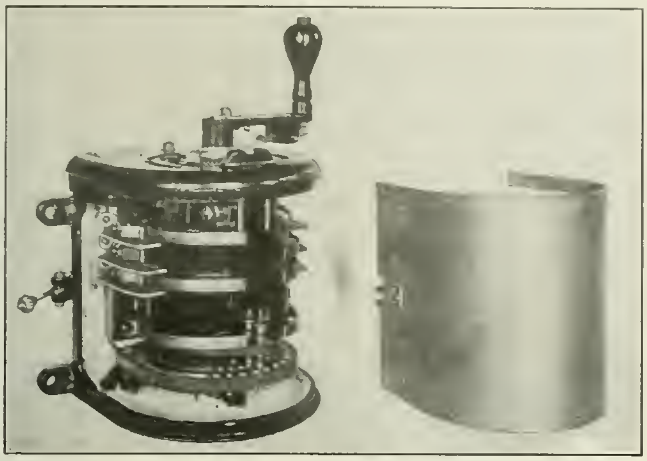


Fig. 9. Drum Type Machine Tool Controller

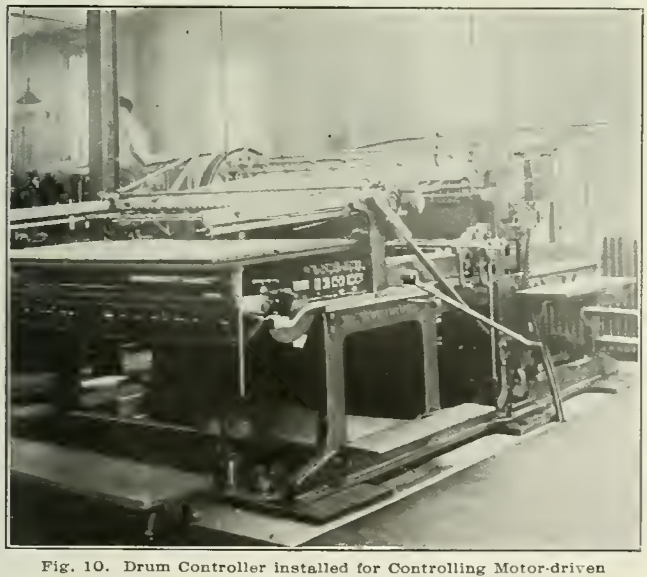


Fig. 10. Drum Controller installed for Controlling Motor-driven Printing Press

Modern Motor Starters

The present standard motor starter of the manually-operated type illustrated in Figs. 4 and 7 is built on the same principle as the first Blades structure. This device has, however, led to the development of innumerable kinds of motor controlling devices. The recognition of the value of the Blades patent by a Milwaukee electrical manufacturing company has been the means of the establishment of the largest plant devoted to the designing and building of motor controlling devices in the world.

Motor starters, starting rheostats, or "starting-boxes," as they are sometimes called, are used, as already stated, for starting an electric motor without excessive current inrush and bringing it gradually up to its normal speed. Some types of speed regulators are similar in appearance to starting rheostats, but the resistance employed is designed for carrying the full current constantly.

A starting rheostat used with the ordinary shunt or compound motor cuts out steps of resistance in succession as the lever is passed over the contacts. When the lever is held in contact with the magnet of the no-voltage release, no resistance is in circuit, but the current passes directly to the motor. Five to fifteen seconds is the usual period for starting a motor under ordinary load. Where the motor is driving a machine which requires very heavy starting torque, a starting rheostat having resistance designed for a longer starting period should be selected. A motor heavily loaded should be started slower, allowing the handle to rest for longer periods on successive contacts. This prevents large current inrushes and blowing of fuses, and takes from thirty seconds to one minute for the whole operation, depending upon the load.

Speed regulators for machine tool motors, fans, pumps, printing presses, controllers for hoists, cranes, elevators, etc., are made in types for every application, each providing special features, as required. In all cases the character of the drive and the motor data must be considered. For instance, a controller for a printing press must be differently proportioned from a controller for a lathe. With a printing press, the torque is about the same whether running with paper or without, and the vital requirement is to bring the motor up to speed smoothly and quickly.

A motor speed regulator, such as used considerably for regulating ventilating fans, illustrated in Fig. 5, is practically a motor starter with resistance designed to be capable of being in circuit all the time the motor is in operation, instead of just five to ten seconds, as required in starters. The resistance must be ample to carry the full load motor current for long periods of time, so that the operating lever can be left on any contact segment. Fig. 8 shows a 10-foot fan driven by a 25 H. P. C. & C. direct current motor regulated by a Cutler-Hammer regulator mounted against the wall.

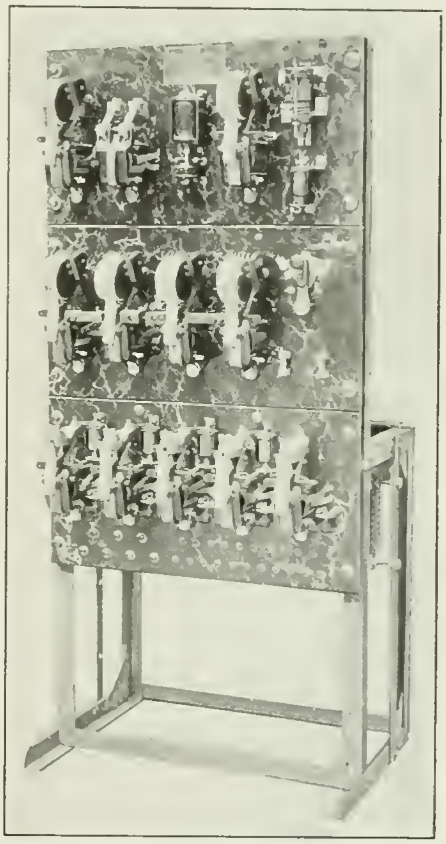


Fig. 11. Automatic, Magnetic Switch Type, Elevator Control Panel, for High-speed Electric Passenger Elevators, Multiple Solenoid Type

Speed regulation of shunt-wound and compound-wound motors may be effected by inserting resistance in the armature circuit of the motor, or by inserting resistance in the shunt-field circuit. The first method reduces the speed of the motor below its normal rated speed. The second method increases the speed of the motor above normal. Fig. 8A is an example of the latter type of control. The drill press shown is driven by a ½-horsepower Watson motor and a speed variation above normal is obtained by the combination starting and regulating rheostat within easy reach of the operator. By a combination of the two methods the speed of a motor may be both decreased below and increased above normal speed, thus affording a wide range of speed variation.

Speed regulation by armature resistance is open to two objections: first, the difficulty of maintaining constant speed under varying load conditions, and, second, the necessity of wasting energy to secure speed reduction. These objections are in part offset by the fact that speed reduction by armature resistance may be applied to any motor of standard design and requires nothing more than the simplest (and, therefore, least expensive) speed-regulating rheostat. In cases where the motor will be operated nearly always at full speed, and only occasionally at less than its normal speed, the difference in first cost of the installation may justify the use of the armature resistance method of control. When the speed is changed frequently regulation by shunt-field resistance is preferred.

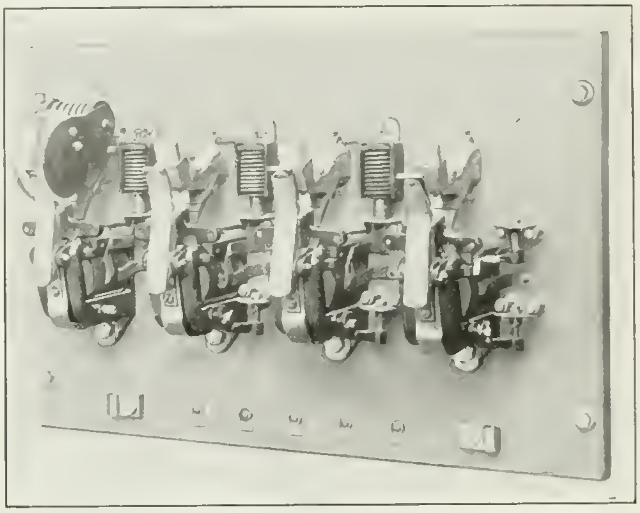


Fig. 12. Series Relay Multiple Solenoid Type Self-starter

One of the most common errors is that of selecting a regulating rheostat of insufficient capacity. If the current required to operate the motor at full speed with no resistance in circuit is greater than the rated capacity of the rheostat, overheating of the resistance will result. An increase in temperature even to a point where the hand cannot be held on the enclosing case need cause no apprehension, but should the resistance become red-hot, the regulator is being worked beyond its capacity and the load on the motor should be reduced or a regulator of greater capacity substituted. If the current required to operate the motor at full speed with no resistance in circuit is less than the rated capacity of the regulator no over-heating will occur, but it will not be possible to secure the full fifty per cent speed reduction which the rheostat is designed to give with all resistance in circuit.

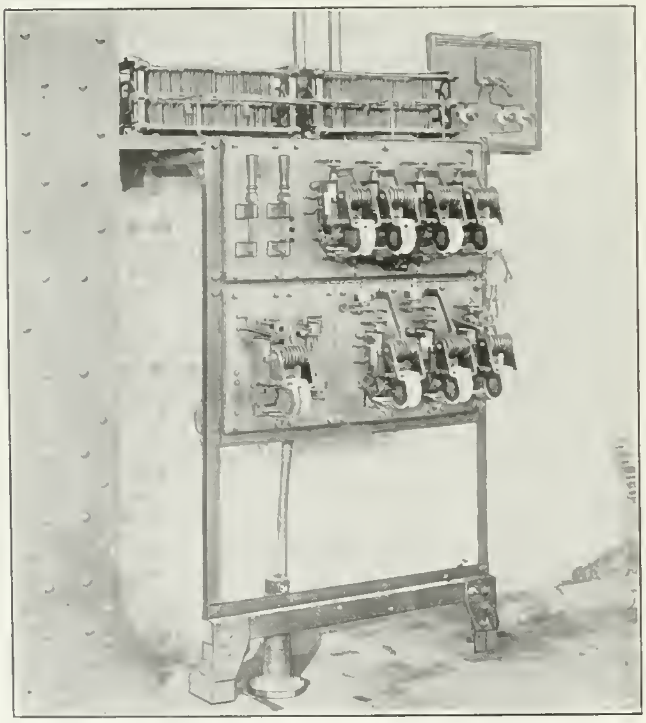


Fig. 13. Control Panel for Steel Mill Service. Magnetic Switches on the Panel are operated by Small Control Master Switch on Rolling Mill

The power required by some kinds of motor-driven machines when running at slow speed is less in proportion to the reduction in speed than in other classes of machines, some of which take almost as much current when operating at one-half speed as at full speed. Typical examples of the two classes of machines referred to are furnished by a ventilating fan and a hydraulic pump, the current required to operate the fan becoming less and less as the speed of the fan is diminished, while in the case of the pump practically the same amount of current is required to operate it at half speed as at full speed. In other classes of service, such, for instance, as the speed regulation of ice cream freezers, several ventilating fans driven by one motor, line-shafting subject to variable loads, etc., the current requirements can only be determined by tests made at various speeds.

Drum type controllers, such as are used for machine tools, printing presses, cranes, etc., operated by a revolving handle at the top, are built on the same principle. They vary the speed by inserting resistance in the armature circuit and in the shunt-field circuit, and provide several reverse speeds or full reverse operation of the motor, as desired. A revolving drum carries segments, as shown in Fig. 9, so arranged as to make contact in a predetermined order with contact fingers. By means of accurate control the output of a machine can be increased, because for the various operations the most efficient speed can be employed. The method of mounting a drum type controller is illustrated in Fig. 10, which shows a flat bed printing press.

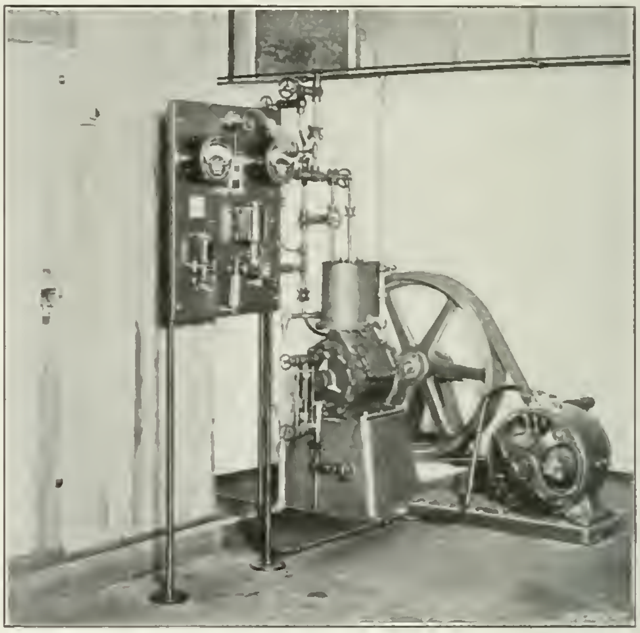


Fig. 14. Automatic or Remote-controlled Self-starters, used in Connection with Motors operating a Refrigeration System

On the simple regulator, Fig. 5, it may be noted that contact to cut in or out the various steps of resistance is made by moving a handle or lever by hand. On automatic starters, regulators or controllers, the cutting out of the resistance is accomplished by magnetically operated switches. The principle is exactly the same. A simple automatic starter is illustrated in Fig. 6. The solenoid at the right side, when energized, closes the fingers at the top in succession and starts the motor with which it is used in the same manner as if the operation were by hand. In the "off" position all resistance is in circuit so that on starting there will be no current inrush. As each finger closes, a step of resistance is cut out. The last finger cuts out all the resistance.

An automatic control panel for varying the speed may consist of a number of magnetically operated switches, the closing and opening of which may be accomplished by pushing buttons connected in the switch magnetic circuit. Assuming that a motor is running at its normal speed and that it is desired to increase this, a control button connected so as to magnetize a switch, the closing of which would connect a resistance in the shunt field, is one means. The button may be located at any location remote from the motor and control panel. Several typical control panels are illustrated in Figs. 11, 12 and 13.

For some motor applications it is now desirable to have the starting-box automatically operated, or capable of being started by pushing a button or closing a switch at some remote point. The "self-starter" or automatic starting device is one of the most interesting devices employed in connection with motors. Unless one has been able to keep in close touch with the development of electrical apparatus in recent years, one is likely to be astonished at the results accomplished by the various applications of the solenoid. This coil of wire which "sucks" in its iron plunger or core when energized by the passage of current through it, is used in what is called the dashpot-controlled self-starter and in the multiple solenoid current relay type.

In some plants automatic motor starters are installed solely for the purpose of preventing careless employes from starting up the motors too suddenly, but the value of the self-starter consists chiefly in the fact that when combined with suitable energizing devices, such as float switches, pressure regulators, limit switches, or even a push button switch, it dispenses altogether with the need of employing someone to start and stop the motor at the proper time, or else enables the one charged with this duty to control the motor from a distance.

In connection with motor-driven pumps and air compressors the self-starter finds one of its widest fields of usefulness. By means of a switch operated by a copper float in the tank, the circuit to the motor is automatically opened and closed through the self-starter whenever the water in the tank reaches a predetermined high or low level. The same device may be used in sump pits or, indeed, wherever there is sufficient change in water level to operate a float switch. In compression tank systems, and when used with air compressors, a pressure gage is substituted for the float switch, the circuit being made and broken as the needle, or indicator, moves back and forth between two fixed points.

A good example of the advantage of remote control is found in mining work where (in mines employing manually-operated starting-boxes) it is oftentimes necessary to send a man down the shaft to start a motor. In mines where self-starters are installed, every motor can be controlled by switches located in the power house, or at any other convenient point. In connection with electrically operated elevators, hoists, etc., the self-starter insures a smooth start and gradual acceleration to full speed, since by means of the dash-pot referred to the starting period is predetermined and is not affected by carelessness on the part of the operator.

In connection with refrigeration systems, automatic motor starters are frequently used for various purposes. The panel shown in Fig. 14 carries a main line knife switch, fuses, voltmeter and ammeter at the top, with an automatic starting rheostat and pilot switch for the motor driving the brine pump. By running control wires to several points in the building it is possible to start or stop the motor as desired from any of these locations. The starting is accomplished in the same manner each time, and the time of acceleration can be regulated to suit each particular requirement.

In short, practically every motor installation requires a controlling device. The choice of control is equally as important as the choice of a motor. All conditions should be considered in selecting the controlling device. Will the ordinary type of hand-operated starter be most economical or convenient, or would an automatic starter be better in the long run? Is speed regulation required? Is the device to be located where dust, lint, etc., are present in excessive quantities? Is the motor to be reversed? Is the motor of direct-current—series, shunt or compound type? Or of alternating current—single phase, or, squirrel cage or slip ring polyphase type? What duty will the motor be required to do? These are all questions concerning which information is required when considering the installation of the controlling apparatus.

* * *

In all places where bolts, studs, cap-screws, etc., are used, care should be taken to allow enough room for the use of a standard wrench.

CASEHARDENING TEMPERATURES

In an article in *Le Genie Civil*, Dr. L. Guillet gives some interesting information relating to casehardening methods and temperatures to be used in casehardening processes. In general, the regular carbon steels should be carbonized at a temperature of about 1560 degrees F. After carbonizing, the objects should be permitted to cool to about 1100 degrees F. or lower. They are then again heated and quenched from a temperature of about 1875 degrees F. for refining the core, after which they are again heated and quenched from a temperature of 1380 degrees F. for the final hardening. The quenching in both cases is done in water.

The carbon contents in ordinary carbon steel for casehardening should, in general, be from 0.10 to 0.15 per cent, and in no case should it exceed 0.20 per cent. In alloy steels the carbon contents may be as high as 0.30 per cent. The manganese contents should not exceed 0.40 per cent if a single quenching only is employed, but can be somewhat higher if two quenchings are used. Silicon increases the brittleness in all cases, and should not exceed 0.30 per cent. Tungsten and molybdenum also increase the brittleness of the core.

Nickel steels are very suitable for casehardening, but have, however, both advantages and disadvantages. Among the latter are that nickel seems to retard the process somewhat and the hardness of the case is somewhat lower than that obtainable in ordinary carbon steels. On the other hand, nickel tends to oppose the crystallization of the steel at high temperatures and to eliminate the consequent brittleness. Because of this, the first quenching for refining the core is not always necessary, although it noticeably increases the tenacity of the core. With a 2 per cent nickel steel the following temperatures are recommended: The first quenching should be from a temperature of 1830 degrees F. The second heating should be to 1380 degrees F., after which the quenching should take place after the objects have cooled off to about 1290 degrees F. A single quenching from 1290 degrees F. gives the greatest hardness in the case but not the greatest tenacity in the core. Quenching from 1380 degrees F. gives a somewhat higher tenacity but a slightly lower hardness in the case. A 6 per cent nickel steel should be quenched in the first instance from 1560 degrees F., and after reheating from 1245 degrees F. Since this high nickel percentage almost completely prevents the brittleness of the core, one quenching from about 1290 degrees F. is in most cases sufficient.

Steels with from 1 to 1.2 per cent chromium are sometimes used when an especially hard case is required. This element, however, aids the crystallization of the core and the double quenching is, therefore, absolutely necessary. Chrome-nickel steels with a low chromium content require about the same heat treatment as pure nickel steels.

The author does not recommend charred leather for a casehardening mixture, as he considers that it works too actively, but, instead, believes that a mixture of 60 parts wood charcoal and 40 parts of barium carbonate is the best to use. It is easy to obtain, is not expensive, and can be used over again for a number of times.

* * *

A combination of the moving picture machine and the phonograph has been recently demonstrated in London. The invention is of French origin and its development has been under way for a couple of years. Two electric motors are used, one for the moving picture machine and one for the phonograph. These are kept in synchronism by a special arrangement which makes it possible to instantly remedy any defects in the relative speeds of the two instruments. The combination machine is called "chronophone." At the demonstration, prominent actors could be seen reciting monologues. The sounds and the movements on the screen were in perfect harmony. One remarkable picture was that of a lion tamer in the cage of the animals. The mixture of sounds—those of the man speaking, the crack of the whip, the thud of an iron bar falling on the floor of the cage, and the growls of the lions—harmonized perfectly with the pictures. As these are also shown in natural colors, the illusion seems perfect.

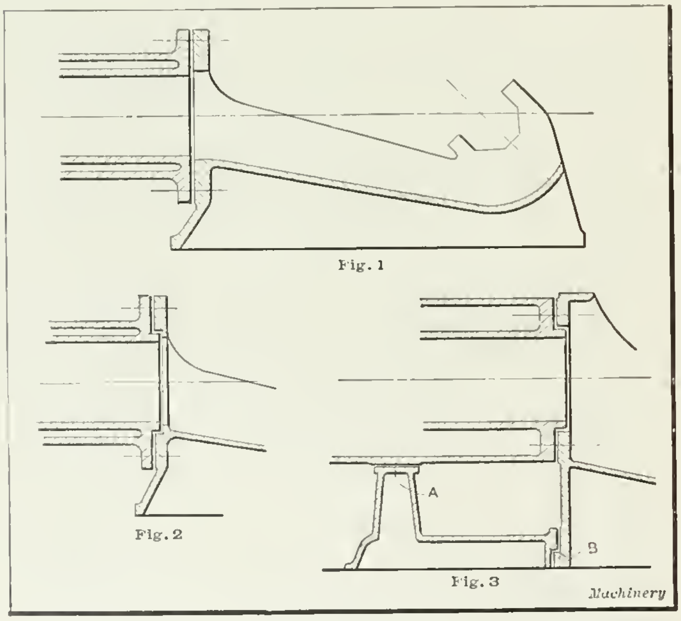
DESIRABLE IMPROVEMENTS IN AMERICAN GAS ENGINE DESIGN*

By C. F. HIRSHFELD†

The designer of gas engines has a double problem to solve. He must not only develop an apparatus which will function properly through a long life, but he must also, in general, design it in such a way that it can be built at a cost which will make it possible to meet competition. In criticizing commercial designs one must, therefore, bear in mind that manufacturing costs limit the refinement of design; but manufacturing costs do not excuse poor designs which a resourceful designer could improve without making the machine more expensive; nor do they excuse designs which make it difficult or impossible for an engine to function properly through a reasonably long life. Such design may give a manufacturer a temporary advantage, but it can never result in giving him a permanent share of the engine business. In the following paragraphs, some of the faulty constructions which are more or less common in small and medium sizes, will be pointed out, and better methods suggested.

One of the most glaring faults still found in many American gas engines of the horizontal type is the unsupported, overhung cylinder shown in Fig. 1. In very small sizes this construction would be justifiable if it were not more expensive than other and better designs which can be used for small engines; in medium and large sizes it is well-nigh inexcusable. The studs or bolts which hold the cylinder to the frame, and which often pass through unfinished, cored holes, cannot be depended on to keep the cylinder in proper alignment. These fastenings are, moreover, not well adapted for taking care of the normal pressure of the piston and of the weight of the cylinder and piston. In the case of large engines constructed in this way it is sometimes possible to notice a measurable deflection of the cylinder during the expansion stroke.

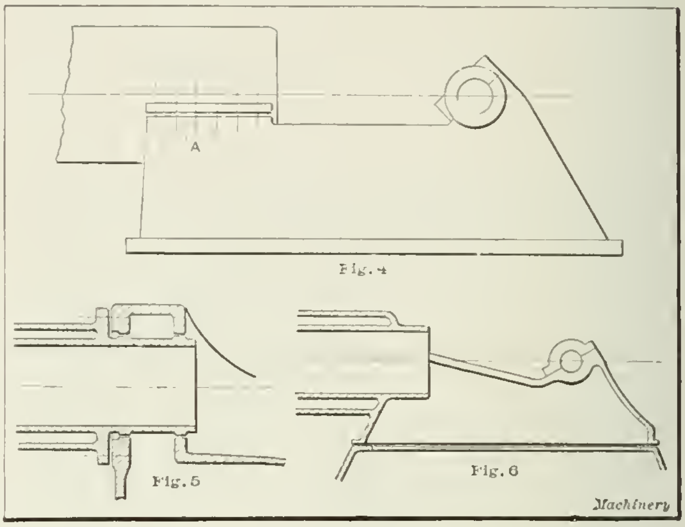
If this general type of design is deemed necessary because of the present investment in drawings, patterns, etc., it should at least be modified as shown in Fig. 2, so that a generous counterbore serves to locate the cylinder and to prevent motion of the crank-end with respect to the frame. The next simplest improvement is to slightly modify the patterns, using a support such as that shown in Fig. 3. This should be cast with, or bolted to, the frame, and should be so arranged that the cylinder can slide back and forth upon it at the point of support *A*. To secure accurate alignment when this auxiliary support is bolted to the frame, some kind of shoulder bearing, such as that shown at *B*, should be provided. Another solution, but a more expensive one, is to allow the cylinder barrel to extend into the frame for a considerable distance, as shown in Fig. 5.



Figs. 1 to 3 Methods of Attaching and Supporting Cylinders

One of the most satisfactory designs, so far as locating and supporting the cylinder is concerned, is that shown in Fig. 4. By making the bench at *A* short in the smaller sizes, the necessary support can be given the cylinder without necessitating the use of an excessive amount of metal in the frame. As the size of engine increases, this bench can be made relatively longer, thus giving the more perfect support required in higher powers. This design is particularly desirable from the manufacturing point of view, because the machine work is simple in character, and because, if properly designed, one frame can be used with several sizes of cylinders.

For very small single-cylinder engines some makers have developed designs similiar to those in Figs. 6 and 7, in which the working bore, jacket and frame are all cast in one. For small sizes this is a satisfactory solution; for larger engines it should be so modified as to permit of the use of a separate cylinder liner, as shown in Fig. 8.



Figs. 4 to 6. Methods of Attaching Cylinders to the Frames

In tandem engines the front cylinder should be supported in much the same way as in the single-cylinder type. The rear cylinder should be located with respect to the front cylinder by counterbored flanges which are finished when the cylinders are bored. These flanges should not, however, be called upon to resist bending moments caused by the weight of the cylinder, the thrust of valve mechanisms, etc. This bending moment should be taken care of by a simple support. A modification of the support shown in Fig. 3 is adapted to this case. The use of a support entirely separated from the main frame, a common practice in tandem constructions, is not to be recommended. The accuracy of its location depends entirely upon the care exercised by the erector, and is beyond the control of the manufacturer.

There seems to be a difference of opinion as to the necessity of a crosshead in single-acting tandems. From the viewpoint of rational design, there can be no question: a crosshead should be used. A piston cannot perform the functions of a crosshead without impairing the perfection of its action as a piston. From the viewpoint of the designer, however, the case is different. However desirable a crosshead may be, financial considerations may not be neglected. Although the crosshead itself is not necessarily a very expensive piece, it involves the use of a piston-rod and guides; but many manufacturers increase the cost of crosshead constructions very considerably by using an unnecessarily complicated crosshead. With proper slipper surfaces, no wedge adjustment is required on this member. A simple construction so arranged that the lower slipper can be moved down by the insertion of shims, if it should become necessary, is all that is required. As a result of the balance between cost and desirability, trunk-piston designs are generally used in smaller sizes, and crossheads in larger engines. The split might well be made at about 100 horsepower per crank. The reboring and ultimate replacement of 50 horsepower cylinders will, in general, about balance the interest on the additional investment involved in a crosshead engine.

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* For additional information on this and kindred subjects, see MACHINERY, February, 1912, engineering edition, "Points in the Design of Two-stroke Cycle Engines," and the articles there referred to.

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The cylinders of single-acting engines of American design are often open to considerable criticism. One of the most common faults is the use of a working barrel and jacket of too nearly the same diameter, giving inadequate jacket space. Faults that generally accompany this are the entire omission of openings through which this space can be cleaned, or the use of openings so small and so distributed that they are of little practical use. Builders of what may be called "stock" engines can seldom be sure that their engines will not be used in places where the only available water is muddy or carries large quantities of mineral matter in solution. If designers would regard the jacket as a water heater as well as a cylinder cooler, fewer designs of the kind mentioned would appear. Openings into the jacket space should be of such size and number that all parts of the interior can be easily reached, so that mud and scale can be cleaned out.

It is not good practice to make provision for cleaning by combining the jackets of the cylinder and of a separate cylinder head, that is, making them continous, as shown in Fig. 9. Experience has shown that joints of this kind are very difficult to pack. Leakage of water into the cylinder is apt to occur, causing irregular operation, or, if this can be prevented, water is apt to leak to the outside of the engine. If such cored passages are deemed necessary by the designer for the support of cores or for simplicity of construction, the head should be made to fit into the end of the cylinder with a metal-to-metal contact at some point in the counterbore, in order that the gas pressure acting on the inner edge of the gasket may be reduced to a minimum. It is, however, far better to cast the abutting faces solid and to carry the water around from jacket to jacket by means of a U-shaped connection. Even in this case many troubles will be eliminated if the counterbored construction is adopted. This method of protecting the gasket against blowout is well worth while.

Vertical engines have many head joints which are difficult to properly care for in operation. Whenever valves are placed in side chambers or pockets in high-compression engines of this type, it becomes difficult to design proper covers for the cylinder and valve chambers. The ideal arrangement would be the use of circular covers for each part, with each cover fitting into a counterbore, as shown in Fig. 10. When high compression and large valve diameter are desired, it becomes necessary to decrease the distance between the center line of the cylinder and the center lines of the valves. This generally makes it impossible to leave enough metal at point *A* to make it feasible to use separate covers, and there is a tendency to split along the line *BC*, move the valve toward the cylinder, and use non-circular covers. Not only does this construction require non-circular gaskets and prevent the use of counterbores, but it also often makes it impossible to finish the abutting surfaces with circular cuts which do not run off the edge of the casting. The satisfactory packing of a joint of this kind is often a matter of great difficulty. If, in addition to the disadvantages already enumerated, the gasket is called upon to take care of a continuous jacket, such as that previously mentioned, it will require both skillful manufacture and attendance, to keep the engine in successful operation.

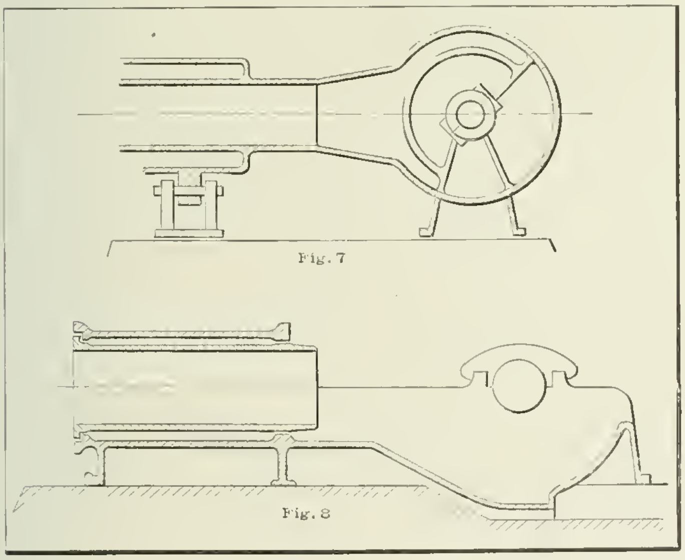
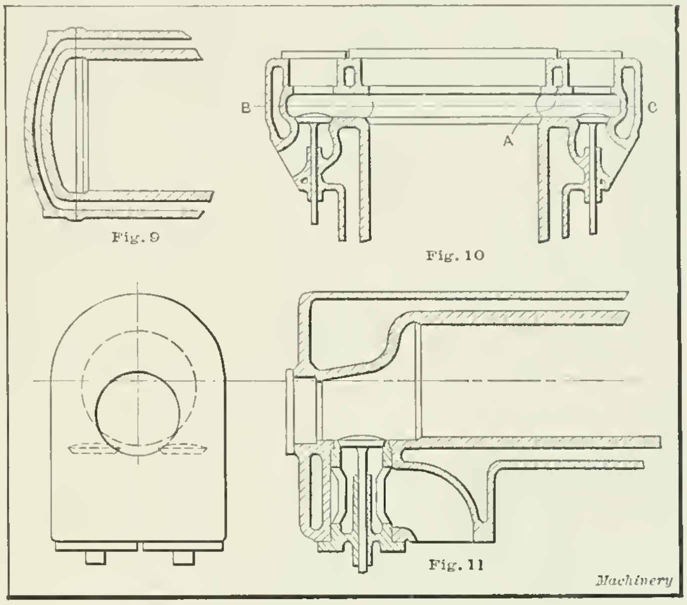


Fig. 7. Arrangement for Small Single-cylinder Engines. Fig. 8. Frame for Heavy Engine

These considerations and others to follow form strong arguments in favor of the location of valves in the head in high-compression vertical engines, if not in all engines with a vertical center line. Other advantages are simple cylinder castings, better shape of combustion space, and general accessibility of valve operating mechanism. The advantages accruing from valves in the head are particularly noticeable in Diesel engines, which are almost universally constructed in this way.



Figs. 9 to 11. Cylinder and Valve Arrangements

While speaking of valves and valve gear, it will not be amiss to consider some of the designs used in horizontal constructions. There are still a large number of these engines constructed with horizontal valves, that is, valves with their longitudinal axis horizontal. It needs no theoretical discussion to prove that such an arrangement is incorrect; the engines themselves prove that. Such valves are bound to wear their guides and seats out of round at a comparatively rapid rate. It is no more expensive to use vertical valves, and it is no more difficult to devise the operating mechanism for such valves.

In small types of horizontal engines with vertical valves, these members are located at the top and bottom in the cylinder or head, in chambers at the side or sides, and side by side in the bottom of the combustion space. The last-named location is generally preferable on the grounds of cheap construction and simple operating mechanism. An arrangement of this kind is shown in Fig. 11. This design is open to the objection that the volumetric efficiency of the cylinder is decreased by the heating of the incoming charge, which must pass in close proximity to the hot exhaust valve. The thermal efficiency is also apt to be slightly decreased by the loss of unburned mixture, if any considerable overlap of valve events is permitted. For small engines, however, these considerations are insignificant in comparison with the advantages to be gained by this construction.

Valves in pockets cast or bolted to the walls of the cylinder are open to criticism because of the poor shape of the combustion space, the complication of the cylinder end and its jackets, and the more complicated mechanism generally found necessary; but these pockets have the advantage of making it possible to remove the valves through plugged openings, so that valve cages are not necessary. In this sense the construction is cheaper than that just recommended; but on the other hand the advantages of valve cages are so great and the difference in cost so small, that cost can hardly be urged as a justification for valves in pockets.

Such seemingly simple things as frames are often incorrectly designed, particularly in the smaller sizes of horizontal engines. It is evident that the end of the frame to which the cylinder is fastened and the end which supports the bearings tend to separate during each combustion and expansion. To prevent this they are tied together by the metal in the frame. The most effective way to tie two pieces together against the action of separating forces is to put the tie member in such a position that its gravity axis coincides with the line of action of these forces. If this is not done there must be a bending moment on the binding member. A common type of frame is shown in Fig. 12. The two arrows in the center line show the line of action and the directions of the separating forces. It is evident that the upper surface of the frame will tend to separate at some such point as *A*. The result will be a crack extending downward. The trouble can be remedied by raising the upper lines of the frame as shown in Fig. 13, in which the dotted lines indicate the construction of Fig. 12. This results in bringing the gravity axis of the frame section nearer to the center line of the engine and thus reduces the bending moment.

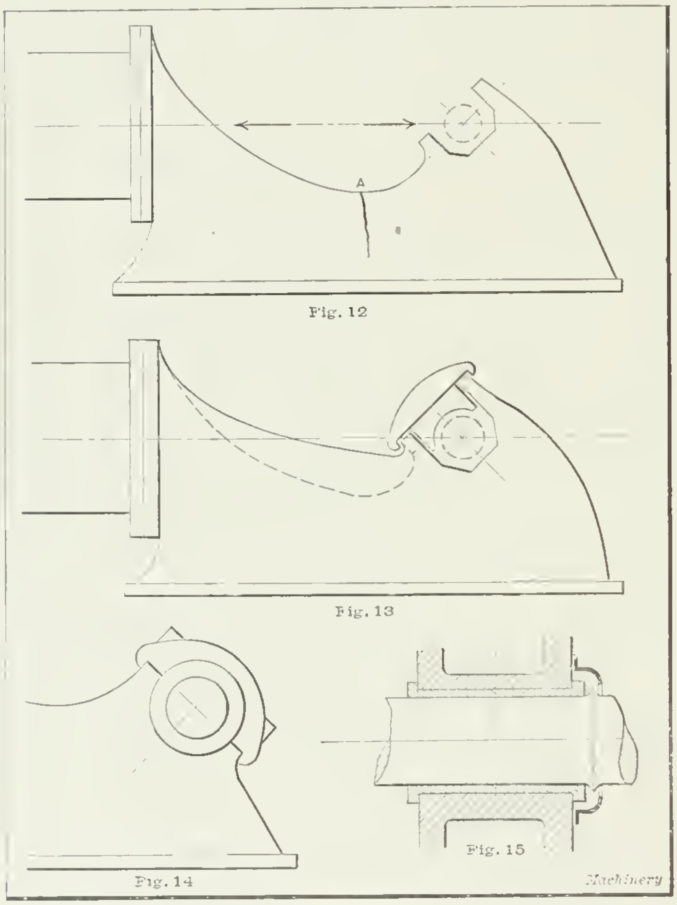


Fig. 12

Fig. 13

Fig. 14

Fig. 15

Figs. 12 to 15. Frame and Bearing Design

Many designers deem it desirable to use a bearing split at an angle as shown in Fig. 13, in order to take up the maximum thrust with the strong, cantilever-like piece which backs up the bearing. With this design it is difficult, although not impossible, to carry the top line of the frame as high as desirable, and as a result many of the engines now built in this way have abnormally strong bearings in proportion to the strength of their frames. In all but the smaller sizes it is better to use a design such as that shown in Fig. 8; it gives more nearly the same strength in different parts of the frame. Some makers are still using the type of bearing shown in Fig. 14. For this type there can be no justification. The maximum thrust must be taken largely by the cap and transmitted to the frame through the studs which hold that cap in place.

Another fault in some frames as now built in this country is to be found in the footings or surfaces on the lower side of the frame which are to rest on the foundation. In large engines, which may reasonably be expected to receive proper care in erection, it is good practice, when necessary, to use transverse footings within the walls of the frame, as shown in Fig. 8. In small engines there is no need for such supporting surfaces. The support furnished by the feet on the walls at side and end, is amply sufficient, and bearing surfaces inside of the walls may do more harm than good in the hands of a careless erector.

The downwardly projecting crank-case is a weak point in many engines of the smaller type. In large engines it is often necessary, if the shaft is to be at a convenient height above the floor, but this argument does not hold for the smaller sizes. Where small engines are designed as stock types, it is far better to protect the bulge of the crank-case with slightly deeper frame walls.

Many designers have not yet realized the desirability of an oil groove or channel on the outside of the frame at the bottom. Such a groove adds little to the molding cost, but adds materially to the ease with which the engine and foundation can be kept clean and free from oil. The channel should be properly sloped to insure drainage, and a drain provided at the lowest point, preferably at the front of the engine. It should also be noted that oil channels which are broken up into several undrained or imperfectly drained parts by bosses for foundation bolts are little better than no channels at all.

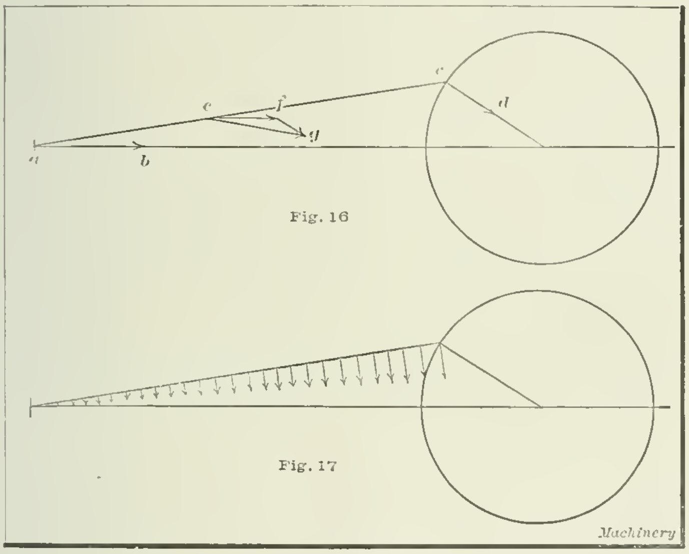
In the same class with these oil channels are oil guards over the crank-case in horizontal engines, and oil drains at the lowest point of the crank-case in all types. Unfortunately these are often ignored through ignorance, or as a foolish means of cutting down costs. Many of the larger engines in which oil channels, crank-case guards and oil drains are provided as a matter of course, are still faulty in that no provision is made for taking care of the oil which works out of the bearings and along the shaft. Splash rings and guards, such as those shown in Fig. 15, are not very expensive, and they materially assist in maintaining cleanliness.

A very weak point, characteristic of American design, is the exposed or partly exposed gear. When possible, cam shaft and similar gearing should run in an oil bath and be entirely enclosed. There are, however, many types in which such an arrangement would be very expensive, but this should not be used as an excuse for leaving these gears poorly protected or not protected at all. Danger of injuring the attendant is not the only thing to guard against; it is also necessary to prevent accidental damage to the gears. There are many engines now on the market in which the gears are so protected that it would be practically impossible for an attendant to get caught in them, but which have the guards arranged in such a way that tools can easily be dropped onto or between the meshing teeth. Several engines which were temporarily disabled in just this way within a few weeks after installation have recently come to the attention of the writer.

Another weak point in American design, which fortunately is now being rapidly eliminated, is the use of a malleable iron connecting-rod. It is generally conceded that the proper material for connecting-rods is steel, forged or cast in the smaller sizes, and forged in the larger. It is true that malleable rods are used only on single-acting engines, in which the maximum load puts the rod in compression, but these rods are too weak and are liable to fracture. The compression loading is only part of the story. Every connecting-rod, in operation, is also loaded like a beam, and iron is notably not the proper material for use in a beam. This beam loading is illustrated in Figs. 16 and 17. The acceleration at the wrist-pin end of the rod is shown in Fig. 16 by the arrow *ab*, and the normal acceleration at the crankpin end by *cd*. Any point between these two is subject to an acceleration which may be regarded as made up of two components, one parallel to and smaller than *ab*, the other parallel to and smaller than *cd*. These components and their resultant are shown for one point in the length of the rod by *ef*, *fg* and *eg*. If the normal accelerations of all the points be found, they will be about as represented in Fig. 17. Since there can be no acceleration without an accelerating force, there must be forces acting along the length of the rod in the same general way as do the accelerations in the illustration. It will be observed that these forces load the rod as a beam. The existence of these forces also shows the folly of using an H-section as is done by some makers. An I-section is rigid in the plane of rotation and is well able to care for the beam loading; an H-section is not sufficiently rigid in this direction.

While on the subject of connecting-rods, it would be well to speak of the methods provided for taking up wear at the two ends. In normal operation the wear at the crankpin end will be far in excess of that at the wrist-pin. The design of adjustments which will leave the distance between the pins the same is, therefore, practically impossible. The designer must decide whether the rod is to grow shorter with age, giving decreasing compression and efficiency, or whether it is to grow longer with the opposite results, and with the possibility of causing preignitions because of high pressures. The former is generally preferable as being safer, although the kind of fuel, the compression pressure for which the engine is designed, the kind of attendance which may reasonably be assumed, and a number of other considerations should also be given due weight in arriving at a conclusion. One case has come to the writer's attention which is interesting as illustrating what extreme conditions may be attained in practice. Wear was taken up in such a way as to lengthen the rod to such an extent that the first piston ring was driven into the counterbore of the cylinder and effectually locked the piston. This is, of course, a most exceptional case, but serves to show what is possible with some engines in some hands.

It has become recognized as desirable to provide means for adjusting the time of ignition while the engine is in operation. There are still many engines built in which such adjustment cannot be made. It may surprise some, but it is nevertheless a fact, that several large engines which are commonly recognized as "standard designs" have no such provision. The convenience of being able to adjust the time of ignition during operation can hardly be questioned, and it is absolutely necessary with producer gas engines.



Figs. 16 and 17. Forces acting on Connecting-rod

Another weak point in many ignition systems is the lack of proper provision for taking up wear. The parts are of necessity rather small, and rub across one another millions of times per year. Adequate lubrication is difficult, and wear is certain. Such systems should always be so arranged that the effect of wear upon the timing can be compensated for in a simple manner, and that considerable wear can occur before it is necessary to replace parts of the apparatus. It is rather remarkable that more manufacturers have not deemed it advisable to adopt the high-tension system which has proved its worth under the severe operating conditions pertaining in automobile practice. This type combined with careful construction can be relied upon to give most satisfactory results.

* * *

The methods of Russian high finance are startling, if we can accept the report current in regard to the use of certain die-casting machines recently bought. It is alleged that ten die-casting machines were lately bought by the Russian Government from a New England concern, for making certain Russian coins. The price was the mere bagatelle of $40,000 each.

THE INFLUENCE OF HEAT ON HARDENED TOOL STEELS*

By testing various samples of carbon steel in the tool steel testing machine designed by the author, it was found that carbon tool steels have a very low durability at a low cutting speed; that there is an increase of durability as the cutting speed increases; and that a maximum durability of cutting speed is obtained at about 50 to 80 feet per minute. There is then a decline of durability to a very low value if the cutting speed is further increased. These general characteristics are common to all tool steels that have been tested, whether of the carbon or high-speed steel type (tungsten or tungsten-vanadium varieties). All of these give, when the durability is recorded in diagrammatic form, a single- or double-peaked curve, according to the heat-treatment they have received. All show a low durability at low cutting speed, this characteristic being especially marked in the case of some high-speed steels, which latter often retain their durability at very high speeds.

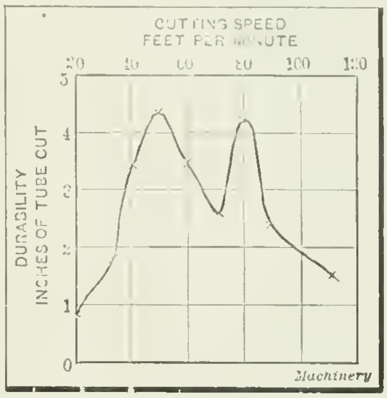


Fig. 1. Example of Double-peaked Durability Curve

The author, at a previous occasion, has pointed out that the observed changes in the durability of cutting tools are mainly caused by the changes in the temperature of the cutting edge, due to the heat generated at different cutting speeds. This heat theory has been confirmed by experiments showing that changes of durability corresponding to those which occur under varying cutting speeds can be produced by varying the temperature of the tool in other ways, while the cutting speed remains constant—for instance, by varying the temperature of the water with which the tool is flooded, or by varying the depth of the cut (a heavy cut generating more heat than a light one), or by dispensing entirely with the cooling water.

The various problems that were dealt with in the experiments were as follows:

1.—It has been found by experiments on the tool steel testing machine that all tool steels, without exception, have a very low durability, and are very quickly blunted when cutting under water at low speeds and fine cuts, that is, under conditions which preclude any considerable heating of the cutting edge; and it has been found that any alteration in the cutting conditions which tends to increase the temperature of the cutting edge results in an increased durability of the tool. What, if any, are then the correlative changes in the physical properties (strength, hardness, toughness, etc.) of hardened steel which occur when it is raised from a low to a higher temperature?

2.—All varieties of tool steel have been found to be capable when suitably hardened, of producing double-peaked speed-durability curves (see Fig. 1), the characteristics of such steels being that at a certain speed they are less durable than at either a higher or lower speed. Is it possible to correlate this low durability at a certain speed with a particular physical condition at a certain temperature?

3.—All tool steels are found to lose their durability when the cutting speed is raised above a certain limit. Is there any corresponding change in their physical properties when they are heated above a certain temperature?

4.—Assuming that each cutting speed corresponds to a definite temperature of the cutting edge (the weight of cut and all other conditions remaining constant), what are the actual temperatures of the cutting edge corresponding to the various cutting speeds, and corresponding to the various changes in the durability and physical properties of the steel?

Before dealing with these problems, it is necessary briefly to consider the nature of the actions tending to wear or blunt a cutting tool, and the correlative physical properties constituting durability, which the tool must possess in order to withstand these actions. The principal action to which a tool is subjected in cutting is one of friction under heavy pressure. This tends to rub away the surface of the steel, by causing

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* Abstract of a paper read by Mr. Edward G. Herbert before the Iron and Steel Institute, Great Britain, at the May, 1912, meeting.

the particles of steel to slide over one another. To resist blunting by this action a tool must possess hardness. But the stress on the tool point is not constant: as the chip is detached it breaks up into a series of short segments (more or less completely separated), and this process subjects the tool to a succession of changes of pressure, amounting almost to blows, and tending to chip off portions of the cutting edge. To withstand this action the tool must possess toughness.

If we make a tool of glass and another of copper, and use them to turn a cylinder of soft material such as lead in the lathe, we shall find that both are very soon blunted, but from totally different causes. The glass tool, though extremely hard, is brittle, and is blunted by the chipping away of minute particles of the cutting edge. The copper tool, though very tough, is soft, and is blunted by the rubbing away of the cutting edge. If now we imagine that by some subtle alchemy we can gradually change the tool of glass into one of copper, it will probably pass through some intermediate stages where it will retain some of the hardness of glass without all its brittleness, and will have attained some of the toughness of copper without all its softness. The tool in this intermediate state will probably keep its sharp cutting edge much better than either the glass or the copper tool.

In order then to measure, throughout a range of temperatures, those physical properties of steel which constitute its durability, it is necessary to test it at each temperature for hardness and for toughness. Experiments with suitable apparatus were, therefore, carried out for measuring the hardness and toughness at various temperatures, taking into consideration such factors as different methods of grinding the tools, etc. The experiments made it possible to answer the questions propounded above, as follows:

1.—The low durability of all tool steels, cutting under water at low speeds and light cuts, seems to be completely explained by the low values of hardness and toughness which always occur at cutting temperatures of 50 to 100 degrees C. (122 to 212 degrees F.). The breaking tests have shown in every case the product, hardness times toughness, increases in value as the temperature is raised above 100 degrees C. The cutting tests have shown in every case that the durability increases when the cutting speed is raised above 20 feet per minute. These cutting tests have also shown that the durability always increases when a tool working at 20 feet per minute is allowed to cut dry instead of with water, or with hot water instead of cold. It is impossible to doubt that these are different manifestations of the same physical change in the steel.

A clear recognition of this phenomenon is of great practical importance. A great deal of the metal cutting in every machine shop consists in taking fine finishing cuts, often with water on the tool. If such cuts are taken at a slow speed, the temperature of the cutting edge may not rise above 100 degrees C., in which case the tool will be quickly blunted. Its durability can be increased by increasing the speed or by cutting dry. Many cases are known to have occurred in ordinary workshop practice, where an increase in cutting speed has actually resulted in increased durability of the tool. Low durability at low cutting temperatures (on, for example, finishing cuts) is a familiar characteristic of high-speed steels, and is most marked in tools which have been suitably hardened for very high temperature work. High-speed steel can be so hardened as to retain its durability at fairly low temperatures, and there are now on the market tungsten steels specially adapted for low temperature work, such as finishing very heavy forgings; but every description of steel known to the author loses its durability if the cutting temperature is low enough. It should be noted that a low cutting temperature can only occur when there is a combination of low speed with light cut. A heavy or moderate cut raises the temperature of the cutting edge above 100 degrees C., even at very slow speeds.

2.—The phenomenon of the double-peaked curve is not completely elucidated, though the evidence goes some way to explain it. The variations of hardness and toughness with temperature are of a complicated character, and the cleft between the two peaks of a durability curve appears to be caused by the conjunction of depressions in the hardness and toughness curves at a particular temperature. The relative heights of the two peaks are found to vary with the conditions of cutting, and this variation may be due to a change in the relative importance of the hardness and toughness factors, according to the quality of the material cut, or the shape of the tool.

3.—The decline in durability which takes place when a certain limiting speed is exceeded, is evidently caused by an actual softening of the cutting edge by the heat generated in cutting. This softening, which is extremely local, takes place even when the tool and the work are practically immersed in running water. The speeds and temperatures at which the softening occurs depend largely on the particular hardening process which has been applied to the tool, and are generally highest in high-speed steel.

4.—It is not yet possible to establish an exact scale of cutting temperatures corresponding to the scale of cutting speeds, but a comparison of the temperature-durability tests with the speed-durability tests enables us to make an approximation, as in Fig. 2.

To establish the relation between the speeds of cutting with and without water, a comparison was made between the various results obtained in the tests, from which it appears that the effect of using water is approximately to double the cutting speed; in other words, the edge of a tool flooded with water attains about the same temperature as the edge of a tool cutting dry at half the speed. This must not be taken as a general statement applicable to all cutting operations. The dry cutting temperature depends largely on the volume of metal operated upon. The tube used in the tool steel testing machine is small in diameter and light in section; it becomes considerably heated under a dry cut. In machining a large forging, the body of metal absorbs a great deal of heat, with only a slight rise in temperature, and the use of water has less effect on the cutting speed.

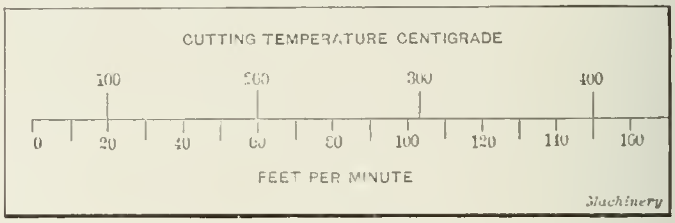

Fig. 2. Approximate Scale of Cutting Temperatures and Cutting Speeds when Testing in Tool Steel Testing Machine

Considerable interest attaches to a comparison of the durabilities of carbon and high-speed steels. It appears that the high-speed steel has two distinct features of superiority. The speeds at which it attains its maximum durability are not very different from those at which carbon steel is most durable, but the high-speed steel is several times as durable at these speeds. Quite distinct from its superior durability at moderate cutting temperatures is the property possessed by high-speed steel of retaining some durability at temperatures high enough to soften carbon steel, but its actual durability under such conditions is much less than under conditions which do not unduly heat it. In other words, its abrasive quality appears to be more important than its heat-resisting quality.

* * *

ERRORS IN JUNE DATA SHEET

We have been advised by the Society of Automobile Engineers that a few errors appear in the specifications for heat-treatment of carbon and nickel alloy steels reported by its Iron and Steel Division, January, 1912. The data of this report which was condensed into the June Data Sheet also contains the errors which are as follows: In Table I, reduction in area for annealed 0.10 carbon steel should be 55 to 65 per cent instead of 60 per cent; elongation of 0.50 heat-treated carbon steel should be 5 to 20 per cent instead of 0 to 20 per cent. In Table III, elongation of 0.40 carbon high nickel-chromium steel should be 2 to 15 per cent instead of 0 to 15 per cent; same for 0.45 carbon high nickel-chromium steel; and 150,000 to 225,000 pounds elastic limit for heat-treated 0.50 carbon chromium-vanadium steel instead of 150,000 to 200,000 pounds.

* * *

A few years ago engineers considered that 8, 10 or 12 square feet of heat transmitting surface per boiler horsepower was good practice, but improvements in the circulation system of steam boilers have made possible great increases in efficiency and now the ratios have been cut down to 4, 5 or 6 square feet per boiler horsepower.

THE RIVETT INTERNAL GRINDING MACHINE IN THE AUTOMOBILE FACTORY*

By CHESTER L. LUCAS†

The manufacture of automobiles has done much to develop general machine shop practice, and the necessity for mechanisms requiring hardened and ground parts has created a demand for the best that can be produced in grinding machinery. In internal grinding of the smaller variety, considerable trouble was met with at first in securing a suitable quill-spindle that would maintain its accurate adjustment and still run at the high speeds required in the grinding of holes of small diameter. A second difficulty was encountered in grinding holes perfectly straight, without tapering or "bell-mouthing." Grinding machine builders soon recognized the fact that before internal grinding could become of great value as an accurate machining operation, these two primary troubles must be overcome.

One of the first persons to recognize the possibilities of internal grinding, as well as the limitations of the machines in use, was Mr. Edward Rivett of the Rivett Lathe Mfg. Co., Boston, Mass., who, in 1900, took out a patent on an improved form of grinding machine quill-spindle. This spindle was designed to run at the high speed required for internal grinding and was designed particularly to overcome the end shake of the spindle, as well as to insure the proper fit of the spindle in the bearings. Essentially, this spindle consists of a centrally located shaft upon which is a fixed collar. Against this collar, sleeves are fitted which may be adjusted laterally against suitable washers which bear against the sides of the collar, thus effectively taking up the end thrust. The spindle itself runs in two split bushings, one on each side of the collar. These bushings are adjusted to the spindle by means of two sets of tapered wedges fitted in holders placed about these bushings. With this spindle, which is driven by belts passing from pulleys at both ends of the quill-spindle, speeds as high as 100,000 revolutions per minute can be obtained, although the usual speed employed is far less.

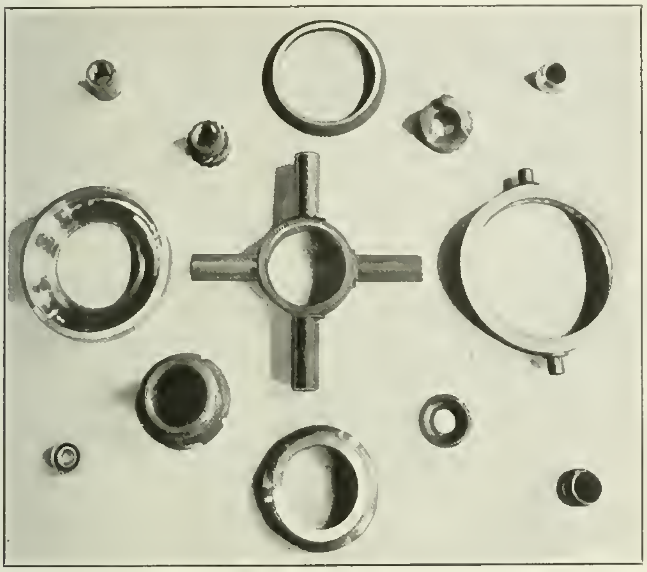

Fig. 1. Some of the Automobile Parts ground on Rivett Grinding Machine at the Stevens-Duryea Co.'s Factory

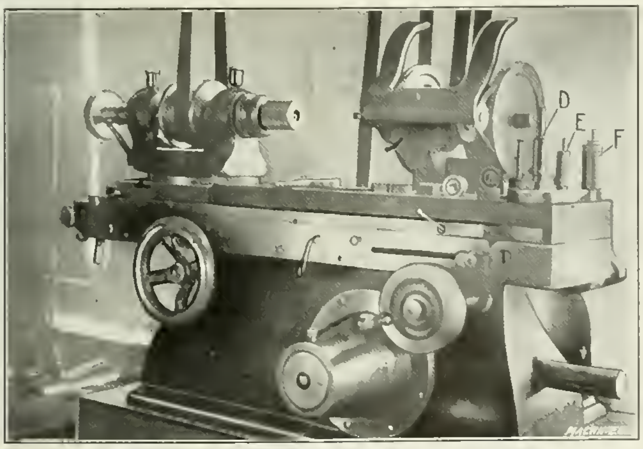

Fig. 2. Grinding the Bores of Tappet Rolls

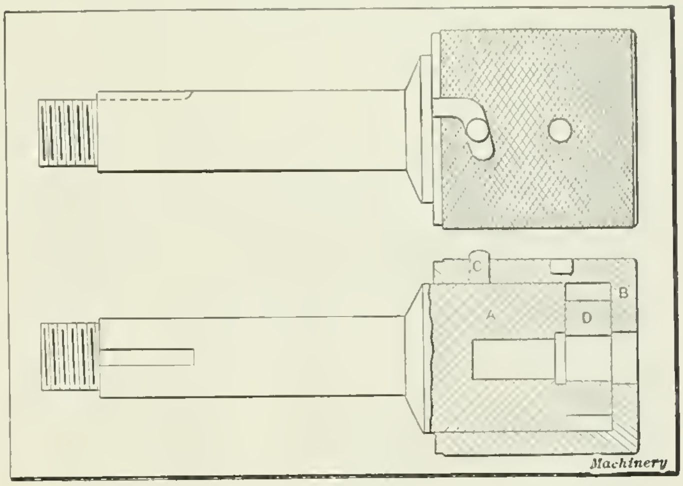

Fig. 3. Method of holding Tappet Rolls for Grinding

This style of spindle was used successfully for several years, until in 1907 Mr. Rivett brought out the new high-speed ball bearing spindle, which has superseded the former one. This spindle has specially designed ball races, made of a high grade of steel, and ground and lapped on Rivett ball grinding machines, which makes it a most rigid and durable type. The adjustment of these spindles is very simple, as there is but one screw, which governs both the end and side shake simultaneously.

In meeting the second obstacle in the path of successful internal grinding, that is eliminating the tendency toward grinding tapering or bell-mouthing, an important problem was solved. It was generally conceded that this tendency toward bell-mouthing in internal grinding was due to the fact that in reciprocating the table of the grinding machine in the ordinary way, the table moved with varying speed throughout the whole distance of travel. Thus, at the extreme ends of the stroke the table was moving more slowly than at the central portion; consequently more stock was removed from the ends of the hole than from the central portion, as the wheel was in contact with the work longer at these sections. In 1904, Mr. Rivett patented a mechanism for changing rotary into reciprocating motion, and applied the principle to his grinding machines. In brief, this mechanism consists of a lever mounted on the base of the grinding machine and fulcrumed near its central point. The upper end of this lever is connected to the table by means of a link, and the lower end carries a roller whose position is adjustable in relation to the fulcrum. This roll serves as a means of contact with a conical heart-shaped cam.

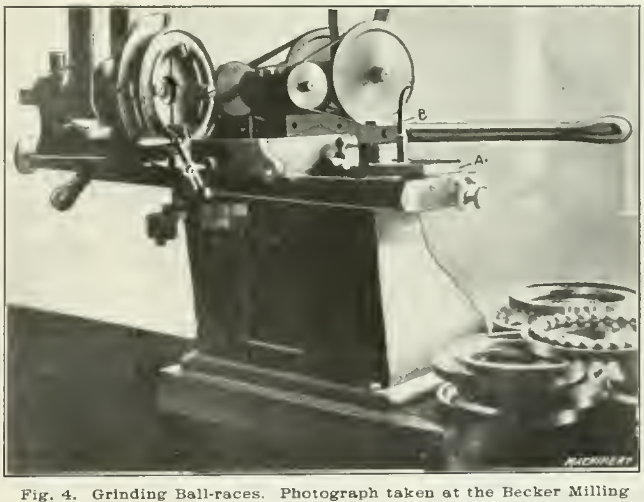

Fig. 4. Grinding Ball-races. Photograph taken at the Becker Milling Machine Co.'s Shops, Hyde Park, Mass.

The object of this special table traversing motion is to provide a slight retardation at the middle of the stroke. The gradually accelerated traverse of the table towards the ends of the stroke gives less cutting time on the ends than at the center, thereby producing a hole which is about one ten-thousandth of an inch larger in the center than at the ends. In order to provide for the traversing of the table on long and short strokes, the heart-shaped cylinder cam is made conical, and by moving the roll upon the lever to a suitable position along the cam, the stroke can be reduced to any desired length.

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* For additional information on this and kindred subjects, see the following articles previously published in MACHINERY: "Holding Work for Grinding," March, 1912; and "Internal Grinding Practice in the Hardinge Bros. Shop," May, 1912.

† Associate Editor of MACHINERY.

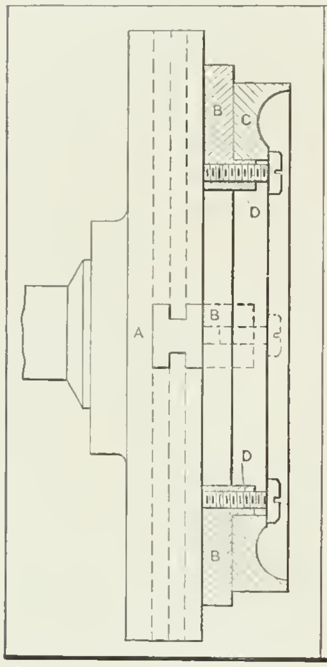


Fig. 5. Special Chuck used for the Grinding Operation shown in Fig. 4

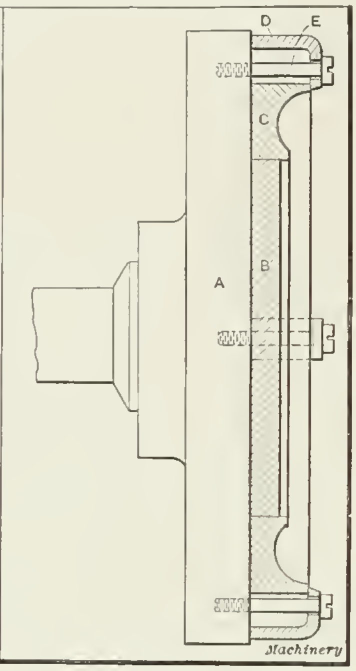


Fig. 6. Another Method of holding this Class of Work

By thus securing an even table travel, an important improvement in internal grinding was made which enables these machines to grind internally without tapering or bell-mouthing.

Special Grinding Operations and Chucking Devices

In order to illustrate some of the possibilities of internal grinding and to show some of the chucking devices used in performing these operations, the accompanying illustrations and descriptions of modern internal grinding operations have been secured from leading automobile factories. Fig. 1 shows various automobile parts that are regularly ground in the Stevens-Duryea Co.'s factory in Chicopee Falls, Mass.

Grinding Tappet Rolls

Small tappet rolls like those shown on the end of the table of the grinding machine in Fig. 2, one of which is also shown in Fig. 1, are ground in an interesting manner on the Rivett No. 3 grinding machine. These rolls are used on the ends of the tappet rods and, when in use, are in constant contact with the cams on the camshaft that operate the valves. In order to obtain satisfactory action of the valves it is necessary that the holes in these rolls be ground true with the end-faces. The rolls are first ground on these faces on ordinary surface grinding machines, and come to the Rivett grinding machines with their faces ground true and parallel.

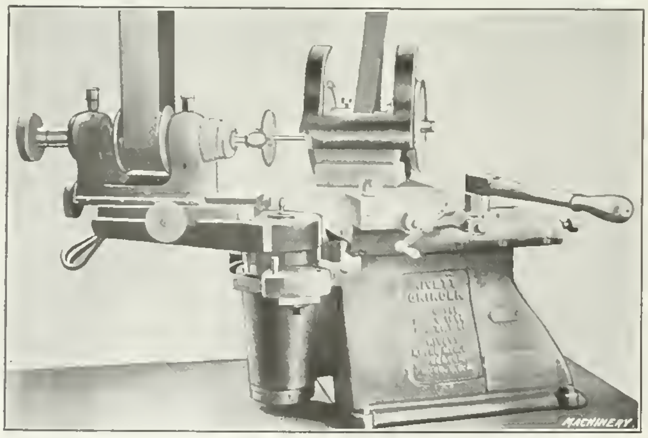


Fig. 7. Ball-grinding on the Rivett No. 5 Grinding Machine

By means of the special chucking fixture shown in Fig. 3, the rolls are chucked for the grinding of the bores, being held by their faces. This chucking device consists of a central shank *A* which fits into the spindle of a grinding machine after the manner of an ordinary draw-in collet. Over this shank, a sleeve *B* is fitted. A hole is bored in the end of this sleeve slightly larger than the hole in the tappet roll. By means of an inclined slot in the wall of the sleeve, acting in conjunction with a pin *C* driven into the shank, it is possible to hold the tappet rolls securely by the faces. This method of clamping is of the bayonet-lock order. Previous to clamping the tappet rolls in position, however, they are centrally located by means of a locating plug shown on the end of the table of the grinding machine at *D*, Fig. 2. The end of this plug is fitted to a central hole in the shank *A* of the chuck, and being a close fit for the hole in the tappet roll, the latter is thus located in a central position ready to be clamped and ground.

In grinding these holes, the grinding wheels used are of Norton make, J grade and No. 38 grit. The wheel spindle is operated at a speed of 17,500 revolutions per minute and the work spindle travels at the rate of 200 revolutions per minute. Limit gages are used for testing the work; these are shown at *E* and *F* on the end of the table of the grinding machine. The holes in these rolls are 0.4375 inch diameter and limits of but 0.0005 inch above or below are allowed. The thickness of the rolls is 7/16 inch. It will be noticed that the table and slides of the grinding machine are protected with a wooden guard which keeps out a great deal of the emery and saves the bed from the wear occasioned by contact with wrenches and pieces of work.

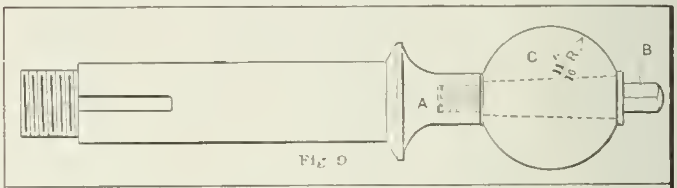


Fig. 9

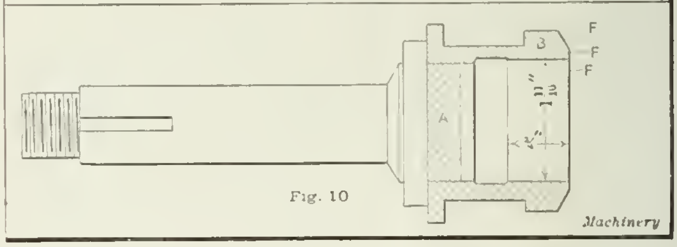


Fig. 10

Fig. 9. How the Balls are held for Grinding. Fig. 10. Method of holding Steering Post Cones on the Grinding Machine

Grinding the Races of Large Ball Bearings

In the shop of the Becker Milling Machine Co., Hyde Park, Mass., the races of large ball-bearings are ground on the No. 5 Rivett grinder. Some finished work is shown at the right of the machine in Fig. 4, and one of the pieces is shown mounted in the chuck of the machine. The method of holding the work is shown in Fig. 5. The rings are held in a chuck *A*, being gripped from the inside by means of chuck jaws *B* and held back against the jaws by means of four screws *D* whose heads extend over the inside edge of the work. In setting up the machine for this job the locating fixture shown on the end of

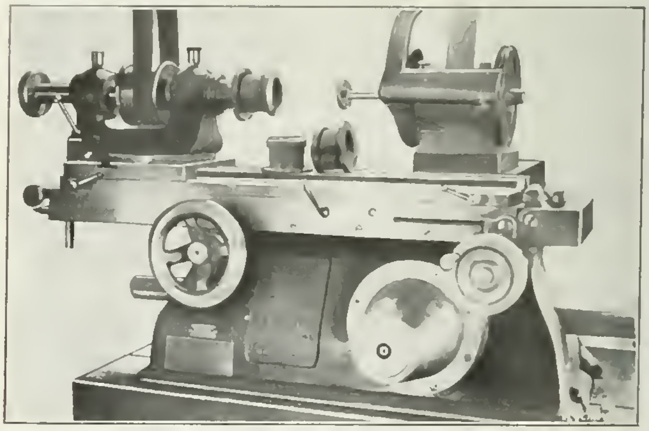


Fig. 8. Grinding Steering-post Cones

the machine in Fig. 4 is used. This locating fixture consists of a base *A* having, on its under side, a projecting stud that fits into a recess over the swiveling point of the work slide. At the top of arm *B* a thin steel disk of the proper radius is located, it also being at the correct distance from the center. By inserting the stud of this gage in the recess in the grinder bed, the chuck may be moved the proper distance from the swiveling point, thus insuring that the work will be ground at the right radius and to the proper diameter.

Fig. 6 is an illustration of the method used by the Stevens-Duryea Co., for holding similar ball bearing parts for grinding. This device consists of a faceplate *A* having a central stud *B* over which the ball bearing member is a close fit. For holding the work shown at *C* against the faceplate, four clamps *D*, held by screws *E*, are used. This work is ground at a spindle speed of 150 revolutions per minute, the wheel traveling at the rate of 17,500 revolutions per minute. Richardson elastic wheels, grain 80, grade 2R, are used.

Grinding Balls

One of the most difficult of grinding jobs is the grinding of a ball. This operation is shown in Fig. 7; the method of holding the balls for grinding is shown in Fig. 9. The holding fixture consists of a solid shank which is held in the grinding machine by the same method as an ordinary draw-in chuck. The end of this shank is tapped to receive set-screw *B* whose body is tapered to fit the tapered hole in ball *C*. After locating the work slide at the proper distance from the swivel post, it is easy to grind the balls spherical.

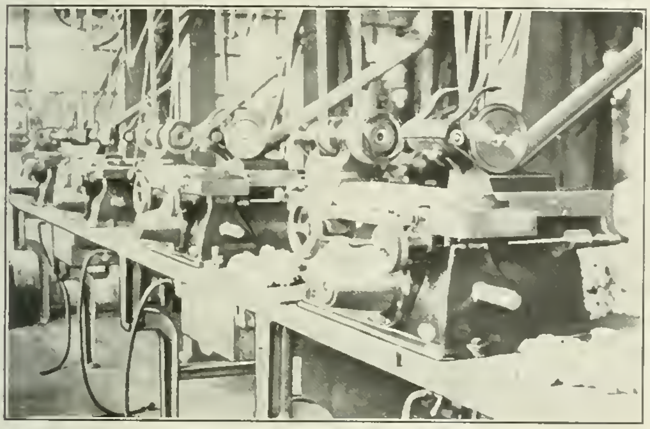


Fig. 11. A Row of Rivett Grinders in the Brown-Lipe-Chapin Gear Co.'s Factory, Syracuse, N. Y.

Grinding Steering-post Cones

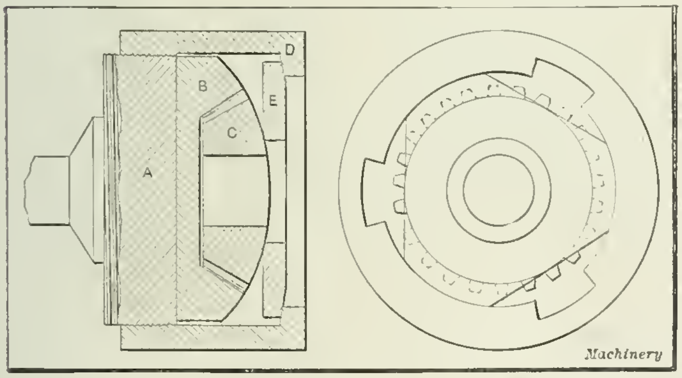


Fig. 12. Special Chuck for holding Bevel Gear Pinions for Grinding the Holes

The No. 3 Rivett grinding machine is also used for grinding steering post cones, an operation shown in the half-tone illustration Fig. 8. These cones are made from low-carbon steel and casehardened. The method of grinding these pieces is shown in Fig. 10. The work is held upon a threaded stud *A* which engages the internal thread in the piece to be ground, *B*. It is then a simple matter to grind the inside to size and also to grind the outside flange, finishing the three surfaces indicated by *F*. The work spindle revolves at the rate of 200 revolutions per minute and the wheel spindle at 17,500 revolutions per minute. The wheels used are of Norton make, being of J grade and 38-80 combination grit. The internal size must be accurate to within 0.001 inch. It is on work of this kind that the improved method of traversing the table is used to advantage, because it is essential that these pieces be ground straight—without bell-mouthing.

The Rivett Grinding Machine on Automobile Gear Work

The machines shown in Fig. 11 were photographed at the shops of the Brown-Lipe-Chapin Co., Syracuse, N. Y., where they are used for grinding the bores of small bevel gear pinions. These pinions are made from low-carbon steel and pack-hardened. As will be seen by referring to the grinding machine in the foreground, the gears are held by a special chucking device. This chucking arrangement is shown in the line illustration Fig. 12 and consists of a threaded base *A* held in the work spindle. Against the outside face of this base rests the lead matrix *B* which receives the bevel pinion *C*. A sleeve *D* is threaded onto the base and serves to draw the plate *E* down against the gear and matrix, pressing both against base *A*. In this position the bore of the pinion may be conveniently ground and when finished may be removed by loosening the sleeve and removing the plate by means of the three openings in the flange of the sleeve. One operator looks after two machines and turns out 500 finished pinions per day. For cleaning out the chuck and its parts, compressed air is used; the air is supplied to the hose seen beneath the bench.

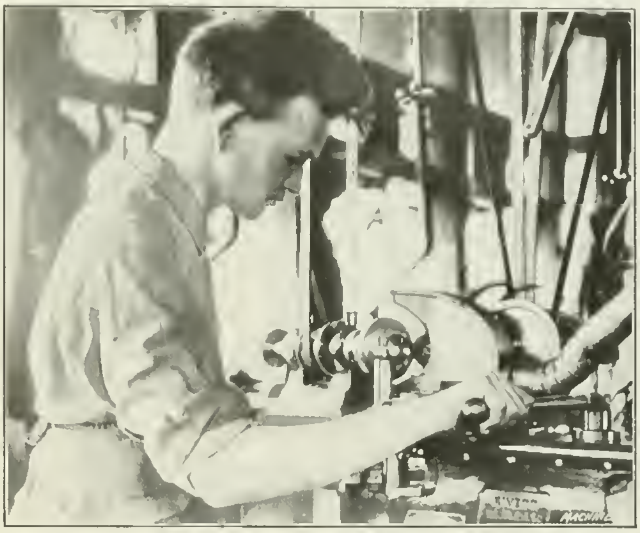


Fig. 13. Grinding the Spherical Faces of Bevel Gear Pinions

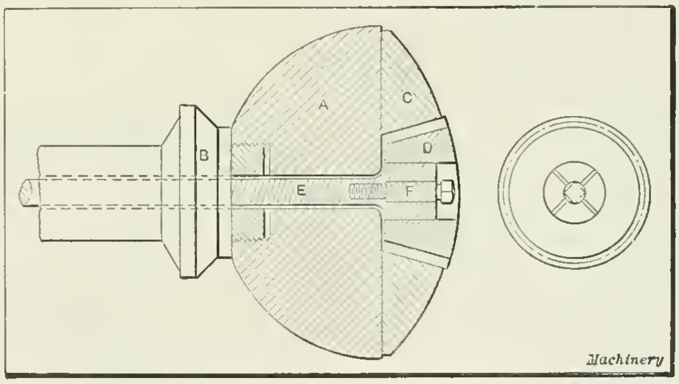


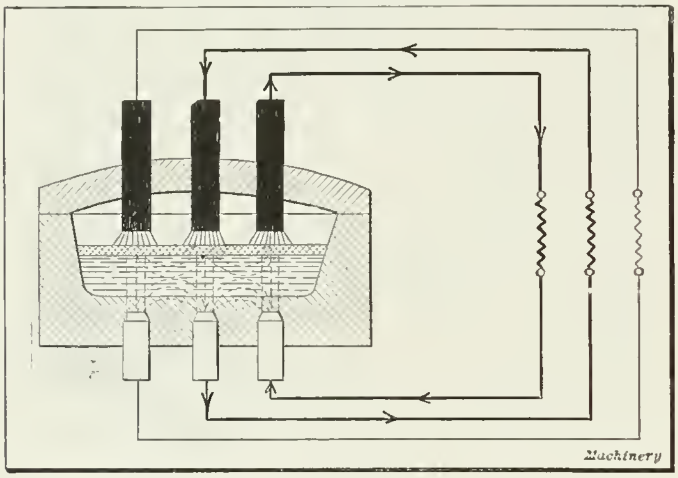
Fig. 14. How the Gears are held True with the Boss when grinding the Spherical Faces

Grinding Spherical Faces of Bevel Gear Pinions

A second grinding operation is performed on the pinions mentioned above. This operation consists in grinding the spherical face, as shown in Fig. 13, the method of holding the work being shown in Fig. 14. A base *A* is threaded to the work spindle *B*. Against this base rests the lead matrix *C* in which the pinion is seated. This matrix is free to slide upon the face of the base *A*. By means of a split arbor *E*, expanded by set-screw *F*, the pinion is held by its bore, and after being gripped, is pulled back into contact with the matrix by the draw-in spindle integral with the expanding arbor. The faces of these pinions must be ground very accurately, a variation of 0.0005 inch from standard being the limit allowed. An average day's production is 650 gears.

IMPROVEMENTS IN ELECTRIC FURNACES

A paper was recently read before the Iron and Steel Institute of Great Britain by Mr. H. Nathusius on "Improvements in Electric Furnaces and their Application in the Manufacture of Steel." In this paper the author first took up the induction furnace and then the arc furnace, calling attention to the advantages and disadvantages of each. One of the disadvantages of the induction furnace is that the electrically induced heat can only be generated in the metal bath and not in the slag, which must, therefore, be heated indirectly by the underlying metal. It is, however, uneconomical to heat the slag by means of molten steel as the melting point of the latter is lower than that of the slag. Consequently, a higher temperature has to be imparted to the metal bath than would otherwise be necessary.



Diagrammatical View of the Nathusius Electric Furnace

The objection to the arc furnace, while it otherwise has exceptional advantages, is that while it heats the slag and the surface of the charge exceedingly well, it does not offer as good a means for heating the charge itself as does the induction furnace. Mr. Nathusius has, therefore, for many years made a special study of arc furnaces and their working conditions, and while he was soon obliged to acknowledge the great advantages of electric arc heating, the idea occurred to him at the same time that it might be possible to combine the advantages of the arc furnace (good heating of the slag) with the advantages of the induction furnace (heating in the charge itself), and thus avoid the disadvantages of both systems. It became evident to him at once that the electric current offered the possibility of applying heat not only at the surface of the charge, but also at any part where an intense heat is required, such as in the charge itself and especially at the bottom of the furnace. He also recognized that the natural method of heating consisted in applying heat not from above but below. If this could be effected by some simple means a substantial advantage over other arc furnaces would be gained.

In order to meet these requirements, he has constructed a furnace which consists of a combination of an arc and resistance furnace, as indicated diagrammatically by the accompanying engraving. The characteristics of this furnace are that it has three carbon electrodes above the surface of the charge which project through the roof into the furnace, and three or a multiple of three bottom electrodes of mild steel rammed in the hearth. The upper as well as the bottom electrodes are arranged in an equilateral triangle. In this way as much as possible of the energy required for a particular furnace may be transferred to the bottom of the bath and the method of heating thus approximates that of an induction furnace. By the aid of special means for the distribution of the current, it is possible to transfer a greater or smaller amount of energy to the arcs at the surface or to the bottom electrodes, as desired. The current employed is a three-phase alternating current.

The three surface carbon electrodes are connected to the outer terminals of the secondary windings of the furnace transformer and the three bottom electrodes are connected to the three inner terminals of the secondary coil. The three inner terminals of the transformer are obtained by separating the windings at the neutral point where the three secondary windings of an ordinary three-phase transformer are connected. By this means the neutral zone—it is permissible for the sake of clearness to thus represent the electric conditions—is transferred to the bath itself and the current must gravitate from all points of supply toward this neutral point. In other words, the current, though supplied from a single source only, is forced to flow not only between the upper and bottom electrodes, but also between any upper electrode and any bottom electrode. It is thus possible, with a single source of current, to heat the charge in all parts, provided that its resistance is sufficiently high or that the current is strong enough to produce sufficient heat in the charge when the resistance is low.

INTERESTING PRINCIPLE APPLIED TO A BORING JIG AND PLANING FIXTURE

An interesting principle applied to boring and planing jigs is shown in the accompanying illustrations. Fig. 1 shows a jig which was made for boring the holes in the head of the boring machine built by the Cleveland Machine Tool Works, Cleveland, Ohio. The jig consists essentially of a planed and grooved base to which brackets carrying bushings for guiding the boring-bar are attached. The principle followed in boring these brackets for the guide bushings is illustrated in Fig. 2.

The bracket *A*, at the extreme right in Fig. 1, is slid along to the other end of the fixture, as shown in Fig. 2, and then the other bracket *B* is clamped to the right of it. This is done so that the lugs at the base of the brackets do not interfere with clamping them close together. This arrangement facilitates the accurate boring of the holes in the brackets, both laterally and vertically. Slight errors in alignment existing when the holes are bored are greatly reduced when the brackets are set at opposite ends of the base. In fact, the principle insures that the centers are practically the same distance from the base and in line with the axis of the base slot or groove when they are placed in their respective positions on the fixture. The brackets, of course, are provided with lugs formed on their bases, which accurately fit in corresponding grooves in the jig base.

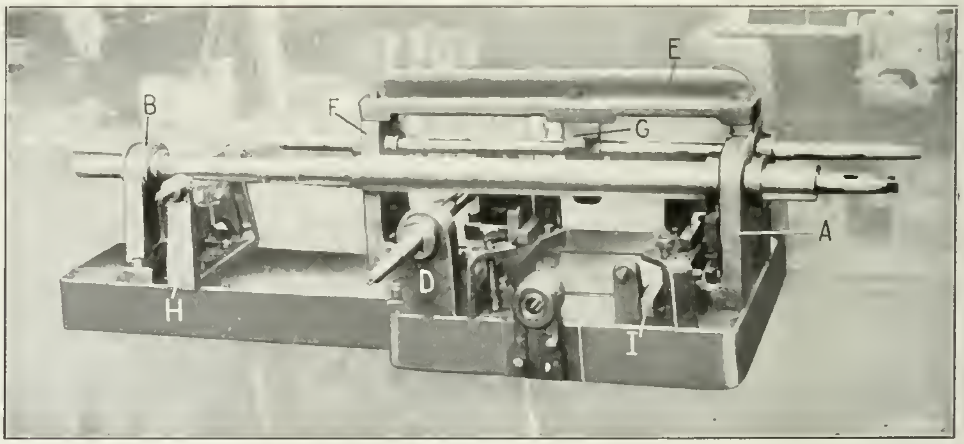


Fig. 1. Boring Jig used by Cleveland Machine Tool Works for boring Machine Heads

The bushing guide holes in the bracket *A* and the corresponding holes in the other bracket were at the vertices of a triangle, as is shown at *C* in Fig. 2. The lines joining their centers were neither parallel to the platen nor to the vertical travel of the boring machine head. So the lengths of the bases a, a_1 and altitudes b, b_1 of the triangles were computed to obtain the correct settings of the boring machine head for the various holes, and the settings of the head and platen were accomplished by means of the scales and verniers regularly supplied on these boring machines.

When the three holes in the two brackets were bored, the fixture was swung around to bore the two side brackets, one of which is shown at *D*, Figs. 1 and 3, with a boring-bar in place. The center lines of the four brackets *A*, *B*, *D*, and the one on the far side (not shown) must be at right angles. The bridge *E* was bolted and doweled to the brackets *A* and *F*, and then the center bracket *G* supported by the bridge was bored and bushed.

To clamp the work in the fixture, it is adjusted centrally in the saddle *H* by means of the screws. Then the wedges *I* under the front and rear of the right-hand end of the work are adjusted, clamped and the screws in the saddle tightened, as illustrated in Fig. 3. This gives a three-point bearing or support. To hold the work rigidly in position the wedges to the right of the center of the casting at the front and rear are adjusted and clamped. This method of clamping the casting prevents straining it, and holds it rigidly. When the wedges were first considered as a means of adjusting the work, it was thought that they would move under the cut, and thus require adjusting screws to hold them. This, however, was not the case, for after three years' service, the wedges have not been found to slip. The taper on the wedges is three-quarters inch per foot. Thirty-three boring and facing operations and six milling operations are performed on the head casting before it is unclamped from this combined jig and fixture.

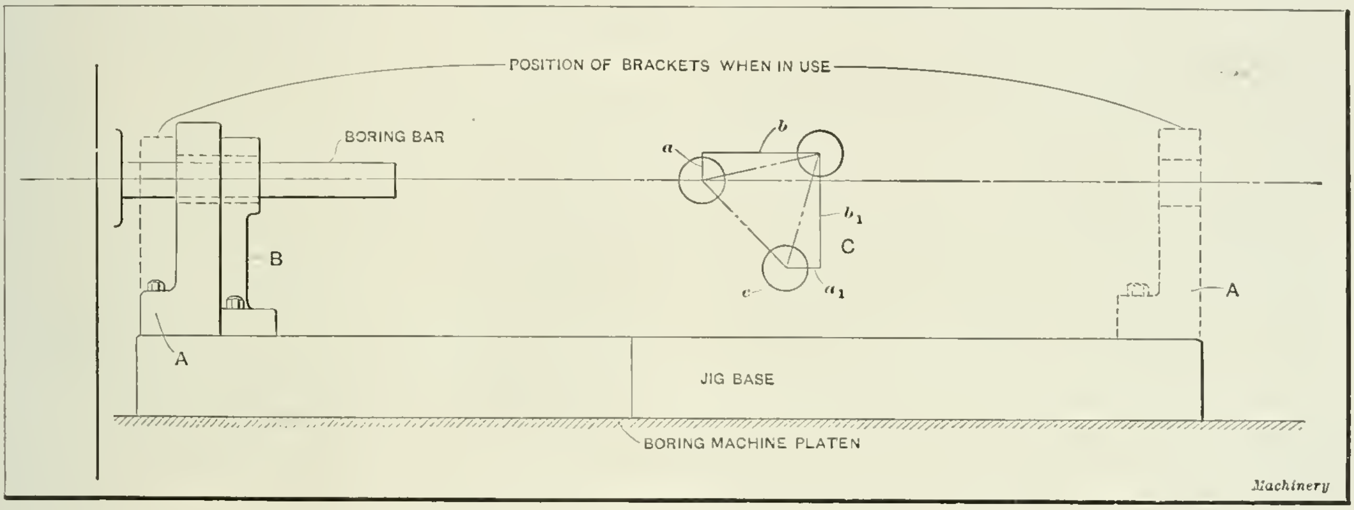


Fig. 2. Diagram illustrating Principle of Construction embodied in Boring Jig

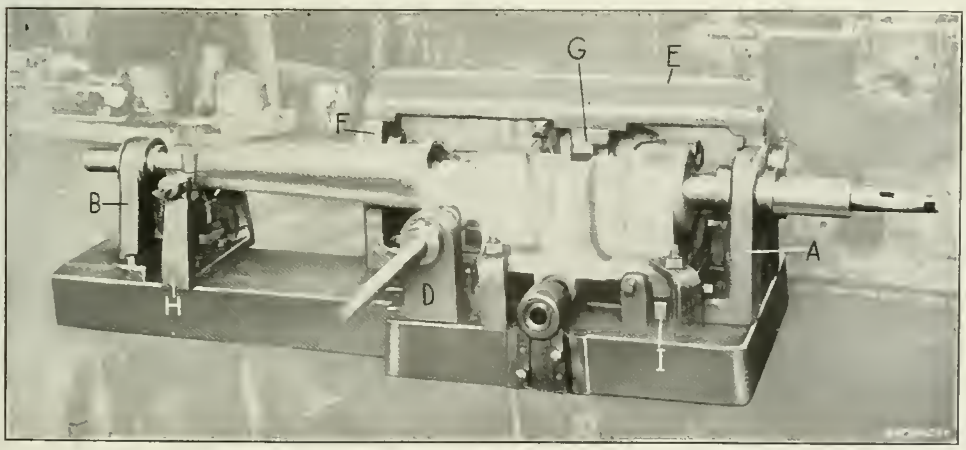


Fig. 3. Boring Jig with Head Casting clamped in Place ready for Boring

This same principle of aligning the brackets applied to a planing jig is illustrated in Fig. 4, the brackets *J* and *K* at each end being bored in a manner similar to those of the jig illustrated in Figs. 1, 2 and 3. The bar *L* is employed to set the casting so that the face to be planed shall be parallel with the axis of the hole in which the bar is placed.

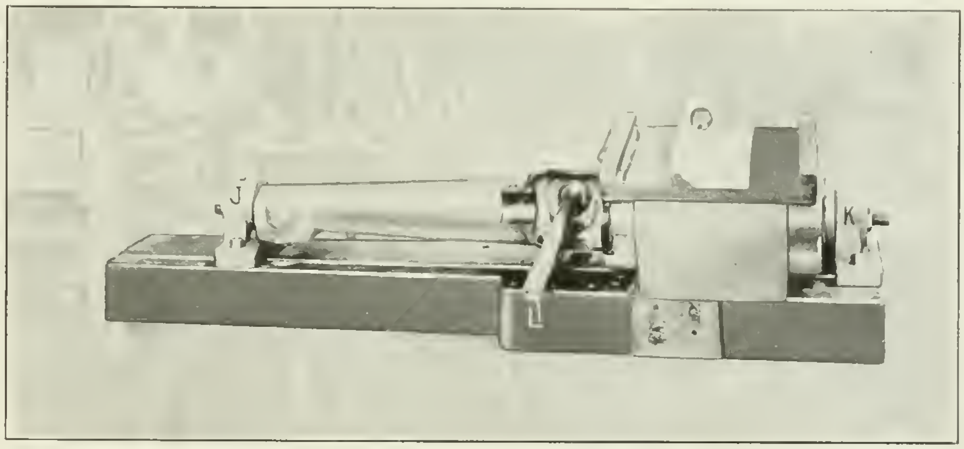


Fig. 4. Planing Fixture for Heads, made on Same Principle as Jig in Fig. 1

* * *

The Hamburg-American liner *Imperator*, for the time being the largest ship afloat, was launched in May at the Vulcan Works in Hamburg. The length of the new vessel is 880 feet and the width, 98 feet. The gross tonnage is about 51,000 tons and the speed at sea will be 22 knots. It is equipped with four classes for passengers and can carry 700 first class, 600 second class, 940 third class, and 1750 fourth class passengers. The crew will number about 1100 so that the total number of persons on board with the accommodations fully used will be about 5100. As an indication of the enormous size of the fittings of the vessel, it may be mentioned that the weight of the anchor and chain is about 225 tons (of 2000 pounds). The diameter of metal in the individual links in the anchor chain is about four inches. One hundred life-boats will be provided on the vessel and the latest design of davits has been adopted. The electric lighting installation includes about 10,000 lamps. The vessel will be driven by four four-blade propellers of 16½-foot diameter, which are driven by steam turbines at a normal rate of 185 revolutions per minute.

* * *

It is a whole lot easier to find fault with a foreman than it is to fill his place.

PROPOSED CHANGES IN PATENT LAWS

Several bills have been introduced in Congress during the present session relating to changes in the patent laws. In one of these, introduced by Mr. Oldfield (House Bill No. 23,417), a number of clauses are included which are of considerable interest, some of which are quoted in the following. Section 17 relates to the term of patents and their compulsory working, and reads as follows:

"Sec. 17 (R. S., sec. 4884). Every patent shall contain a short title or description of the invention or discovery correctly indicating its nature and design, and shall have annexed thereto and made a part thereof a copy of the specification, claims, and drawings of the application therefor, to which it shall refer for the particulars of the invention or discovery, and contain a grant to the patentee, his heirs or assigns, of the exclusive right to make, use, and vend the invention or discovery throughout the United States and all Territories and possessions under the jurisdiction thereof, for the term of seventeen years. But every patent granted for an invention shall be so limited as to expire nineteen years from the date of the filing, in this country, of the application upon which the patent was granted, exclusive of the time actually consumed by the Patent Office or the courts in considering the application, and where the application has been involved in interference, of the actual time in which it has been so involved, and in no case shall the patent be in force more than seventeen years.

"If at any time during the term of the patent, except the first four years, the patented invention shall not be manufactured, or the patented process carried on within the United States, its Territories, or possessions aforesaid to an adequate extent by the owner thereof, or by those authorized by him, then any person demanding it shall be entitled to a license from the owner of the patent to manufacture the invention or to carry on the patented process, unless the owner shall show sufficient cause for such inaction. Upon the refusal of such a license by the owner of the patent, the person seeking such license may apply to the district court, in the district wherein the owner has a residence or an established place of business, to compel the granting of such license. The court shall thereupon hear the person applying for said license and the owner of the patent, and, if the court is satisfied that the reasonable requirements of the public in reference to the invention have not been satisfied by reason of the neglect or the refusal of the patentee, his legal representatives, or those authorized by him to make, use, or vend the invention, or to grant licenses to others on reasonable terms to make, use, or vend the same, said court shall issue an order requiring the owner of the patent to grant a license to the person applying therefor in such form and upon such terms as to the duration of the license, the amount of royalties, security for payment, the period within which the patented invention shall be manufactured or the patented process carried on, and otherwise, as the court, having regard to the nature of the invention and the circumstances of the case, deems just.

"From the order of the district court granting or refusing to grant such a license, appeal may be taken (by the party aggrieved) to the circuit court of appeals in the same manner and form as in other cases arising under the patent laws: *Provided*, That the citizens of any country which by treaty, convention, or law provides that the manufacture of the patented invention or the carrying on of the patented process in the United States shall be equivalent to the manufacture or the carrying on of the process in such country, will be considered to have sufficiently complied with the requirements of this section if the invention is manufactured in said country within the period heretofore mentioned.

"If at any time during the life of a patent a material and substantial improvement shall be patented, the manufacture of which would be an infringement of the original patent, the owner of the improvement patent may apply to the district court in the district wherein the owner of the original patent has a residence or an established place of business to compel the granting of such a license as will enable the improvement to be manufactured. The court shall thereupon hear the respective parties, and if the court is satisfied that the improvement is of such a material and substantial nature that the reasonable requirements of the public demand that it should be manufactured and sold, the court shall issue an order requiring the owner of the original patent to grant a license to the owner of the improvement patent in such form and upon such terms as to the duration of the license, the amount of royalties, security for payment, the period within which the patented invention shall be manufactured or the patented process carried on, and otherwise, as the court, having regard to the nature of the original invention and improvement and the circumstances of the case, deems just.

"From the order of the district court granting or refusing such a license appeal may be taken by the party aggrieved to the circuit court of appeals in the same manner and form as in other cases arising under the patent laws."

Section 19, relating to the conditions under which applications must be made, reads, in part, as follows:

"Any person who has invented or discovered any new and useful art, machine, manufacture, or composition of matter, or any new and useful improvements thereof, not known or used by others in this country before his invention or discovery thereof, and not patented or described in any printed publication in this or any foreign country, before his invention or discovery thereof, or more than two years prior to his application, and not in public use or on sale in this country for more than two years prior to his application, unless the same is proved to have been abandoned, may, upon payment of the fees required by law, and other due proceeding had, obtain a patent therefor."

Section 32, relating to the use of patented articles by persons to whom the patentee has sold or otherwise transferred the right to use or sell the article, reads as follows:

"Sec. 32 (R. S., sec. 4899). Every person who purchases of the inventor or discoverer, or, with his knowledge and consent, constructs any newly invented or discovered machine, or other patentable article, prior to the application by the inventor or discoverer for a patent, or who sells or uses one so constructed, shall have the right to use, and vend to others to be used, the specific thing so made or purchased without liability therefor.

"Any person who purchases of the owner of a patent, or of any interest therein, any machine, manufacture, or composition of matter covered by such patent, shall have the unrestricted right to use, vend, or lease to others to be used the specific thing so purchased without liability to action for infringement; and it shall not be lawful to insert a condition in any contract relating to the sale, lease, or license to use any article or process protected by a patent or patents, the effect of which will be to prohibit or restrict the purchaser, lessee, or licensee from using any article or class of articles, whether patented or not, or any patented process supplied or owned by any person other than the seller, lessor, or licensor or his nominees; and it shall not be lawful to insert a condition in any contract relating to the sale, lease, or license to use any article or process protected by a patent or patents, the effect of which will be to require the purchaser, lessee, or licensee to acquire from the seller, lessor, or licensor, or his nominees, any article or class of articles not protected by the patent, and any such condition shall be null and void as being in restraint of trade and contrary to public policy."

Two bills have also been introduced in The House of Representatives, by Mr. Thayer, being, respectively, House Bill 11,380 and 11,381, differing only in some minor details and in respect to the penalties imposed for violations. These bills would legalize contracts to the effect that users of patented articles must buy all such supplies as are used in connection with the operation of the patented article from the owners of the patent. Bill 11,380 reads, in part, as follows:

"No person, firm, corporation, or association engaged in interstate commerce having any interest, whether as owner, proprietor, beneficiary, licensee, or otherwise, in any tool, implement, appliance, or machinery shall, directly or indirectly, in making any sale or lease of or any license to any article, restrain or attempt to restrain or prevent the vendee, lessee, or licensee from using any tool, implement, appliance, machinery, material, or merchandise not furnished by the vendor, lessor, or licensor, whether by making any condition or provision, express or implied, against such use by a term of any sale, lease, or license to use, or by requiring any obligation, express or implied, against such use from the vendee, lessee, or licensee of the article, or by imposing any restrictions upon the use of the article sold, leased, or licensed, or by making in the price, rental, royalty, or other terms of any such sale, lease, or license any discrimination based upon whether the vendee, lessee, or licensee uses or purchases any such tool, implement, appliance, machinery, material, or merchandise or not, or by any other means whatsoever: *Provided, however*, That nothing in this Act shall be construed to prevent any such vendor, lessor, or licensor from requiring that during the continuance of any letters patent on any such article no component or constituent parts of the tool, implement, appliance, or machine required for use thereon be purchased except from such vendor, lessor, or licensor, or from requiring that material to be used in the operation of any machine must be obtained from the vendor, lessor, or licensor."

* * *

A HANDY SURFACE PLATE

A convenient arrangement for holding a surface plate is used in the shops of the Cutler-Hammer Mfg. Co., Milwaukee, Wis. It consists of a heavily built and well braced table, fitted with good sized castors. The surface plate is supported on this table, which can be wheeled to any point where it may be wanted. Taking the surface plate to the work often eliminates considerable trucking of the work.

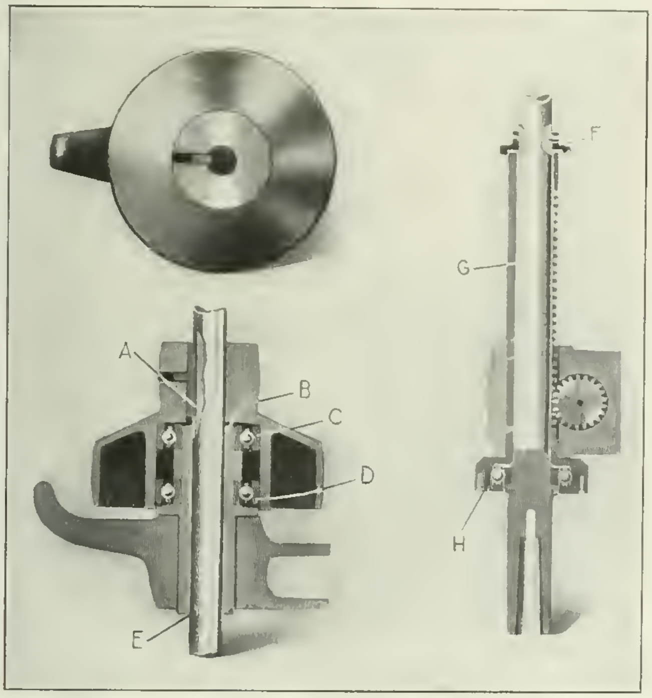
LETTERS ON PRACTICAL SUBJECTS

We pay only for articles published exclusively in MACHINERY

TOO MANY PATENTS A HINDRANCE TO PROGRESS

The article in the May number of MACHINERY on "Too Many Patents a Hindrance to Progress," raises a very interesting question: What is, in equity, a reasonable basis for the granting of patent rights? The writer of the article mentioned uses as a peg on which to hang his argument the granting of patents on the application of ball bearings to sensitive drilling machine spindles, and suggests that such patents would be valueless were it not that the maker's name and position acted as a watch dog against encroachments.

As the article in question hails from England, it appears as though allusion were made to the construction of the Alfred Herbert sensitive drilling machine. If this is so, the present writer has no hesitation in asserting that, although the particular construction of this machine—in so far as the spindle is concerned—entails but a particular arrangement of ball bearings, there exists in this instance extraordinarily good grounds for the granting of a patent.



Sectional Views showing Alfred Herbert Ltd., Coventry, England, Sensitive Drill Ball Bearings—A, spindle centered by this hole; B, fixed sleeve; C and D, pulley bearings; E and G, clearance, no sleeve bearing; F, dust cap, no thrust bearing; H, the only spindle bearing

Novelty is a good basis, and novelty may exist in an arrangement. If mere arrangements are to be barred, then the great majority of inventions could not form suitable subjects for patents. In the drilling machine in question the spindle construction is decidedly novel—nay, more—bold. It is indeed probable that had this particular firm not put this arrangement into use, no one else would have been sufficiently bold to risk such an arrangement. As a matter of fact, ball bearing manufacturers prophesied a failure. The firm, however, in introducing it, knew from experiments that success would be assured; and, after all, if ball bearing manufacturers had but given the matter the careful attention it deserved, their own previous statements would have been sufficient evidence. Most of the catalogues of these firms recommend that journal bearings should not be subjected to more end thrust than 25 per cent of the journal pressure. This statement implies that if a journal bearing be subjected to end thrust only it would be sufficient to choose one large enough, and success would be assured. Here is now an individual who has realized this fact for the first time. Should he be debarred from obtaining a patent? If so, where must a line be drawn, in view of the fact that today the ground of mechanisms has been so covered as to make it almost impossible to invent anything entirely new?

To enable readers to judge of the merits of the case, the spindle construction is shown in the accompanying engraving. The particular advantages claimed are: First, entire absence of journal friction; note the clearance between spindle and pulley support and rack sleeve; second, cheaper construction; any other method of obtaining the same end is only possible by having one bearing to take the thrust from drilling, another to bear the weight of the spindle, and still another for the journal load; third, little necessity for oil beyond the initial supply (grease is used); the makers claim that the machine needs oiling but once a year; fourth, no adjustment necessary, the construction rendering adjustment impossible. Cone bearings—a possible construction—are by no means as efficient, and wear renders some provision for adjustment imperative.

It might be interesting to cite the fact that on machines supplied to the makers of the S. K. F. bearing, these bearings were fitted and were successful. These machines have been on the market now some four years, probably a thousand or more having been turned out in this time. This is in itself sufficient evidence of success.

The following particulars will give some idea of the power of the machine. The spindle, 1 inch in diameter, is driven by a 1½ inch belt. Without appreciable slip, ⅞ inch holes, 1 inch deep, may be drilled in cast iron (hardness: 238 Brinell) at 600 revolutions per minute in four seconds; and in machinery steel (52,000 pounds tensile strength) at 900 revolutions in 7 1/5 seconds. The accompanying table shows the complete range of the possible output:

The writer, who has had the pleasure of operating one of these machines, can assert that in drilling holes up to about ½ inch diameter, no matter what amount of weight is applied at the lever, it is impossible either to break a drill or slip the belt. In the case of the larger holes, the belt is the limiting factor, but then a machine designed to drill ⅞-inch holes at the same rate as ¼-inch holes, could no longer be termed a sensitive machine. If made for ⅞-inch holes, it would be too cumbersome for ¼ inch. If it were not for the belt slipping, the journal "thrust" bearings would probably fail on the larger holes.

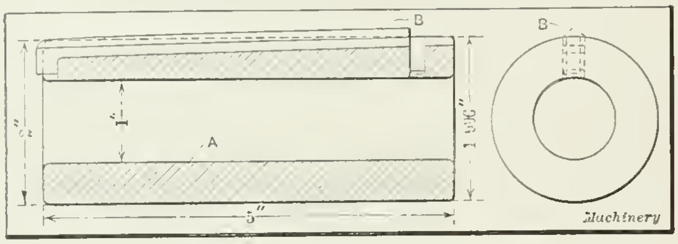
TABLE OF TIME FOR DRILLING ON ALFRED HERBERT SENSITIVE DRILLING MACHINES

Cast Iron			Machinery Steel		
Diameter of Drill	Speed of Drill	Time to Drill 1 Inch Deep, Seconds	Diameter of Drill	Speed of Drill	Time to Drill 1 Inch Deep, Seconds
¼	2050	1⅕	¼	2050	2⅖
⅜	900	2	⅜	900	3⅖
½	900	2	½	900	4
⅝	600	2½	⅝	900	5⅗
¾	600	3	¾	900	6
⅞	600	4	⅞	900	7⅕

Didsbury, Manchester, England. FRANCIS W. SHAW

BABBITT EXPANDER AND OIL-GROOVE FORMER

Considerable trouble is met with in babbitting solid bearings when a shaft or mandrel is used as a core. When babbitt is cast around a mandrel it shrinks and grips the latter, at the same time becoming loose in the casting. In order to overcome this difficulty and at the same time provide for an oil groove in the babbitt lining, the device shown in the accompanying illustration was made. It consists of a piece of machine steel *A* which is turned and bored to the dimensions indicated, one end being 0.004 inch smaller in diameter than the other end, so as to make it easier to knock it out when fast in the babbitt. The so-called expander *B* is a piece of ¼-inch square key steel, bent over at one end, and having an angular top of about 90 degrees included angle. This piece fits loosely in a milled slot in the sleeve *A*. The device is used as follows: A 1-inch shaft is placed through the hole in the sleeve, and the sleeve with its key is turned on the shaft until the key is in the position where the oil groove is required in the babbitt bearing. Now cast the babbitt around this sleeve and when it has set and tends to shrink away from the casting, pull the sleeve with its key out toward the left. The babbitt is then compressed upward and sideways by the key, as it passes toward the left, just enough to force it firmly into the cast iron surrounding it. J. S. B.



A Babbitt Expander and Oil-groove Former

FIXTURE FOR FACING GAS ENGINE CYLINDERS

The fixture shown in Fig. 2 is fitted to a drill press and is used for finishing the inside face *A* of the boss of a gas engine cylinder as shown in Fig. 1. This face *A* is located in such a position that it is difficult to machine, and it is impossible to do so with a side milling cutter, so some other means had to be provided to accomplish the work. About ⅜ inch of material is to be removed from the boss.

Referring to Fig. 2, the frame of the fixture *A* is clamped to the spindle sleeve of the drill press by two bolts which are inserted through the holes in the upper part of the frame. The bar or spindle *B* is provided with a Morse taper shank which fits in the spindle of the drill press and is driven by it. The lower boss of the bracket *A* is bored out in line with the spindle of the drill press, and is bushed with a hardened and ground steel bushing *C*. Inserted in this bushing *C* is another hardened and ground bushing *D* which is prevented from rotating by means of the screw *E* fitting in the keyway cut in the bushing. Inside of the bushing *D* is a cam *J*, which is a good running fit on the bar *B*. This cam is provided with a spiral groove having a lead of ¾ inch to one turn. Fitting in the spiral cam groove is a screw *F* screwed into the bushing *D*. To locate this screw in the bushing *D*, a hole *K* is drilled in the bracket through which the screw is inserted; then the bushing is rotated through an angle of 90 degrees to bring the screw into the position shown in the illustration. The lower end of the cam *J*, which is cylindrical in shape, rests on the top face of the cylinder casting and is operated by means of a handle *G* screwed into it. A thrust ball bearing *H* is interposed between the top face of the bushing *D* and the shoulder on the bar *B* to reduce the friction between these surfaces.

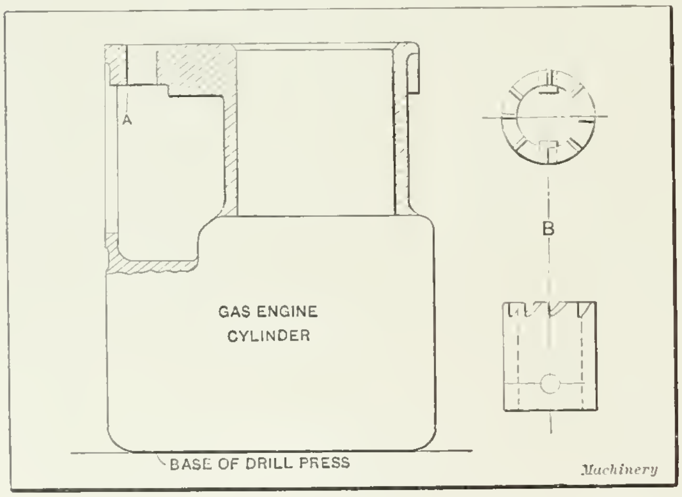


Fig. 1. The Gas Engine Cylinder and the Cutter used in Facing the Boss

In operation, the spindle of the drill press with the fixture attached to it is lowered until the spindle *B* is located in the hole in the cylinder casting. Of course the cutter cannot be placed on the spindle *B* until the latter is located in the hole in the casting. When this is done, the cutter, as shown at *B* in Fig. 1, which is provided with two pins is slipped onto the end of the spindle *B*, the pins fitting in vertical grooves cut in the spindle. These grooves terminate in additional grooves, cut part way around the circumference, so that it is a simple matter to push up the cutter, turn it around, and thus lock it in position. These grooves are cut in such a manner that the cutter when in operation will be held securely.

When the cutter *I* is put in position on the spindle *B*, the operator grips the handle *G*, turning the cam in the direction indicated by the arrow. This movement of the cam imparts an upward motion to the bushing *D*, which, in turn, raises the spindle *B* and also the spindle of the drill press and the fixture which is attached to it, the spindle being disconnected from the worm. This action brings the cutter in contact with the work, when the boss can be faced to the desired distance by simply continuing the movement of the handle *G*. The idea in designing a fixture of this type was to equalize the pressure on the casting while the facing operation was being performed. By constructing the fixture in this manner, the whole weight of the fixture is thrown down upon the bottom of the cylinder, so that the action of the cutter up against the cylinder causes an almost equal and opposing force at that point.

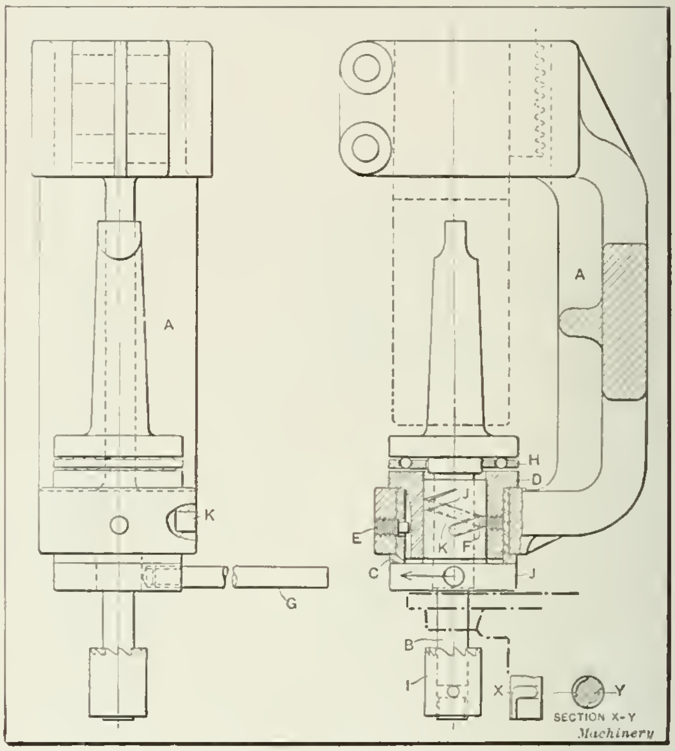


Fig. 2. The Fixture used in Facing the Boss, showing the Manner in which it is applied to the Drill Press

Detroit, Mich. Walter F. Wagner

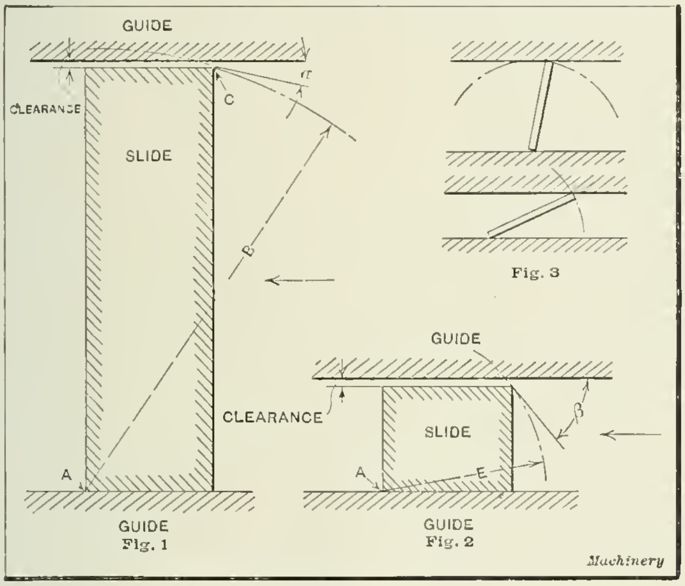
WIDE VS. NARROW GUIDES

The writer has been greatly interested in the discussion of wide versus narrow guides and believes that the ground has not yet been quite covered. Personally, he cannot agree with the conclusions of either Mr. Burley or Mr. Millar, and must endorse the view expressed in the editorial note on the subject accompanying Mr. Burley's article in the April number. Of course one must concur with some of Mr. Millar's remarks, as for example, his conclusions Nos. 3 and 4, but the conclusions Nos. 1 and 2 the writer does not think are yet proved, still holding the idea that the advantages to be gained by a narrow guide are a direct function of the relation of the slide's width to its length. His reasons for so thinking are substantially those advanced in the editorial note just referred to.

Perhaps the accompanying illustrations will make the idea plainer and introduce one element not yet touched upon, and upon which perhaps the whole matter hinges. When a slide advances between parallel guides, cross-wind may be caused by an obstruction to one edge of the slide or by the eccentric application of the propelling force. The simplest case of an obstruction would be some grit at one edge of the slide as at *A*, Figs. 1 and 2. That edge is retarded and the diagonally opposite corner at once rises the clearance distance and strikes the guide. In other words, the slide in Fig. 1 when retarded at *A* tends to rotate with point *A* as a center, and the edge *C* describes a circular path with a radius *B*, the action being limited by the amount of the clearance.

Assume that the wide and narrow guides in Figs. 1 and 2 have the same clearance; when the point *C* of the wide guide approaches the upper guide it will do so along a certain arc, as illustrated in Fig. 1. By drawing a tangent to this arc at its point of intersection with the line of the upper guide, we form the angle α (see Fig. 1) or β (see Fig. 2) which angle may be called the "angle of approach." This angle determines the binding effect. If the angle is small, as seen in the wide guide, the friction becomes great, but if the angle is large, as in the narrow guide, the binding effect is minimized. It is really a toggle action in an unusual form. In Fig. 3 is shown a bar or gage between two walls. The binding effect is greatest when the bar can be placed in a nearly vertical position between the guides, as in the upper part of Fig. 3, while the binding effect is practically nil when the bar is at an inclination as shown in the lower part of Fig. 3. The writer believes that every mechanic who has noted the ease with which a plug gage, say ½ inch in diameter, 1 inch long, can be inserted in a hole and pushed along it, and who has also noted the extreme difficulty experienced when the gage happens to be of the same length, but say about 6 inches in diameter, will agree that the theory just presented is borne out by practice. S. M. Ransome

Cleveland, Ohio.

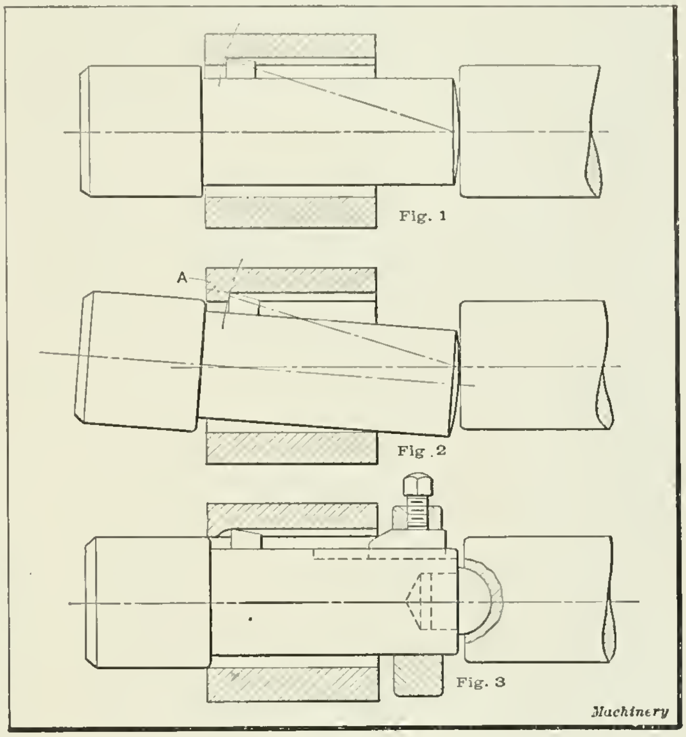


Figs. 1 to 3. Diagrammatical Views illustrating the Action of Slides having Wide and Narrow Guides

CUTTING OIL-GROOVES IN BUSHINGS

In the article entitled "Cutting Oil-grooves in Bushings," published in the May, 1912, number of Machinery, an appliance similar to one which the writer saw a few years ago, but which proved to be a failure, is illustrated and described. The construction of the appliance seen by the writer is indicated in Fig. 1. This device was arranged to be used on a turret lathe, the cutter and holder being pressed in by a plain bar fixed in one of the turret holes. Instead of operating as intended, however, the shank assumed the position shown in Fig. 2 immediately after the guiding part of the cutter holder had passed out of the bushing. The cutter, instead of slipping out of the work, would proceed to cut a groove, the bottom of which would be at an angle as indicated by the dotted line *A*.

Now, even if the end of the shank had been flat instead of rounded, the cutter would not have left the work, but would have proceeded to cut the groove clear through. An examination of Fig. 1 will show that the cutting face of the cutter cannot possibly come out of the groove, as it is in effect undercut in relation to the path of its travel when retreating from the groove, as indicated by the circular arc shown. In order to try to improve matters, a ball and socket joint and an adjustable wedge, as shown in Fig. 3, were fitted, with the idea of compelling the cutter to leave the groove. This arrangement was fairly successful, but owing to the fact that the tool was so short, considerable force was needed, tending to damage the mouth of the hole.



Action of Device for Cutting Oil-grooves in Bushings

Another point that might be mentioned is that the tool as shown in Fig. 1 began to tilt long before the guiding portion left the hole, and the back end of the hole was, therefore, somewhat mutilated.

The writer would like to know if your former contributor had to use any special appliances in order to insure success in his arrangement. The device shown in the accompanying illustration was abandoned and substituted by a simple slotting operation in an ordinary slotting machine. Slotter

SPHERICAL TURNING DEVICE

The lathe attachment shown in the accompanying illustrations, Figs. 1 and 2, and described in the following, has given good results for a long time. It was designed for the requirements met with in turning balls or other spherical parts which must have accurate dimensions, an operation which is rather difficult to carry out by hand. The appliances on the market for the purpose failed to give accurate results. The device shown is strong and capable of producing a practically

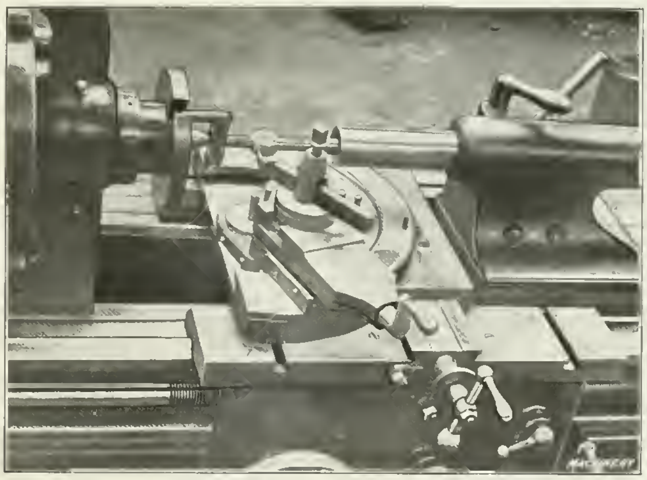


Fig. 1. Spherical Turning Device for Accurate Turning

exact sphere. It is applied to an 18-inch Hendey-Norton lathe.

In Fig. 2, *B* is a cast-iron plate which is fixed directly on the dovetail slide of the lathe carriage by means of taper gibs *C*. The dovetailed groove of the plate *B* has parallel sides, and the two taper gibs, which have the same amount of taper, are introduced one from the front and the other from the back, so as to compensate for the taper. By being attached in this way, plate *B* rests rigidly on the carriage and can be fitted and taken out very easily, or adjusted to any position of the dovetailed guide. On plate *B* is fitted and rotates the turntable *D* provided with a dovetailed groove for the toolpost *P*. The turntable rotates on pivot *E*, which is fixed to plate *B* by four screws. The turntable is also guided by a circular gib *F*.

A circular rack *G* is fixed with screws in a groove provided for it; this groove is protected from chips as indicated. Rack *G* meshes with gear *H* which is fastened by a key to a worm-wheel which, in turn, is carried by shaft *I*. Plate *B* is also provided with two brackets carrying the screw *L* of the carriage. This screw meshes with the worm-wheel to which the bevel pinion *H* is fastened. The circular movement of turntable *D* is thus obtained from the carriage screw *L*, and, as this screw, through the design of the lathe, is provided with several speeds, a suitable feed can also be chosen for the spherical attachment. Stops *M* and *N* are provided in order to prevent the turntable *D* from swiveling too far. Felt packing is used to keep the working surfaces clean and free from dirt and chips. The pivot *E* has a hole in the center which is carefully ground to fit pin *O*. This pin is used for rapidly locating the carriage with relation to the center of the ball to be turned. It can be withdrawn during the operation. If particularly accurate results are required, the rotating axis of the fixture must intersect the axis of the lathe spindle. The fixture is then first located by means of pin *O* and may be adjusted by subsequent trials until a perfect sphere is formed. The form and position of the tool have no bearing on the accuracy of the work.

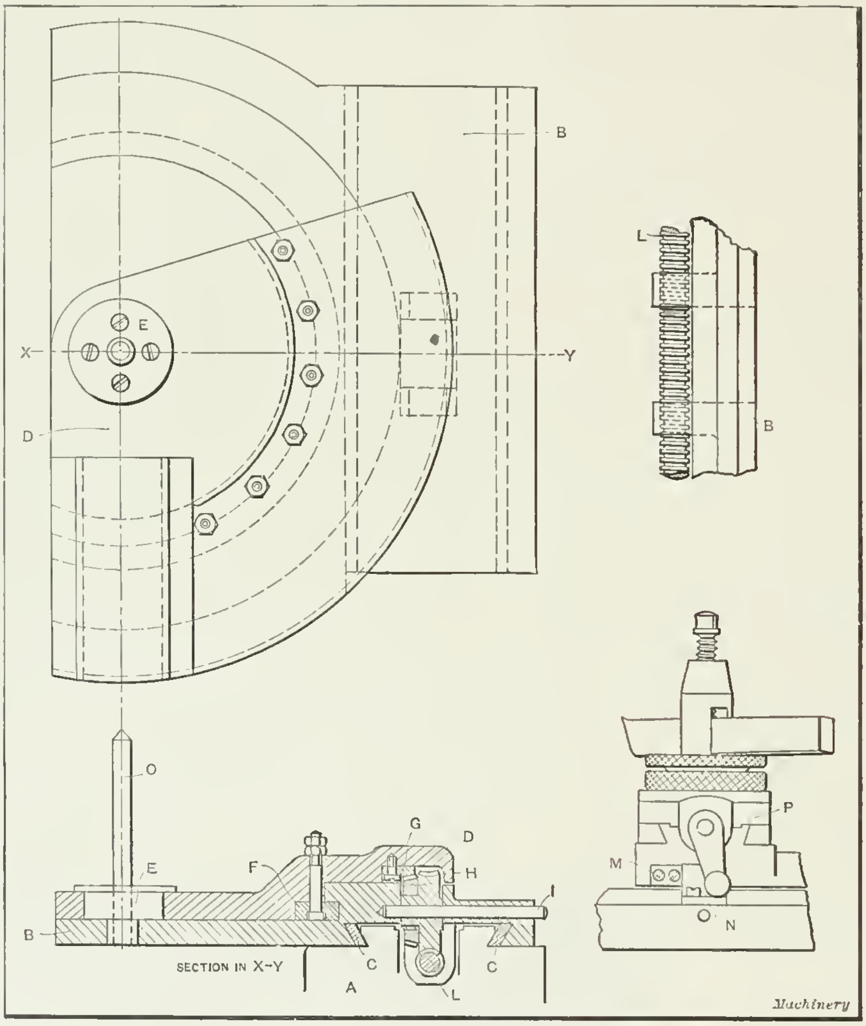


Fig. 2. Design of Spherical Turning Device

By moving the axis of the fixture in or out from the axis of the lathe spindle, circular surfaces such as rims of handwheels, faces of worm-wheel blanks, and similar work, can be turned. Work turned by this fixture can be finished in the same time as would be required for plain turning, and the design of several pieces has been modified so as to be turned by this fixture in order to obtain a more finished appearance.

Turin, Italy. C. Boella

OBSERVATIONS ON GEARING

In the April number of Machinery Mr. F. D. Buffum alludes to the necessity of proportioning gear teeth not merely to resist the load stresses which tend to cause breakage, but also to provide against excessive wear under continuous loads. He also asks for information relative to steel gears which are continuously transmitting the loads allowed by the Lewis formula.

During the writer's experience in designing gear mechanisms as embodied in geared heads and feed motions, there has not been a single case where steel gears running together have proved successful at tooth velocities exceeding about 400 feet per minute. A few have given trouble at even a lower speed, although in these cases the holes were hardened, ground and lapped to prevent the wear of the shafts upon which they rotated, and the gears were running in oil. In many cases the material had been changed on account of unsuccessful results.

It may be of interest to relate how one failure was dealt with. The mechanism consisted of a cone of gears driven from a long pinion through an intermediate gear—the usual tumbler gear arrangement. The long pinion was of 0.50 carbon steel; the intermediate and cone gears of 0.30 carbon steel, and soft. The whole gear mechanism was splash lubricated and the workmanship was good. Trouble first arose from the rapid wear of the tumbler gear, the only gear in continuous service. This was replaced by a casehardened gear which quickly "chewed up" the long pinion which was integral with the shaft and, therefore, could not be easily hardened. The material of the tumbler gear was then changed to phosphor-bronze, but the steel gears now wore out the phosphor-bronze gear. The final solution lay in making the tumbler gear of malleable cast iron, the idea being to provide a material somewhat more durable than phosphor-bronze but not as hard as the casehardened gear. The greasy nature of malleable cast iron probably also influenced the result.

In ordinary cases—cast iron to cast iron, or dissimilar metals, splash lubricated—the theoretical width of the face of gears as required by the Lewis formula has sometimes been cut down as much as 30 per cent. In these cases the tooth stresses have been calculated from the power delivery capacity of the belt under high tension (80 pounds per inch of width) and not from the amount of power actually delivered, which would probably not exceed more than one-half of the belt capacity. In cases of a "jam," the stresses are not always as great as might be imagined, for the reason that the shafts yield torsionally to a considerable extent, and thus relieve the stresses which would otherwise be borne by the teeth.

As regards shaft center distances, the writer does not agree with the statement that a small increase over the theoretical distance is of any great importance. In certain experiments made by the writer in which two gears of different diameters were mounted in such a way that the center distance could be varied to test the comparative noise developed at different center distances, it was found that in the case of eight-pitch gears, a closing up of the center distance of about 0.005 inch made no appreciable difference; beyond this point, owing to the jamming of the teeth, the noise increased considerably. Increases in the center distances above nominal up to about 0.125 inch also made no appreciable difference, but after this point the noise gradually increased up to the point of separation of the teeth. It is presumed that noise is a good index of the amount of wear. Backlash is of little importance if the load is continuous and not reversible.

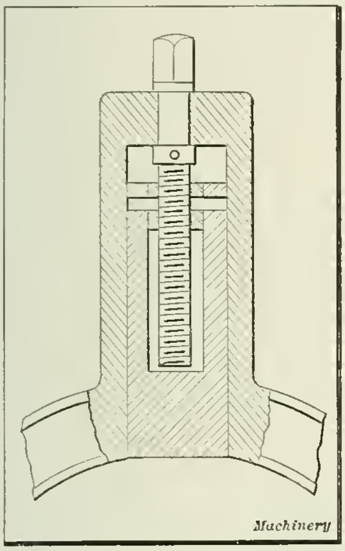
As regards the comparative values of spur, bevel and worm-gearing, the writer would put spur gearing in the first place, unless the worm-gearing be so designed that the pressure angle is of maximum efficiency and the material the most suitable for the purpose. Either spur or worm-gear drives, however, are preferable to bevel gears. Difficulties in cutting accurate bevel gears, the unbalanced area of the tooth surface, the difficulties in setting to the correct pitch cones, all tend to prevent their successful application.

Didsbury, Manchester, England. FRANCIS W. SHAW

A LATHE STEADYREST OF UNCOMMON DESIGN

In the April number of MACHINERY, Mr. H. Terhune describes a steadyrest which the writer thinks impracticable. The writer does not understand the method of obtaining the chamber or body size hole in the jaw, or the method of assembling the screw with the top of the rest. The design is also rather expensive. The accompanying engraving shows a design which would entail the least expense, although even this construction should be used sparingly, as it will be found quite expensive.

Dexter, Me. E. W. TATE



Improved Design of Lathe Steadyrest

[Without entering into any discussion of the relative merits of the designs presented, it is safe to say that lathe manufacturers could undoubtedly afford to give more consideration to the design of steadyrests, even if the cost should be increased thereby. The steadyrest constitutes an important part of the lathe equipment, and if its efficiency can be increased, the comparatively slight increase in cost should not be begrudged.—EDITOR.]

TO FACILITATE THE GRINDING OF FORMING TOOLS

Figs. 1, 2 and 3 illustrate the methods which are most commonly used for making circular form tools. The saw cuts in the form tool, Fig. 1, are intended to relieve the strains due to hardening. Before this cutter can be used, however, the portion indicated by the dotted lines must be ground off. The method described by the writer in the following is intended to facilitate this operation.

The formed surface of a circular tool must be polished to remove the scale if good results are desired. For this reason most form tools are made as shown in Fig. 1, and after the cutter is hardened and polished, a cut, as shown in Fig. 2, is ground into the cutter, after which the cutter is ground as indicated by the dotted line to the appearance shown in Fig. 3. A wide tool made in this manner will require several hours for grinding in order to remove the metal without drawing the temper of the tool. On the other hand, if the tool was originally milled before hardening, as shown in Fig. 3, it would be almost impossible to polish the tool after hardening.

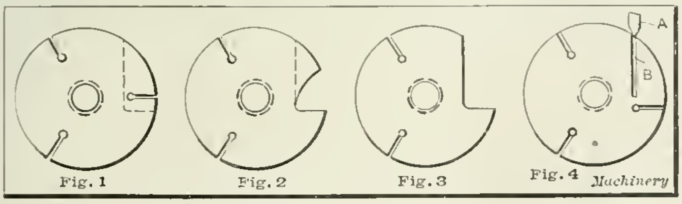


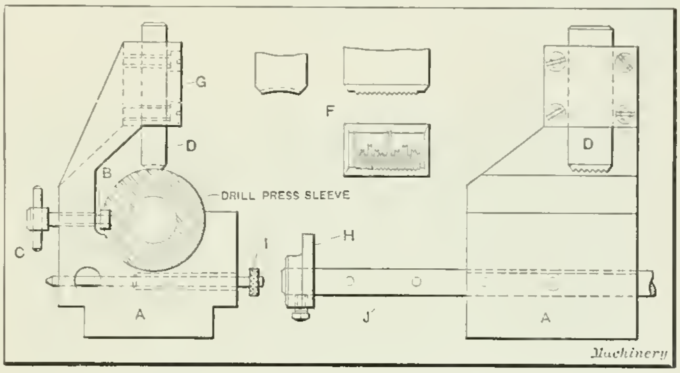
Fig. 1 Fig. 2 Fig. 3 Fig. 4

Figs. 1 to 4. Various Methods of Making Forming Tools

The simplest and most effective means for overcoming this difficulty is indicated in Fig. 4; this will save considerable expense in the making of circular form tools. The cutter is made with an extra slot, as shown, and after the tool is hardened and polished, the piece *B* is easily broken out, without injury to the cutter, by driving in a wedge as at *A*. The cutter may be held in a bench vise and only a slight tap of the hammer is necessary, after which the cut can be quickly finished off with an emery wheel. S. NEVIN BACON

GRADUATING DRILL PRESS SLEEVES WITH A STAMP

The accompanying illustration shows a device which was used satisfactorily for graduating a drill press sleeve with a stamp. The device consists mainly of a casting *A* which is machined out to fit the drill press sleeve. The sleeve has a spline in which the block *B* is held by the screw *C* for retaining the sleeve in the correct position. The stamp *D*, also shown enlarged at *F*, is made to graduate 1 inch, the graduations being 1/16 of an inch apart. The stamp *D* is held in a slot in the fixture by means of a cap *G* and screws as shown.



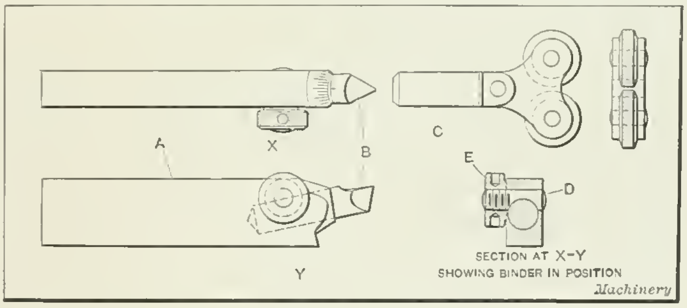
A Device for Graduating Drill Press Sleeves with a Stamp

In operation, the drill press sleeve is placed in the fixture and the end of it brought up against the stop *H*. The stamp is then given a blow with a hammer, after which the spring plunger *I* is pulled out allowing the rod *J* carrying the stop *H* to be shifted to the next hole. The spring plunger is now inserted, the stamp struck and the preceding operations continued until the sleeve is graduated to the desired distance.

J. S. B.

UNIVERSAL KNURLING AND TURNING TOOL HOLDER

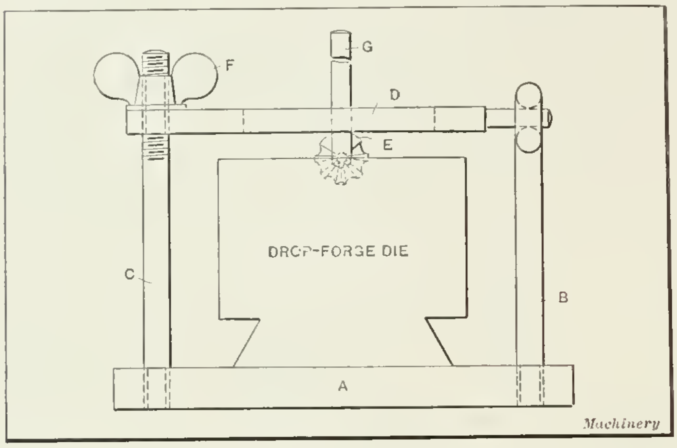
The accompanying illustration shows a handy and useful knurling and turning tool holder, designed by a fellow workman for toolmakers' or mechanics' use and especially for those employed in experimental work. This device consists essentially of a holder *A* in which the turning tool *B* or knurling tool *C* can be held with the clamping screw *D* and clamping nut *E*. The turning tool is made from drill rod or from high-speed steel if preferred, and is cut off and ground to the required shape. It will be noticed that the hole in the front end of the holder is inclined at an angle



A Universal Knurling and Turning Tool Holder with the base of the holder, the purpose of which is to obtain a positive rake on the turning tool for steel, etc. A holder containing a single roll knurl can be made and inclined in either direction at any angle with the axis of the work; for this purpose the front end of the holder is graduated in degrees, as shown in the illustration. The knurl-holder shown is supplied with two knurling rolls. C. F. S.

A CHERRYING FIXTURE FOR A DROP-FORGE DIE

The accompanying illustration shows a fixture which was designed for cherrying a hole in a drop-forge die. The hole to be produced is full at both ends, as indicated in the illustration, so that an ordinary milling cutter could not be used for producing it. The hole to be cherried is first chipped out as near as possible to the required shape, care being taken to leave an equal amount of metal on both sides of the hole to prevent the cherry from "crawling."



A Cherrying Fixture for a Drop forge Die

The drop-forge die is placed on the bed *A* of the fixture, which is provided with two studs *B* and *C*, and a strap *D* is used for applying pressure to the cherry *E*. The stud *B* has an eye-bolt on its upper end, and the strap *D* is turned down to fit it. The bolt *C* is threaded to fit a wing-nut *F* which is used in connection with the strap for applying pressure to the cutter, the cherry being worked back and forth by means of the handle *G*. The cherry or cutter *E* is provided with teeth cut both right- and left-hand, starting from the central tooth. The handle *G* is driven into a hole drilled in the cherry. C. H. Wilcox

Springfield Mass.

BEATING THE SWEDISH GAGES

In relating the following incident, I ask the readers' indulgence for not giving names, as I fear that my reception at the works where the thing happened might not be as pleasing the next time I call, should I disclose too many of the true facts in the case.

Not long ago, a well-known company producing a very fine quality of machine work, got the improvement "bug" in its head and threw out some fair machinery in order to put in the very latest types. The result of this improvement proved quite satisfactory, and the quality of the product improved correspondingly. In showing the customers through the remodeled plant, much stress was placed upon the high-class workmanship obtained by the use of the new machines. All visitors were duly impressed with the fact that the shafts were right up to their correct diameters, that the holes were just right for running fits, that plane surfaces were spotted all over with contact spots, and that every piece interchanged with every other. The general manager was usually doing the showing around, and he did not look sorry to see the president loom up in the distance and join the group. Indeed the latter person was also duly impressed with what he was shown.

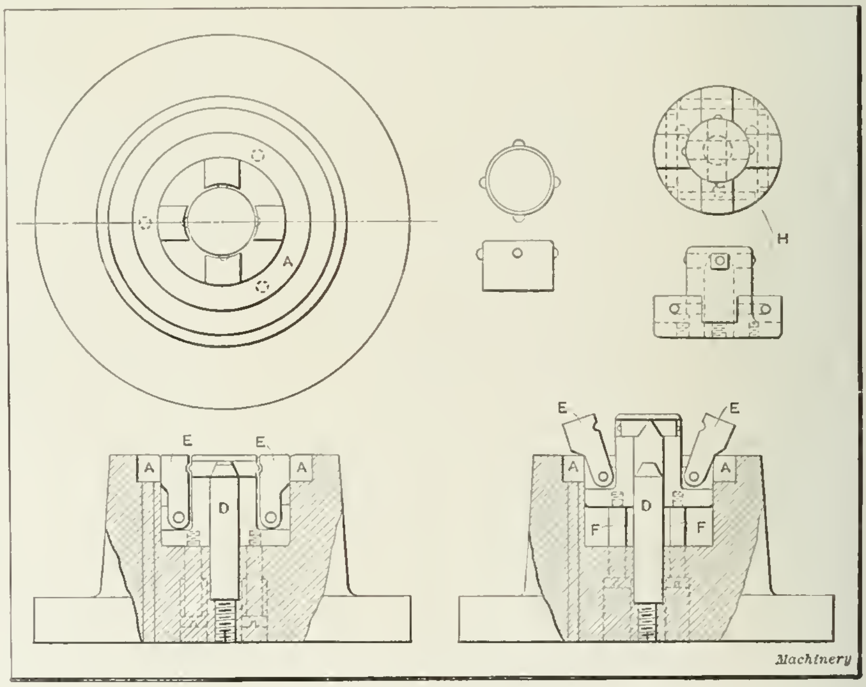
One day as the manager took a little group of visitors—prospective customers—through the plant, the climax was reached when he picked up some hardened and ground steel rings. He piled five or six on each other, in an absent-minded way, and was probably as much surprised as his visitors when he found that the surfaces were so perfect that he could lift the whole pile by the top ring. He instantly realized that this "beat the Swedish gages all hollow," and so he took full advantage of the situation, and puffed to a great extent.

A few days later he started to show another visitor this fine work, talking loudly and impressively about it, but, lo! there was "nothing doing," for just the top ring remained in the manager's hand as he lifted it up, while the others were left "peacefully at rest" upon the bench. Evidently these rings were not as well ground as the previous lot, and he asked the grinder hand why they were not as carefully ground as the lot that were lying on the bench a couple of days ago. The grinder hand claimed that he had ground but one lot of rings, and that, undoubtedly, the rings now lying on the bench were the same as the ones that had been there a few days ago. There was an old hand around the shop, however, who had seen the manager grow up in it, and had never been able to get over calling him "Jimmy," and he offered the explanation: "Well, I nearly died laughing to see you showing up the fine work of the grinder to that crowd. It did look good, sure, but it was not the grinder but the magnetic chuck that should have had the praise for the job." W. D. F.

TOOLS FOR RAISING LUGS ON SHELLS

The accompanying engraving shows a method for shaping half-spherical lugs on brass shells. The lugs were to be in an exact position in order to engage with grooves in a mating part. The method proved very successful and may be of interest to others.

A ring *A* is turned, hardened, and ground, and driven into a cast-iron bolster. The upper inside corner of the ring is well rounded. In the center of the device is provided a holder for the brass shells, this holder being shown in detail at *H*. Four square holes are provided in the upper part of the holder for the punches with half-spherical ends which form the lugs. The punches are a good sliding fit in these holes, and are tapered at the back end and expanded by means of plunger *D*, which is the shape of a truncated pyramid on the end. This piece is hardened and driven lightly



Method of Producing Half-spherical Lugs on Small Brass Shells into the bolster, and adjusted by means of a screw from the bottom. The four jaws *E* are attached to the central holder and secured by a plain pin. They are hardened and polished on the outside. The central holder is a sliding fit in the bolster and is raised by means of three springs beneath it (not shown), the limit of the movement being governed by the screws *F*. The two positions of the jaws and punches shown indicate clearly the operation of the device. When the jaws are in the outward position, after the lugs have been formed, the shell may be removed. The removal of the shell pushes the small punches in flush with the holder, which is then ready for the next shell. Any plain, flat punch may be used in the press. J. Gallimore

Meriden, Conn.

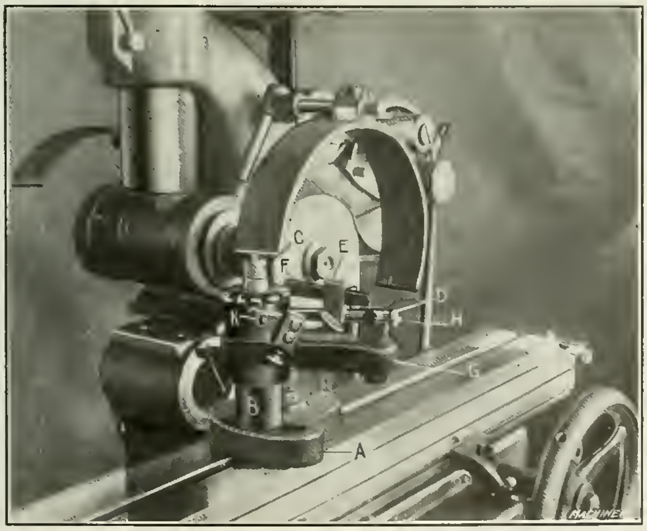
STANDARDIZATION OF GRINDER SPINDLES

The other day the writer overheard a manufacturer saying: "If the grinder spindles only were alike, how much it would save." Quite a number of different makes of machines for rough and finish grinding were used in this shop. If both roughing and finishing grinding is to be done on the same machine, it is necessary to carry a full set of wheels for each machine. On account of the different sizes of the spindles, this requires quite a large investment in emery wheels and considerable storage room for the wheels as well. Standardization with respect to the grinder spindles, especially in the larger types of machines, would be of considerable value. The change may involve some trouble to the machine manufacturers, but, when the necessity is realized—in other words, when the buyers "holler" loud enough—this change will, undoubtedly, come about. J. M. Henry

New Britain, Conn.

A GRINDING ATTACHMENT

The grinding attachment shown in the accompanying illustration is intended for correcting errors in forming cutters caused by the hardening process. It is often said that when forming cutters are ground, they must not be indexed from the back of the tooth, because this does not give equal spacing. Now, we do not really care for equal spacing; what we want is to have all the teeth of the same length. In hardening, the cutter loses its shape, and the teeth become of different lengths, but the error can usually be easily corrected. On gear-cutting machines one tooth of the cutter often does all the work. The arbor is frequently blamed for this, but in most cases it would be found that one or more teeth are too long. These long teeth should be ground on the face until the teeth are all of equal length, as tested by an indicator, with the cutter on a mandrel between centers. This grinding will produce an uneven spacing, but it will produce a cutter where all the teeth will cut, and the cutter will remain in this condition, practically, until worn out.



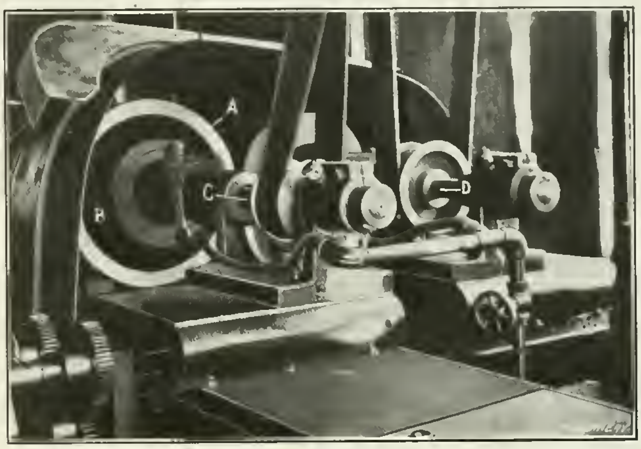
Attachment for Grinding Form Milling Cutters

The device shown in the illustration can be used on almost any cutter grinder. It takes but a short time to set up and gives satisfaction. The construction of the device, which might be varied to suit individual conditions, is apparent from the illustration. It consists principally of a base *A* to which is fitted an upright stud *B*, turned down at its upper end *C* to take the cutter. On the stud is also mounted a collar having an arm *D*. To this arm is clamped a bracket *E* into which is inserted the spring *F* which acts as a stop against the back of the tooth. The arm *G* is fastened by a set-screw to upright stud *B*, and, by means of adjusting screw *H*, the arm *D* with spring *F* can be slightly adjusted, relative to the fixed parts of the device, so that the cutter tooth can be gradually fed in towards the grinding wheel. A gage *K* is clamped to the device in such a manner that it will just touch the top of the tooth when this is of correct length, and by means of this the length of the teeth can be accurately measured. The whole device is simple, but it is possible, by means of it, to grind each tooth independently of the rest, gaging each in turn to make sure that they are all of correct length.

Nashua, N. H. Charles E. Jacobs

SIMULTANEOUSLY GRINDING INTERIORS AND EXTERIORS OF RINGS

In building the Dayton swaging machine, the Excelsior Needle Co., Torrington, Conn., grinds all hardened parts that are to serve as bearing surfaces in connection with the operation of the machine. The machine shown in the accompanying engraving was improvised to grind the interior and exterior of the steel ring that is forced into the head of the swaging machine. It is essential that the interior and exterior of the ring be true with each other; therefore, both of these surfaces are ground at one setting of the work. The ring, shown at *A*, is soldered to the special faceplate *B*. The wheel for grinding the interior of the ring is mounted on spindle *C*, while the wheel for the external grinding is mounted on spindle *D*. These spindles are mounted upon carriages on the same cross-slide and are driven in the usual manner. Provision is made for cooling the work at each of the cutting points. The method has proved very satisfactory. C. L. L.



Method of Grinding Interior and Exterior of Swaging Machine Rings Simultaneouely

TAPS AND THEIR WORK

Though many of the questions in connection with taps and their work have been decided, and admit of no discussion, some points still remain on which a diversity of opinion exists. These should be rapidly reduced in number when investigators are not only willing to build testing machinery and carry on expensive tests, but freely give the world the benefit of the results of these investigations. The article on "Taps and Tapping" which appeared in the April, 1912, number of Machinery reflects credit on the investigators, but the writer would like some further information.

If but fourteen taps were used in obtaining the data presented in Table 1, it is not at all surprising that the amount of power consumed increased rapidly after tapping the two crucible tool-steel nuts. It will be seen that the second nut of this metal required more power than the first in more than half of the fourteen cases. In other words, the taps dulled rapidly. The same holds true in the case of the phosphor-bronze nuts. Hence, it seems that the comparison between the power consumed in tapping hexagon drawn brass and that consumed in tapping phosphor-bronze is scarcely a fair one, as the tap gradually becomes dull. While it may be said that tapping ten nuts need not make much difference with a tap, the figures given show an average increase of power consumed by the second nut tapped in each kind of metal.

It is interesting to note the reduced amount of power consumed by tap No. 10 in tapping its second nut in both the third and fourth metals tapped, and the increase of 65 per cent in the case of the second phosphor-bronze nut. The hexagon screw stock seems to require less power for tapping in the case of the second nut, but for steel the average is slightly greater for the second nut. From these irregular results it would seem that such experiments should include scores of taps and hundreds of nuts, in order to reduce the effect of such amounts of power as are consumed by taps Nos. 8 and 10.

The fact that decreasing the diameter of the hole to be tapped by a ½-inch tap from 0.425 to 0.400 inch increases the amount of power consumed about 100 per cent, is not surprising, as the amount of metal removed is, thereby, also increased nearly 100 per cent, and the chance of clogging the flutes is very much greater, as we have less room in which to take care of nearly double the amount of chips.

Could not someone who has the facilities for carrying on tests of this kind also let us know the amount of power consumed in removing the metal from a thread groove under conditions as similar as possible to tapping, but with the wedge and chip-choking elements eliminated? Comparison between the amount of power consumed in tapping and in cutting threads externally would also be interesting. Has not the large amount of tool surface in contact with the work and the ever-present tendency to wedge a great deal to do with the amount of power consumed by the taps?

As a cutting tool a non-relieved tap is not an inviting proposition, but when a tap must be reversed a relieved land is supposed to gather small chips and thus dull and even break the teeth. Most tap makers avoid the tendency to wedge by making their taps slightly "reverse" taper. A reverse taper tap cannot do perfect work, but the very slight inaccuracy of thread angle caused by the reverse taper used is in most cases negligible. Reverse taper taps, however, consume much less power than parallel taps.

Hamilton, Ohio. W. S. Rowell

[With regard to the methods of making the tests recorded in Table I, in the article on "Taps and Tapping" in the April number, we are informed by the test department of the Wells Bros. Co., Greenfield, Mass., that the figures in the chart "represent the average variation of a number of tests of each material. In making these tests different sequences were used (with regard to the different materials tapped), so that the tests would be absolutely fair to each material."—Editor.]

OVERHANG IN MACHINE DESIGN

In the March number of Machinery, "Onlooker" quotes, "Overhanging is a vital error in design," and adds, "Mechanical designers are beginning to recognize this fact to a marked degree." Assuming that by "overhang" is meant the condition of a part similar to a cantilever and that a "vital error" means an absolute mistake, the writer takes exception to these statements, and will attempt to show that the former is not a practical proposition so far as design of machinery is concerned.

It is obvious that there are many types of machines impossible to design so that they will fulfill the object for which they are intended, without overhang. A radial drill, for example, of the general kind, must necessarily have an arm that can be quickly and easily swung from one position to another. If an outer stay is provided, the machine becomes restricted in its capacity. Such stays are often supplied as temporary attachments, but it is often impossible to apply them when the heaviest duty is required from the machine. Hence, the arm is made strong enough to safely withstand the strain imposed upon it by the work performed without the use of the stay.

Some English makers have eliminated the overhang of the drill spindle from the arm by designing what is called a "central thrust" arm. Thus the torsion is eliminated, but the deflection of the arm upward, with relation to the column, is not affected thereby. The deflection due to three inches of overhang is eliminated, but that due to, say, forty-two inches remains unaltered. In a well designed machine without the central thrust arm, the torsional deflection is not appreciable, even under maximum duty, so that this attempt to avoid overhang is of little practical value, as it is often obtained at a sacrifice in handiness of operation.

The shaper offers another example of a machine where overhang is unavoidable. For a large class of work it is much more suitable than the planer, although in the latter the tool is carried on a beam supported at each end. (The uprights, by the way, which carry this beam, are "overhung" from the bed, so that even the planer does not answer the requirements for a good comparison.) It is not practicable to use some kind of a support for the outer end of the shaper ram, as the usefulness of the machine would then be greatly reduced. Some makers, however, place a support under the table so as to minimize the effect of the overhang. The advantage gained by so doing may be more apparent than real, for with a given pressure between the tool and the work, the sliding ram is deflected to a greater extent than when the table is not supported; yet, this support may be useful when very heavy work is secured to the table. Notable cases of overhang are also met with in gear teeth, most cutting tools, lathe spindles, tail-stock spindles, etc.

The objection to overhang is, of course, deflection under load, but this is not avoided if a beam supported at its ends is substituted for a cantilever. Under similar conditions of length and section it is reduced, but the difference is one of degree, not of kind. The writer does not, of course, advocate overhang when it can be advantageously avoided, but he realizes that conditions exist which call for a compromise, and he does not agree to the statement that "overhang is a vital error in design," and does not believe that it should be accepted without some qualification. Joseph Jewsbury

Birmingham, England.

[While somewhat erroneously expressed, it is, of course, clear that "Onlooker" did not intend to convey the idea that overhang was never permissible in machine design. Read in connection with the paragraph in which the expression occurred, it is reasonably clear that the idea in "Onlooker's" mind was that overhang was a serious error in all cases where there was no need for it—where ample support underneath or near the end of a cutting tool, for example, was possible. Undoubtedly, "Onlooker" did not intend to be taken quite so literally as our correspondent has understood him.—Editor.]

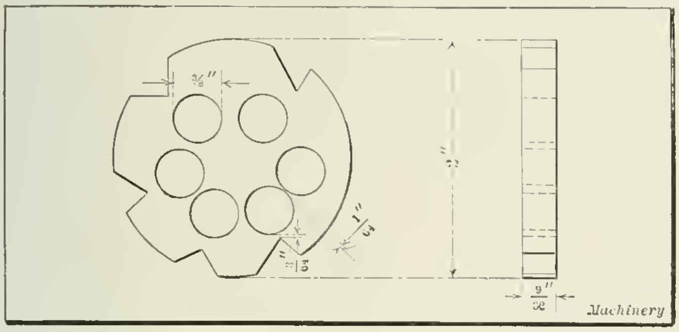
HEATING HIGH-SPEED STEEL IN A BLACKSMITH'S FORGE FOR HARDENING

Various receipts and methods have been given for hardening high-speed steel, but the factor which renders most of these methods unsuitable for the "backwoods" mechanic is that they require conveniences not often found in a small shop. The heating appliances usually consist of a pail of water and a blacksmith's forge. With these facilities one is expected to perform any operation of heat treatment from the welding of a broken crankshaft to the hardening of a "circle tool."

Not long ago the writer was employed in a small shop as foreman, and having difficulty in getting the high-speed cutters through the hardening process satisfactorily, he investigated the methods used. The trouble seemed to be that the cutters came out either without good "red hardness," which constitutes the peculiar value of such steels, or else though hard, they would be blistered and the corners so rounded that they were spoiled. Occasionally the tools would be both soft and blistered. Inquiry revealed the fact that the soft but unspoiled cutters were heated in a gas muffle furnace which had been installed for hardening punches and dies, while those rendered unfit for use by scaling were hardened in a blacksmith's forge with soft coal and plenty of blast.

As it was a rather hopeless task to change the gas outfit so that it would produce the required heat for high-speed steel, some experimenting was done with the forge fire, and it was finally discovered that if the work was covered with a thin coating of fire clay and salt, and further protected by a thin shield of sheet metal, it could be subjected to a coal fire. After being brought to the required heat, the tool was cooled in a tank of kerosene without removing the shield.

The accompanying illustration gives the dimensions of a piece that was hardened in this manner. The holes were drilled and then reamed with a ⅜-inch reamer, and all of the sharp corners were milled. Some idea of the lack of scaling or warping may be obtained from the statement that after the dirt was cleaned out of the holes, the shank of the same reamer could be put through. The burrs caused by milling and reaming were still as sharp and pronounced as before heating. The wall between two of the ⅜-inch holes was only 1/64 inch thick, and the wall between the milled corner and one of the holes was 3-64 inch thick. No cracks developed, nor was there any noticeable warping at these points. The condition of the sharp edges would warrant the belief, that, if it had been a cutting tool it would have been in a fit condition to use without sharpening.



A Piece of Work heated for Hardening in an Ordinary Blacksmith's Forge, without Scaling or Warping

As to the degree of hardness obtained, the writer kept the piece in the condition in which it came from the hardening bath—without tempering—and afterward had the opportunity to test it with the scleroscope; with this instrument a reading of 105 was obtained. This reading compares very favorably with that obtained with the best grade of carbon steel hardened in a satisfactory manner. The piece illustrated is made from Bohler's rapid Styrian steel (high-speed). Judging from various other experiments which were tried, the writer has come to the conclusion that the prime necessity in hardening high-speed steel is to have plenty of heat, and to provide shields for the work to prevent the scaling which is due to exposure to the atmosphere when the tool is at the temperature for hardening. It does not especially matter when using the shield, whether the work is heated in a muffle, a barium chloride bath, or some home-made affair like that previously mentioned. With proper care excellent results may be obtained, even with that old standby, the blacksmith's forge. F. A. Parsons

Milwaukee, Wis.

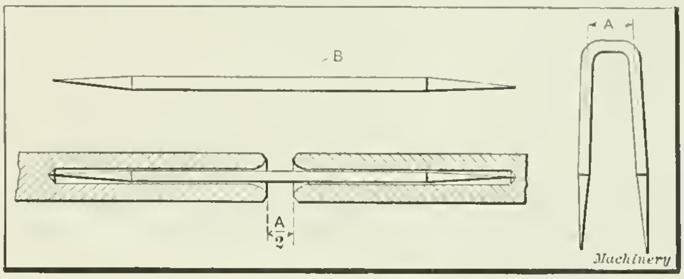
BURNISHED THREADING DIES

Threading dies of the button or spring types will last much longer and produce superior threads if the threads in the dies are burnished after cutting, and also after hardening, than if left unburnished as they ordinarily are. The burnishing is accomplished with a threaded master plug, which is hardened and lapped, but not fluted. This threaded plug is run through the die, which is left from 0.001 to 0.0015 inch small when the thread is cut. Lard oil is used as the lubricant. After the die has been hardened and tempered, the threaded plug is run through again.

Another advantage gained by putting the plug through the die after hardening, is that the lead of the threads, which is distorted in the hardening process, is corrected. A die made in this manner will cut clean and smooth, and will stand up much better than a die that has not been burnished because the material about the threads is compressed by the burnishing plug and all the burrs are removed. D. T. H.

DEVICE FOR MAKING STAPLES

The accompanying engraving shows a simple device for making staples of the type shown to the right. The method is as follows: Cut off the wire to the proper length and point it as indicated at *B*. The device for bending consists of two pieces of steel rod, slightly less in diameter than the width *A* from center to center of the staple legs. Drill a hole in the end of each of these two pieces. The hole should be slightly larger than the diameter of the wire, and the depth of the hole should be about one-half the length of the wire less one-quarter of the distance *A*. The holes should be slightly chamfered, or bell-mouthed, and the corners should be slightly beveled, as shown. When the wire is placed in these handles, they are forced together to a parallel position. The beveled corners come together and act as a fulcrum and a smooth, even bend results. C. M. S.

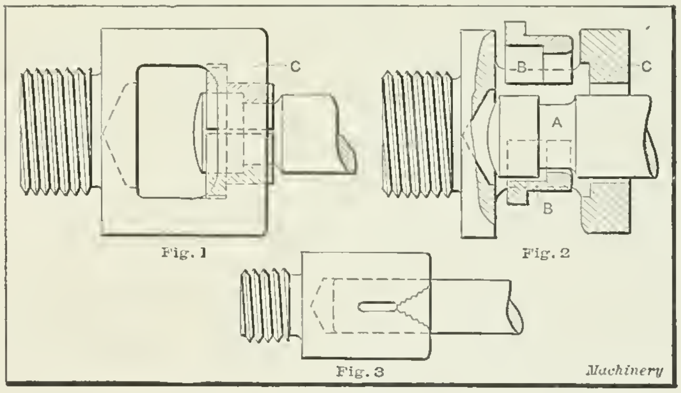


Method of Making Wire Staples

IMPROVED FORM OF PULL-BUSH FOR BROACHES

The broach used with the "La Pointe" broaching machine is usually secured to the pull-bush by means of a cotter passing through the bush and broach. This connection frequently fails, the pull-bush giving way as shown in Fig. 3; or worse still, the end of the broach gives way. The trouble can be overcome by using a pull-bush of the type shown in Figs. 1 and 2.

The end of the broach is reduced in diameter as shown at *A*, leaving a shoulder; half-bushes are turned to suit the bore of the pull-bush *C*, and bored as shown at *B* to freely fit the end of the broach. The pull-bush has a slotted hole, wide enough for the insertion of these split bushes.



Improved Design of Pull-bush for Broaches

In use, the broach end is inserted through the hole in the pull-bush, the half bushes are placed on the neck, and are then drawn back into the hole as shown in Fig. 1. By making the bore large enough when designing a pull-bush of this description, it is quite a simple matter to arrange for one bush to cover a large range of broaches, and in each case retain the greatest possible strength in the broach. Split bushes are made to suit each size of broach. This cannot be done when using a cotter, and therefore the connection is cheaper to make. The half-bushes are easily made as compared with the cutting of the slots for the cotters, and it is advisable to make them so that if anything gives way, it shall be these parts. A little care in determining the width of the shoulders in these split bushes will allow for this tak-

ing place before either the main pull-bush or the broach end can give way.
G. R.

SOLVING OBLIQUE-ANGLED TRIANGLES

The writer wishes to add a few words in reply to the inquiry of O. E. H. in the How and Why columns of the February number of MACHINERY. When two sides (a and b) and the included angle (C) are given, the third side (c) can be found directly from the formula:

$$c = \sqrt{a^2 + b^2 - 2\,a\,b\cos C}$$

This formula is not very convenient to use except when a and b are numbers easily squared; however, this is generally not the case. By using the formulas:

$$\sin x = \frac{2\cos\frac{1}{2}C}{a+b}\sqrt{a\,b}$$

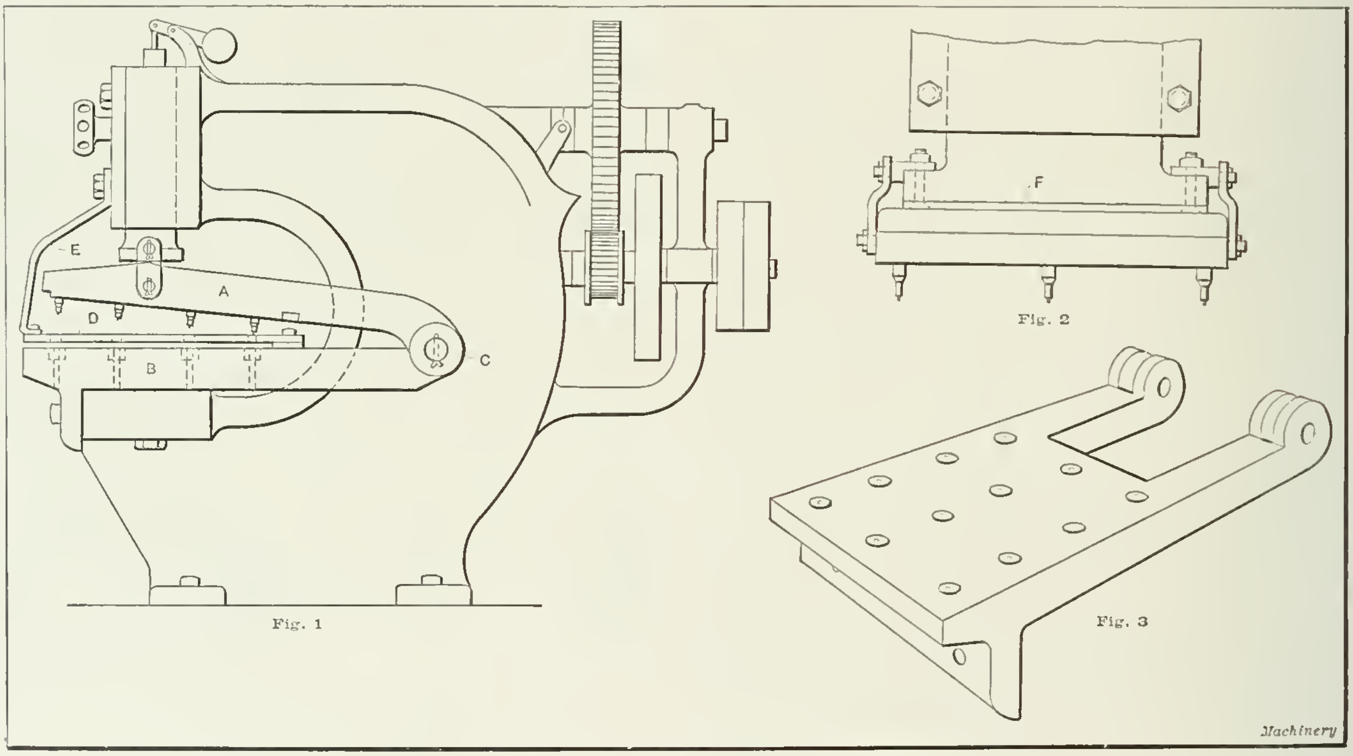
and

$$c = (a+b)\cos x$$

the computation will be much facilitated, especially when using logarithms. By using functions of the half angle we also obtain greater accuracy and avoid the difficulties met with when using negative values.
WM. W. JOHNSON
Cleveland, O.

ATTACHMENT USED FOR GANG PUNCHING

When it is desired to use a gang punch on the ordinary punching and shearing machine and the positions of the holes are such that some of them are a considerable distance outside of the lower face of the crosshead, it is not practicable to use ordinary punch and die blocks. Punching of this kind, however, can be easily done by means of an attachment such as shown in Fig. 1, which represents a side view of an ordinary punching and shearing machine equipped with punch and die blocks for gang punching. The punch block *A* is attached to the crosshead by means of links as indicated, while the die block *B* is fastened to the bed plate by any ordinary means. The punch and die blocks are connected by a hinge at *C*; *D* is the stripper and *E* one of the two braces supporting the front of the stripper.



Figs. 1 to 3. Attachment for Gang Punching

In Fig. 2 is shown a front view of the punch block illustrating the manner of connecting it with the crosshead. The wearing plate *F*, shown in this illustration, is attached to the crosshead and bears against the punch block. In Fig. 3 is shown a perspective view of the die block giving a clear idea of its construction, the stripper being removed in this illustration. No attempt has been made to show the means of securing the punches and dies in their respective blocks, or the provisions made for getting rid of the punchings. This latter may be accomplished, for the central dies, by drilling holes at an angle from the bottom of the die to enter the opening usually provided in the center of the bed plate, and for the others by holes so drilled that the punchings are discharged at the front, back or on the sides of the bed plate.

This device has been used for punching plates about 3/16 inch thick, of high-carbon steel, which is difficult to punch. If thicker plate is to be punched, the distance back to the hinge or fulcrum *C* must be proportionately increased in order to give as nearly a perpendicular motion to the punch as possible. The parts are hinged together sufficiently rigid so that the punches strike the plates squarely over the holes in the dies. It would seem, at first sight, as if there would be enough of a bending action on the punches to easily break them off, but this is not the case, providing, of course, that the fulcrum *C* is placed at a suitable distance away from the center of the crosshead.
W. L. B.

SAVING A SHAFT BY KNURLING

Referring to the article, "Saving a Shaft by Knurling," in the April number of MACHINERY, the writer would like to say a few words. It would seem that a straight knurl would be best for this purpose—one that makes parallel, longitudinal grooves and ridges. It would seem that the spiral or cross-cut knurl would hardly be practicable to use. The best results are obtained when the size is increased only enough to make it possible to obtain a press fit, but it should be remembered that the bearing surface is reduced and, therefore, when an allowance of only 0.0005 to 0.0015 inch is required for a tight fit with a smooth surface, the knurling must increase the diameter from 0.002 to 0.003 inch, in order to produce just as good a fit. The ridges tend to cut into the sleeve, and if the assembled details are taken apart, the fit is none too good the second or third time.

Nevertheless, the method has its advantages. It is cheap, and the fitted part runs true, which it does not always do when some other methods for saving the work are resorted to. Although the writer has never seen the method tried for the purpose, he does not think that it would be suitable where an air- or liquid-tight joint is required, as the sleeve is generally considerably scored when the knurling is heavy.
Erie, Pa.
A. N. HAMMOND

CASEHARDENING GEAR TEETH WITHOUT DISTORTION

In the May number of Machinery a brief item is published on the casehardening of gear teeth without distortion. The writer wishes to make some friendly criticisms on the methods there set forth. It is stated that the gears are copper-plated all over before taking a finishing cut on the teeth. The finishing cut removes the copper plate from the tooth faces and flanks, and when casehardened, these parts only become hard, the carbonizing effect of the pack being prevented on the other parts of the gear by the copper-plate. The practical result is casehardened teeth with so little distortion of the gear as a whole that it can be corrected to practically perfect accuracy by means well-known to gear makers. The well-known means alluded to are, presumably, "setting" under the press, or similar means. This, in the writer's opinion, is very bad practice, as the means used to correct the gear sets up internal strains, which are retained in the gear. Should the gear at any time receive a sudden shock, it may upset the molecular structure of the steel, and so relieve the strains. One often wonders why gears when first placed in a car appear fairly quiet, and then, while on test, suddenly become noisy, and finally have to be replaced—a procedure which has often come to the writer's notice. A great deal of noise and hammering can be traced to "setting" under the press. To overcome the trouble already stated, it should be strongly advised to leave metal for supporting the gear while undergoing heat-treatment and to take a cut all over after carbonizing except on the tooth faces and flanks. Then only these latter parts will harden.

Finally, after hardening, the gear should be located true with the teeth, ignoring all other parts, and then the surplus metal left for supporting the gear should be removed, at the same time truing it up with the teeth. This, obviously, does away with the necessity of "setting" the gear under the press.

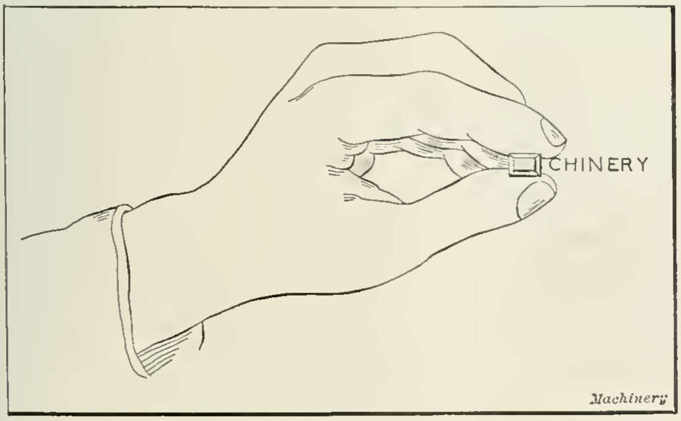
The writer does not want anyone to think that he is in any way condemning copper-plating for preventing parts from casehardening. He has seen this method in use for bicycle bottom bracket axles some ten years ago. The axles were copper-plated all over and then the plating was removed from the ball races only. It is also good practice to copper-plate the threads on the ends of hardened shafts and the like.

Anyone who wishes for further information upon the matter should refer to the article, by the writer, in another part of this issue entitled "Processes in Production of Automobile Transmission Gears."

Birmingham, England W. Betterton

USING STEEL STAMPING LETTERS

The "Remarks by the Onlooker," in the February number of Machinery, relating to the way the average machinist uses steel stamping letters, prompts the writer to describe a method which he has used successfully. Others who have been told about it have found this method equally good, and it is, therefore, submitted with the hope that it will prove useful to someone.



Method of using Steel Stamps

The accompanying engraving shows fully as well as a description the principle of the method. The words are stamped backwards, beginning with the last letter. By doing so, it is possible to see exactly what one is about. The hand does not cover up the letters already stamped. A guide line should be scribed for the figures, so that they will line up properly.

In addition, attention should be called to the fact that cast iron should not be stamped without first chipping off the hard skin. To do so will improve the appearance of the stamping and will considerably lengthen the life of the steel stamps. A nick should be filed across the upper side of the type so that one can see or feel instantly when the right side is up. In this way, stamping of the letters upside down is avoided.

Christchurch, New Zealand. Percy Frampton

SEASONING CAST IRON FOR MACHINES

Having noticed the request for suggestions from readers as to ways and means of cheaply accelerating the seasoning process, the writer offers the following:

First, under the title "The Mobility of Molecules of Cast Iron," (a contribution to a discussion of the physics of cast iron), a resumé of some protracted investigations of this subject may be found in the transactions of the American Institute of Mining Engineers, 1896 (Vol. xxvi, beginning page 176).

Second, it was shown therein that release of cooling strains in iron castings may be very greatly accelerated—without heat annealing—by subjecting such castings to repeated shocks or vibrations while cold. In the case of ordinary test bars of one inch square section, broken transversely, with supports twelve inches apart, there was a gain in strength of bars subjected to shocks in a tumbling barrel for one hour of about twenty per cent, as compared with companion bars of the same size cast from the same ladle, not so treated.

Third, in a report of the committee of Science and Arts of the Franklin Institute on this discovery, entitled "The Molecular Changes in Cast Iron Caused by Vibration," dated May 5, 1897, and printed in the *Journal of the Franklin Institute* July, 1898, a maximum increase in load of 42 per cent and increase in deflection of 55 per cent is shown in a table giving tests of 166 bars, 26 by 2 by 1 inch tested flat, twenty-four inches between supports 83 of which were subjected to shocks as compared with untreated companion bars.

Fourth, the release of cooling strains in castings by shocks without aid of heat having been fully established by these and numerous similar and independent tests, the American Society for Testing Materials inserted a clause in its revised specifications for iron castings to the effect that test bars must not be subjected to shocks or vibrations prior to testing.

Fifth, the most effective and thorough method of removing internal stresses in iron castings "to prevent warping after finishing" is the old one of annealing by heat to cherry-red before machining, but this is impracticable in many cases, and careful tests have shown that an analogous effect may be produced by subjecting the castings while cold to rapid vibrations or shocks, thus accelerating the removal of internal stresses by molecular movement.

Sixth, finally it may be accepted as a fact that all iron castings improve with age, owing to the slow or gradual escape of cooling stresses due to rearrangement of molecules.

Philadelphia, Pa. Alex E. Outerbridge, Jr.
Metallurgist with William Sellers & Co., Inc.

A CUTTING LUBRICANT FOR COPPER

Copper, as most mechanics know, is very difficult to work with the ordinary steel tools, but if the following method is used good results will be obtained. Grind the tool as for cutting steel, giving it as much top and side rake as possible. The most important point is to have the tool well oil-stoned, not along the cutting edge but on the top, as the cutting edge must be kept clear of chips at all times. For a lubricant, use sweet cow's milk. This may seem strange, but it has proved to be about the only lubricant that will produce a surface on copper as smooth as glass.

Milwaukee, Wis. Fred Fruhner

HOW AND WHY

DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST

Give details in full and name and address. The name and address will not be published with the answer.

STANDARD PITCH FOR PIPE

W. K.—Why was 11½ pitch selected as the standard for pipe 1 to 2 inches in diameter? It is inconvenient to gear up for in the lathe, requiring a special change gear. Why would not 12-pitch have answered exactly as well?

A.—Twelve pitch would have been exactly as good as 11½ pitch and is sometimes used when gearing is not available for the standard. For the reason why 11½ pitch was adopted, we refer you to the readers of MACHINERY. If anyone can offer a reasonable explanation, we shall be glad to hear from them.

CAST-IRON PACKING RINGS

L. H.—Why is cast iron so generally employed for piston rings? Has it proved superior to other metals for the purpose? I have searched through several books on machine design without finding the desired information.

A.—Cast-iron packing rings are almost universally used in the pistons of small reciprocating engines and generally in the largest ones. The reasons are that cast iron is low priced; it can be cast in hollow cylinders suitable for making rings and requiring a minimum of machine work; it is close grained, tough and elastic, in suitable mixtures; it wears quickly to a mirror-like surface when working in contact with the wall of a cast-iron cylinder, being an exception to the rule that like metals do not wear well together; it is available wherever ordinary castings are made; and it is easily turned, bored and faced on the lathe. Steel, on the other hand, is higher priced; it must be forged and welded into rings, unless special machinery is available for rolling the rings up to shape; it must contain sufficient carbon to give it temper, if the rings are to be as elastic as cast iron; it wears quickly, working in contact with cast iron, and wears the cast iron rapidly also; and it is harder to machine than cast iron. Some of the bronzes make excellent packings for steam engine pistons, but they are costly and not readily obtainable. The principal objection to cast iron is that the rings are likely to break under shock; in some situations steel must be used because of this defect, especially in steam hammers.

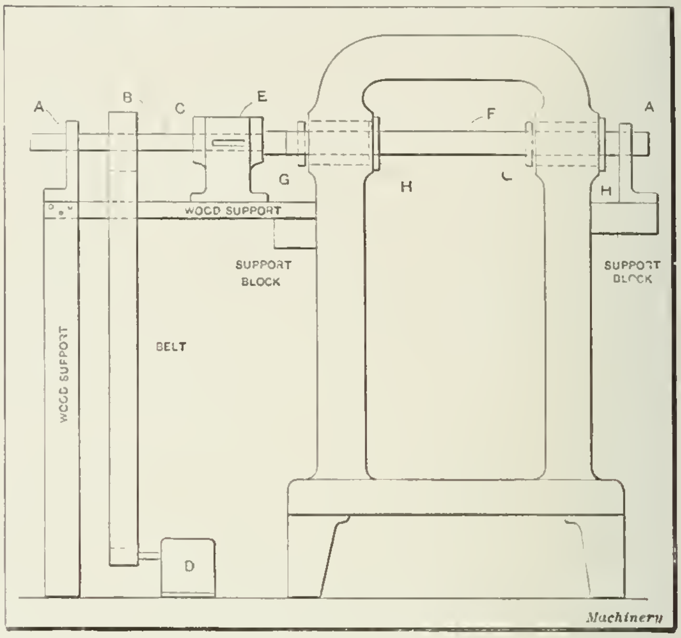
STRAIGHTENING DRILL ROD

D. A. H.—The writer would like to have proposed a method for straightening drill rod 0.105 inch in diameter, furnished in 24-inch lengths. The accuracy must be such that when the rod is rolled on a flat surface no part will be more than 0.005 inch out of true. Also, a method is required for giving a spring temper to these rods and yet have them remain straight. The writer has had to straighten many thousand pieces of untempered commercial rods, as well as a large number of spring tempered rods, and has come to the conclusion that there is no royal road to success in this respect. It seems that this is too close work for wire straightening machines, and, of all the methods tried, none approaches hand straightening. An intelligent helper after careful instruction and some practice has been found to be able to straighten fifteen to thirty rods per hour of unhardened, and ten to twenty of hardened rods, depending on the hardness of the stock, the number of short kinks, etc. The method used has been to mount a hard cast-iron surface on a bench, placing it about on the level with a man's eyes when seated. When the rod is laid on this surface the high spots show the light under them and are straightened by a blow from a 4 ounce hammer. When spring tempered rods are wanted, however, the difficulties are greater, and every rod has to be straightened after hardening. The writer learned from a steel salesman that "our steel can be hardened straight very easily; all you have to do is to heat it uniformly and dip it in water, end first." Marvelously simple until you try to do it! It is possible that someone has had similar work to do and has been more successful than the writer. If anyone has accomplished this work in a more satisfactory manner than outlined above, his experience would prove valuable and interesting.

PORTABLE BORING-BAR

Answered by William N. John, Milwaukee, Wis.

In the How and Why columns of the May number of MACHINERY, J. H. asks for a suggestion for methods to be used for reboring punch and stamping press journals. A couple of months ago we had occasion to rebore the 6-inch bearings in a No. 75½ Bliss power press. We made use of the rigging shown in the accompanying engraving. A scaffold was first erected of 3- by 10-inch planks. Then the saddle or sliding head and spindle were removed from a 24-inch back-geared drill press, the spindle being used to drive the boring-bar. On the scaffolding we also attached the lathe steadyrests from a 16-inch lathe to support the ends of the spindle and bar. On the spindle a 12-inch pulley was fastened with a feather key, this pulley being driven with a 3-inch belt from a 2½-inch pulley on a ¾ horsepower motor fastened to the floor. The boring-bar consisted of a piece of cold-rolled steel about one-half the diameter of the journal. The first cut with the boring-bar enlarged the hole about 1/16 inch. The cut was reduced each time the boring-bar was run through the journals, until a smooth bore was obtained; about 1/16 inch was planed off from the caps.



Diagrammatical View of Arrangement used for Reboring Bearings in a Stamping Press

In the illustration *A* are the steadyrests; *B*, the 12-inch pulley; *C*, the drill press spindle; *D* the motor; *E*, the sliding head; *F*, the boring-bar; *G*, the boring-bar cutters; and *H*, plates having holes which are lined up with the old bore and which support the boring-bar. The illustration simply shows the arrangement in a diagrammatical way.

The work on this rigging was begun when the plant was shut down Saturday, and the punch press was ready for work Monday morning.

* * *

MACHINE TOOL EXHIBITION AT OLYMPIA, LONDON

The Machine Tool and Engineering Association, Ltd., of Great Britain has organized a machinery exhibition covering principally machine tools, to be held from October 4 to 26, at Olympia, London. Nearly two hundred firms have signified their intention to take part in this exhibition so far, and a casual perusal of the list of exhibitors indicates that the exhibition will be of unusual interest to mechanical engineers and to machine tool builders and users. Not all of the exhibitors, of course, are engaged in machine tool manufacture, but a large portion are makers of either machine tools or accessories. A feature of the exhibition which will be of considerable interest, will be the application of the electric drive to a great many of the tools exhibited. The arrangement for safeguarding machines will also be of interest, as it is required by the committee that passes on machines and appliances to be exhibited that all machinery and tools must be properly guarded to meet with the requirements of the ordinances of the London County Council. Altogether, the exhibition will form an unusual opportunity for studying the present status and trend of the machine tool industry in Great Britain.

NEW MACHINERY AND TOOLS

THE COMPLETE MONTHLY RECORD OF NEW DESIGNS AND IMPROVEMENTS
IN AMERICAN METAL-WORKING MACHINERY AND TOOLS

THE DAVIS-BOURNONVILLE "OXYGRAPH"

The "oxygraph" is a recent development effected by the Davis-Bournonville Co., 97 West St., New York, for cutting steel by the oxy-acetylene process. It is constructed on the pantograph principle and is so arranged that steel of several inches thickness can be cut to any desired shape by simply guiding the pantograph arm, which is equipped with a cutting torch and a mechanically propelled tracer. When the steel is to be cut accurately to a given shape, a drawing is placed on the table of the machine, and, as the operator guides the tracer along the outline of the drawing, the cutting torch is given a corresponding movement on a reduced scale. In this way, intricate shapes can be cut with considerable rapidity.

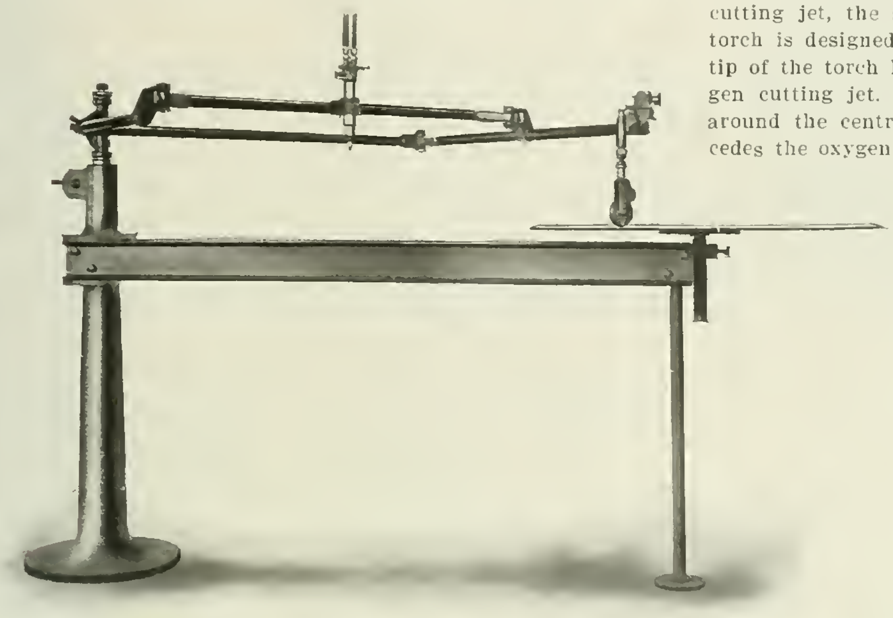


Fig. 1. The Oxygraph—A Machine for Cutting Steel by the Oxy-acetylene Flame

The oxygraph, which is shown in Fig. 1, is very simple, both as regards its construction and operation. It consists of a heavy cast-iron column and an outboard standard, upon which are mounted horizontal supports for holding the work. At the left end of the work-table, the pantograph arm is pivoted, and at the opposite end there is a steel table for holding the drawing corresponding to the outline of the form to be cut. The tracing wheel, which is a thin steel disk, is attached to the outer end of the pantograph arm and rests on the drawing-table. This wheel is positively rotated by a small motor attached to the end of the horizontal arm, and it can be swiveled about a vertical axis for moving in any required direction. This mechanical propulsion of the tracing wheel is a novel and valuable feature and has two decided advantages: In the first place, it provides a uniform predetermined speed for the cutting torch, so that the latter moves at the proper rate to obtain the greatest efficiency; and, in the second place, it is much easier for the operator to follow the lines on a drawing, because his entire attention can be given to the control of the tracing wheel, the latter simply being turned one way or the other, as may be required. The motor is connected with the tracing wheel through small gearing and shafts, and it is started or stopped by a switch conveniently located above the wheel. The motor is small and compact and requires very little power. It can be operated either by a small storage battery or a wire attached to an electric light fixture.

This machine will cut steel three inches thick at a speed of six inches per minute, and the company expects to increase this capacity considerably. It should be mentioned that the cutting is done with the oxy-acetylene flame and the oxygen cutting jet, the same as in ordinary practice, although the torch is designed especially for use with the oxygraph. The tip of the torch has five jets for heating and one larger oxygen cutting jet. The heating jets are arranged in a circle around the central cutting jet, so that a heating flame precedes the oxygen jet regardless of the direction in which the torch is moved, and another heating flame also follows the oxygen jet. It has been found that this arrangement of a heating jet in front and another to the rear of the oxygen jet is much superior to the usual one.

This machine will doubtless prove invaluable in die-making and for a great many other purposes. Fig. 2 illustrates the possibility of cutting out small crankshafts, these shafts having been cut from one-inch steel plates in 8½ minutes. With a high quality of oxygen, the kerf left by the cutting flame is narrow and a clean, sharp cut is obtained. Straight, curved or irregular outlines can be followed easily, and square corners are also cut without difficulty. The piece shown to the right in Fig. 3, was cut out by the writer without any previous experience whatever in operating the machine. This block is illustrated merely to show that straight lines, curves or right-angle turns can be followed by an inexperienced operator. This is made possible by the mechanically propelled tracing wheel, which simply needs to be guided, but takes care of itself as far as the forward movement is concerned. When a corner is reached, the wheel is given a quick turn, and, being motor-driven, immediately starts off in the other direction, so that the corner is cut clean and sharp, which would not be the case if there were any delay. The sides of the narrow path or kerf left by the flame, are remarkably smooth as shown by the sample piece at the left in Fig. 3.

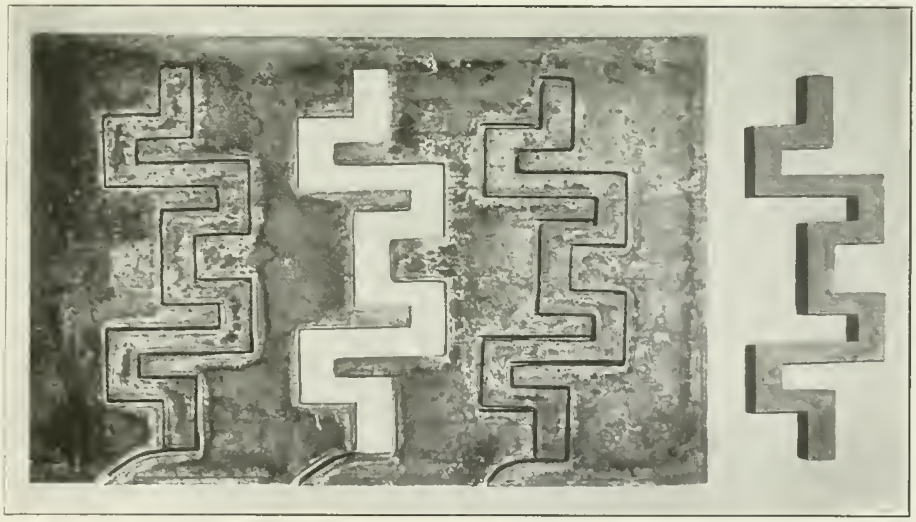


Fig. 2. An Example of Work done by the Oxygraph

The pantograph arm is made of light steel tubing, and the joints are provided with ball bearings to give a free movement. The arm can be adjusted vertically to suit the height of the work, and the drawing-table also has a vertical adjustment. The torch tip is about ⅛ inch above the metal when in operation, and the latest designs will have a fine, vertical adjustment of the torch so that its height can be varied in case the material being cut has an uneven surface. This machine has a capacity for widths up to 18 inches, without moving the piece being cut.

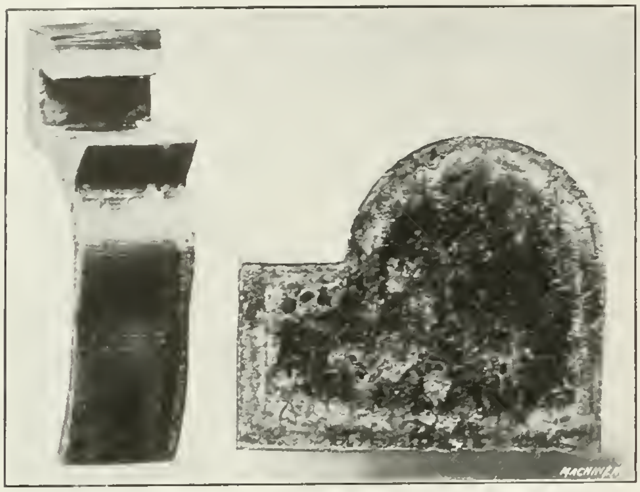


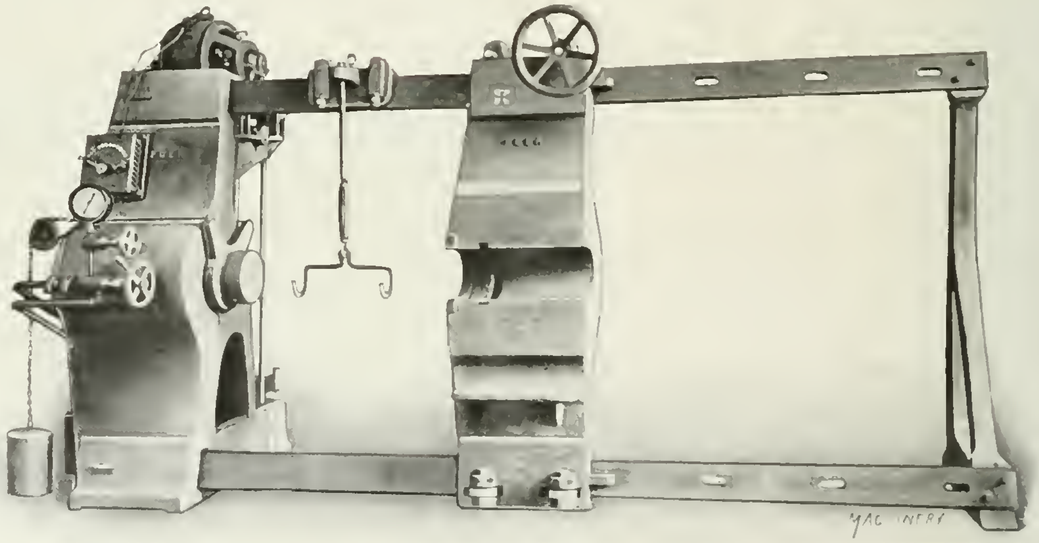
Fig. 3. Sample Pieces cut from Steel Plate by the Oxygraph

The first public demonstration of the oxygraph was given at the Master Mechanics and Master Car Builders convention recently held in Atlantic City, where it attracted considerable attention.

CALDWELL MOTOR-DRIVEN HYDRAULIC WHEEL PRESS

The motor-operated wheel press shown in the accompanying illustration, is manufactured by E. R. Caldwell & Co., Bradford, Pa. This press is a modern design having a rapid adjustment of the ram and a combination of high and low pressures, which facilitate its operation.

For convenience in handling heavy work such as locomotive drivers and irregular-shaped parts that cannot be rolled to and from the press, the upper horizontal parallel bar is not directly above the lower one, but at a slight angle which permits handling the work with an overhead crane. The plungers (not shown in the illustration) are operated by eccentrics on a back shaft which is driven through cut gears having a ratio of 3½ to 1. The plungers operate without vibration and are practically noiseless. The ram is drawn back automatically as soon as the pressure is shut off from the pumps. An extra valve to connect with the city water line is furnished, when it is possible to have such connection. By opening this valve before using the pressure from the pump, the steel-faced ram is moved out against the work more rapidly than would be possible with the pumps; the city water line valve is then closed, the pump valve opened and the plungers started.



Motor-driven Hydraulic Wheel Press built by E. R. Caldwell & Co.

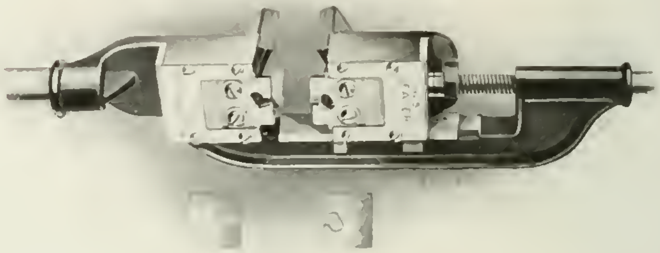
The press is equipped with low- and high-pressure pumps. The low-pressure pump operates the ram up to a certain pressure with a greater speed than the high-pressure pumps, and, consequently, increases the amount of work that can be handled by the use of the high-pressure pumps alone. The low-pressure cylinder is arranged with a relief valve, so that the pump works until there is about 50 tons pressure, when it is automatically "cut out" and the pressing operation is continued at a slower rate by the use of the high-pressure pumps.

In pressing off work, this automatic device is especially efficient. The low-pressure pump works until there is about 50 tons pressure and then the high-pressure pumps begin to operate, and continue until the work is pressed off far enough to enable it to be finished with the low-pressure. As will be apparent, this feature enables the work to be done in a minimum of time.

The pump cylinders are cast from a special semi-steel mixture which gives them great strength, and makes them proof against leakage. All presses are provided with a safety valve to prevent overloading. The plungers are driven by a direct-current, 7½-horsepower, Westinghouse motor.

BEAVER SQUARE-END PIPE CUTTER

The Borden Co. of Warren, Ohio, has brought out a new pipe cutter which severs the pipe by turning or cutting, rather than by squeezing it apart with disks or wheels. This cutter is equipped with square-end turning or parting tools that sever the pipe the same as a lathe tool. The arrangement and form of the tools or blades, and the construction of the central part of the cutter, are shown by the accompanying illustration. There is a tool on each side of the pipe, and, as these tools revolve, a narrow annular groove is cut through the pipe wall. The tools feed inward automatically, and the cutter is turned by two handles the same as a die-stock. The No. 5 size illustrated herewith, has a capacity for pipes varying from ½ to 2 inches. This cutter is said to sever a pipe square and clean and without leaving any burr to remove by filing or reaming. The inside diameter is not reduced and the square end makes it much easier to start the threading die. The cutter is strong and durable, and its blades will sever a great many pieces of pipe without requiring to be reground.



Pipe Cutter equipped with Turning or Parting Tools

BEAMAN & SMITH CYLINDER BORING AND MILLING MACHINE

The machine shown in Figs. 1 and 2 of the accompanying illustrations is a combination type designed to bore two twin-cylinder automobile engine castings simultaneously, and, at the same time, mill the flanges on two other castings. After one set of castings has been milled, it is moved into position for boring by simply revolving the table.

The machine has a substantial bed which supports at one end a carriage with two boring heads, each of which carries two spindles. This is the head seen to the left in the illustration. At the other end of the main bed there is a small cross bed located at right-angles, upon which is mounted a saddle carrying the two milling spindles. The revolving table is located near the center of the main bed. It is 54 inches square and is provided with a ball bearing, which when raised into position by a handwheel, takes the weight of the table and allows it to be revolved easily. The table, however, does not rest upon this ball bearing when the machine is in operation, but on a scraped surface of large diameter. The table has four stop-pin holes and it can be securely fastened after being located by the locking pin.

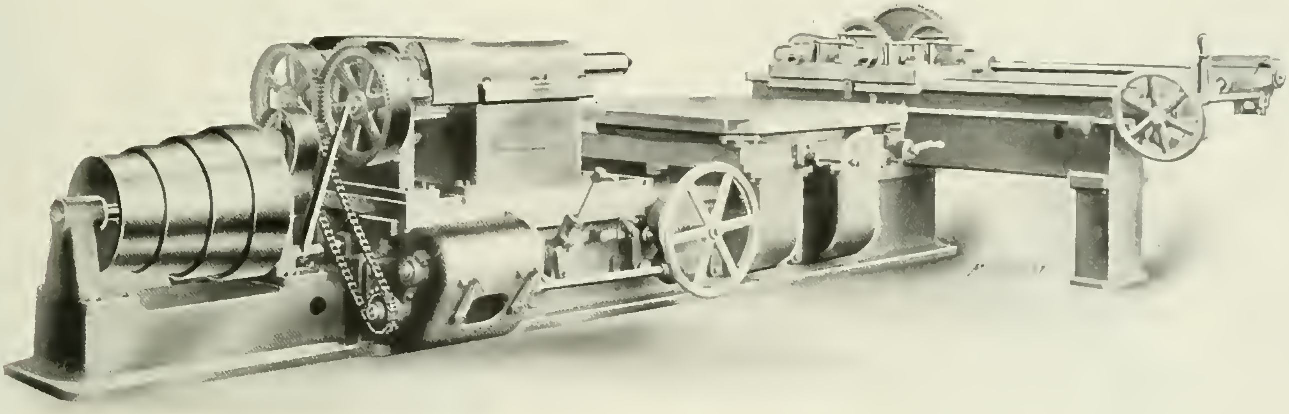


Fig. 1. Beaman & Smith Universal Cylinder Boring and Milling Machine

The carriage upon which the boring heads are mounted, is 34 inches wide, 54 inches long, and has a 30-inch movement on the bed operated by a screw of large diameter which engages a bronze nut. The thrust is taken by ball bearings and the carriage has a quick movement of six feet per minute in either direction. The front end of the carriage extends beyond the ends of the spindles (as shown in Fig. 2) and passes under the table which is bridged across the bed. This extended bearing is for distributing the wear as equally as possible.

The carriage has positive geared feeds which vary from 1/32 to 1/4 inch per revolution of the spindle. The feeds for the milling heads vary from 1 inch to 4¼ inches per minute, for any spindle speed. The four boring spindles are of crucible steel and run in boxes of hard bronze. The ends are made to fit cutters according to specifications. Each of the front bearings is 4 inches in diameter and 6 inches long, and the rear bearings are 2¾ inches in diameter and 5 inches long. Means are provided to compensate for wear. The spindles are fitted in twin heads, and the center distances are made to suit individual requirements. Gearing in the ratio of 8.4 to 1, gives speeds varying from 22½ to 44 revolutions per minute.

The boring spindles are driven by a 6-inch belt operating on a four-step cone, and the milling spindles are driven by a 5-inch belt operating on a three-step cone. The saddle for the milling spindles is 20 inches wide and 41 inches long and has a movement of 52½ inches on the cross bed. It is also provided with a quick power movement, varying from 6 to approximately 12 feet per minute in either direction. This rapid traverse is driven by a 4-inch belt operating on a 10-inch pulley. The milling spindles are also made of crucible steel and run in hard bronze boxes. They have tapered ends 3 inches in diameter for receiving face milling cutters. The front bearings are 4 inches in diameter and 6 inches long, and the rear bearings, 3 inches in diameter and 5 inches long. Gearing in the ratio of 21½ to 1, gives speeds of 7½, 10, and 14 revolutions per minute.

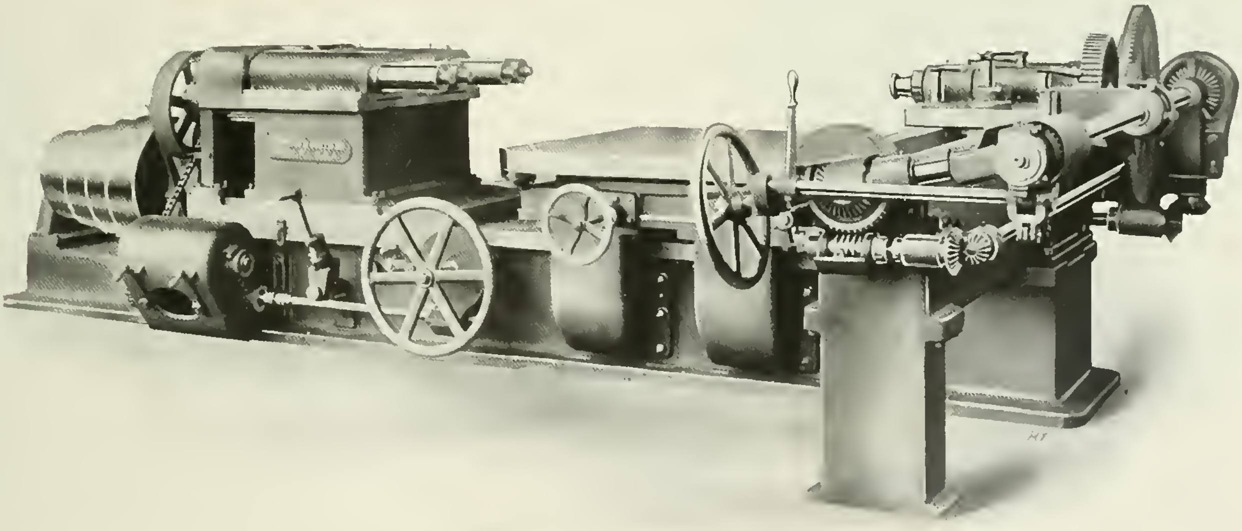


Fig. 2. Another View of the Beaman & Smith Machine

The minimum distance from the center of the table to the face of the boring heads is 27 inches, and the maximum, 57 inches. The minimum and maximum distances from the center of the table to the end of the milling spindles are, respectively, 28¾ and 31¾ inches. The vertical height from the center of the spindles to the top of the table is about 9¾ inches. The weight of this machine is approximately 28,000 pounds. It is known as the No. 2 universal, cylinder-boring and milling machine, and is built by the Beaman & Smith Co., Providence, R. I.

OESTERLEIN MOTOR-DRIVEN MILLING MACHINES

The application of variable- and constant-speed motor drives to the milling machines built by the Oesterlein Machine Co., Cincinnati, Ohio, is illustrated herewith. Fig. 1 shows a direct-connected, variable-speed, motor-driven machine. This same drive is applied to all sizes of plain and universal milling machines built by this company. A large driving gear, which runs loose on the spindle, drives the latter either by connection to the face-gear or through the back-gearing. The intermediate gear is made of hard fiber so that the drive is practically noiseless. With the push-button starter, which is located on the right side of the column above the spindle, the machine is automatically adjusted to the speed for which the motor is set.

The No. 20 plain or universal machines are equipped with a two-horsepower motor, and with a 6 to 1 speed variation all spindle speeds from 19 to 400 revolutions per minute can be obtained. A 4 to 1 variable-speed motor will give all speeds from 21 to 85 and from 100 to 400 revolutions per minute. For the single back-geared No. 24 or 28 plain and No. 25 universal machines, a three-horsepower motor is used, and with 6 to 1 and 4 to 1 variations, the same spindle speeds are obtained as previously given for the No. 20 machines. A double back-geared No. 24 plain, No. 28 plain, and No. 25 universal machine should have a three-horsepower motor, and a 3 to 1 variable-speed type will give all spindle speeds from 14 to 400 revolutions per minute. The No. 34 plain and No. 30 universal machines use a five-horsepower motor. The spindle speeds in any case can be changed by altering the pinion on the motor shaft.

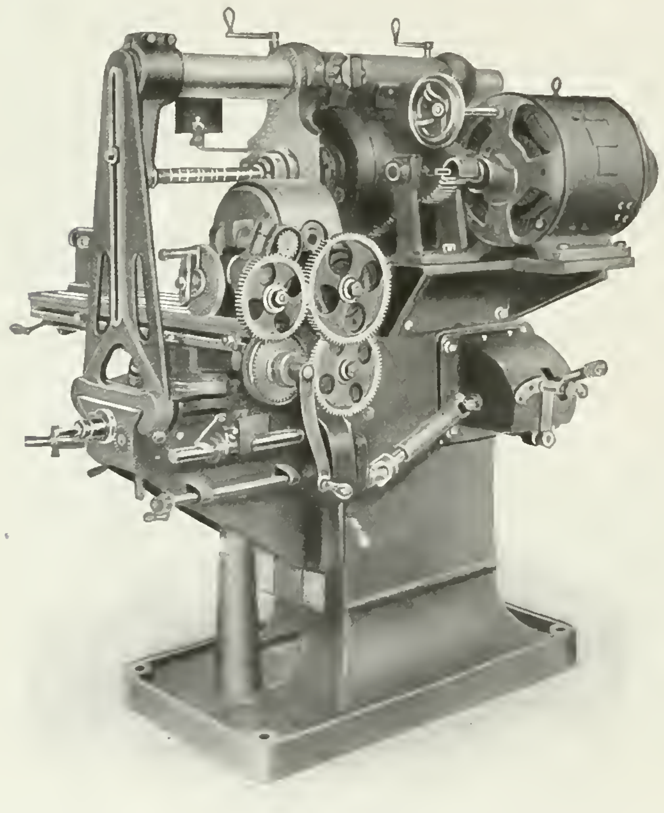


Fig. 1. Oesterlein Direct-connected Variable-speed, Motor-driven Machine

A constant-speed motor-driven machine is illustrated in Fig. 2. The arrangement of the drive is clearly shown by the illustration. The motor may be an alternating or direct-current type. The motor shaft carries a two-step pulley which drives the two-step pulley on top of the machine. On this upper pulley shaft there is a pinion which drives a large gear inside the cone. This gear is secured to the cone, and the latter is bronze-bushed and runs loose on the shaft. The upper pulley shaft is eccentrically mounted and its position can be varied by the belt-tightening lever seen on the right-hand side of the cone. With this lever, a proper belt tension can be secured or the belt can be loosened to permit shifting it easily. The lever between the two cones is provided to facilitate the shifting of the belt.

The single back-geared machines have four-step driving cones operating at two different speeds, so that, in connection with the back-gear, 16 single speeds are secured. The double back-geared machines have three-step driving cones, which, with two speeds and double back-gears, give 18 spindle speeds varying in geometrical progression. A two-horsepower motor is recommended for the No. 20 plain and universal machines; a three-horsepower size for the No. 24 and 28 plain, and No. 25 universal machines, and a five-horsepower motor for the No. 34 plain and No. 30 universal machines.

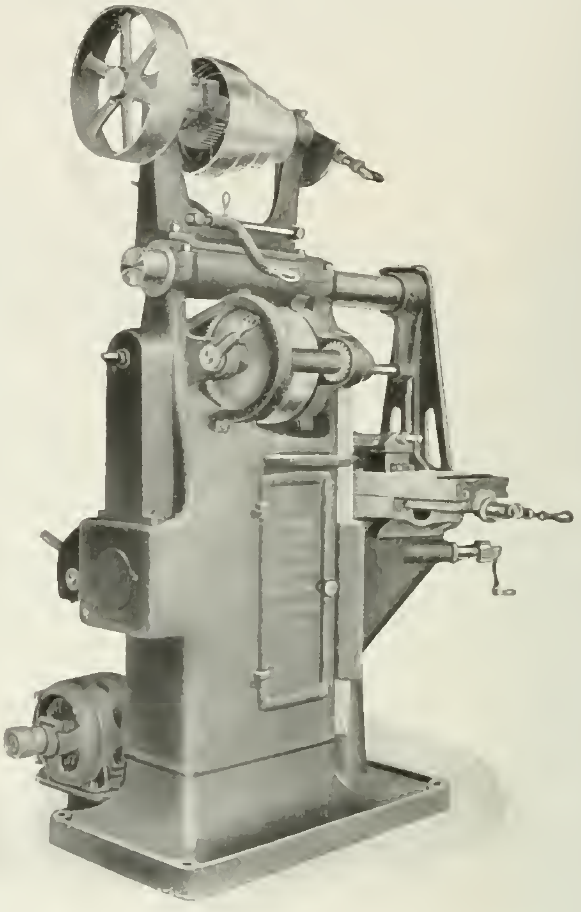


Fig. 2. Oesterlein Constant-speed Motor-driven Machine

CINCINNATI PRECISION ADJUSTABLE REAMER

The adjustable reamer shown in Fig. 1 has been designed by the Cincinnati Precision Lathe Co., Cincinnati, Ohio, for accurate work. The blades of this reamer are inserted in slots cut in a steel shell which is fitted to a taper shank, and held in position by a taper pin which passes radially through both shell and shank. The slots extend clear through the shell, excepting at each end, so that the blades rest directly upon the taper shank. The latter is threaded at each end of the taper, and upon the threaded parts are screwed angular collars which retain the blades, as clearly illustrated in Fig. 2, which shows the reamer with the slotted shell and the angular collars removed.

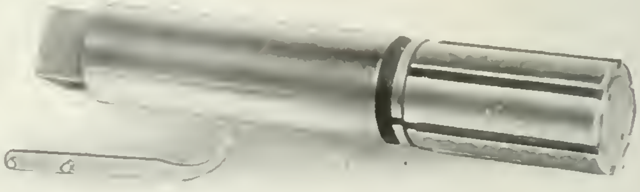


Fig. 1. Cincinnati Precision Adjustable Reamer

The blades are also adjusted radially by these collars, the adjustment being made by screwing the collars one way or the other and thus shifting the blades up or down the taper shank. By employing a ground taper shank as a seat for the reamer blades, a fine degree of accuracy is obtained. The blades, which are jig ground, are exact duplicates, and the slots in the shell are accurately milled to fit the blades.

This construction gives a uniform movement and adjustment of all the blades, so that each one cuts when the reamer is in use. By adjusting the collar next to the body and then turning the collar at the small end of the taper shank, a corresponding amount, the blades are moved along the taper uniformly and cannot become eccentric to the body of the reamer. The inner sides of the collars, which engage the ends of the blades, have a 30-degree angle so that the blades are firmly clamped against the taper shank. All threads and inner working parts of this reamer are protected from chips or other foreign material. The single combination wrench seen in Fig. 1, is used for making all adjustments.

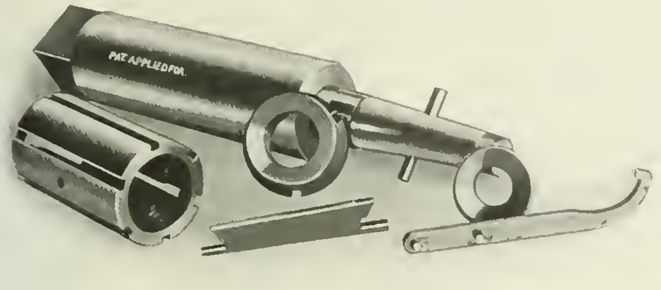


Fig. 2. Component Parts of Adjuetable Reamer

MODERN MACHINE TOOL CO.'S FLAT TURRET LATHE

The Modern Machine Tool Co., 4657 Spring Grove Ave., Cincinnati, Ohio, is now manufacturing the flat turret lathe shown in Figs. 1 and 2. Careful attention has been given to the arrangement of the various parts so as to secure a compact, simple construction and a convenient control. The various parts of the lathe have been made extra heavy.

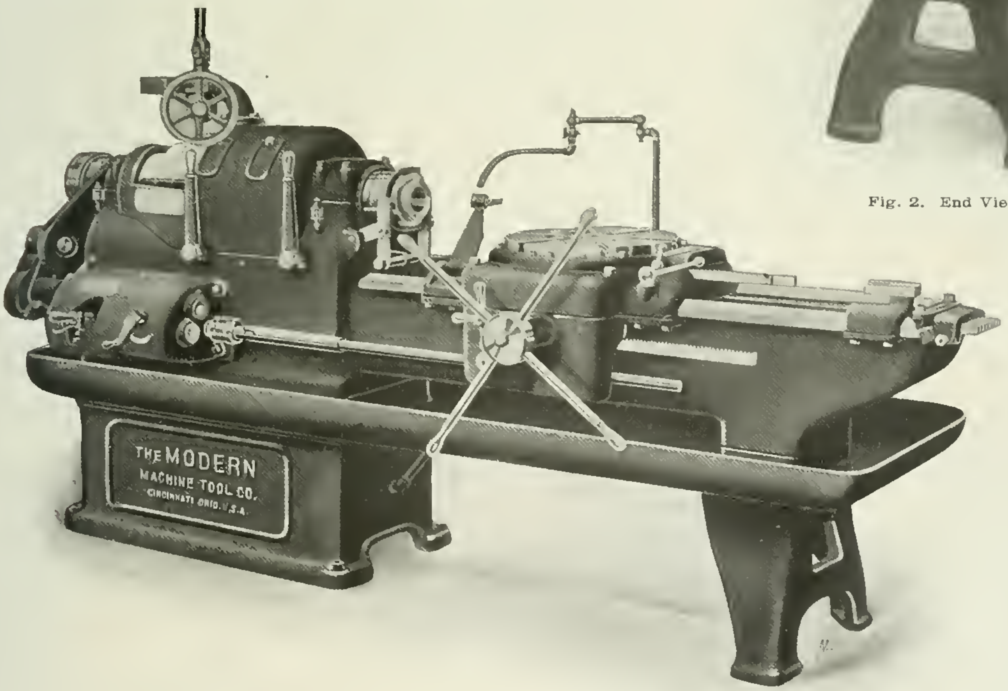


Fig. 1 Flat Turret Lathe built by Modern Machine Tool Co.

The head is very massive and is cast integral with the bed. The head contains the cone pulley for driving the machine, the friction back-gears and the automatic roller feed and chuck. The back-gears are located directly under the spindle. These gears, in conjunction with the three-step cone, give 12 spindle speeds varying in geometrical progression. The bed, which rests on a tripod bearing, is deep and heavy, and is reinforced under the front spindle bearing.

The chuck is operated by a single movement of the lever seen in front of the head. It has a strong unyielding grip and no overhang or end motion. One set of jaws can be adjusted for the full capacity of the machine, and the jaws and seat are hardened and ground. The chuck is constructed for handling rough bars, and the jaws can be made for any size or shape within the spindle's capacity. The automatic roller feed has only three moving parts. It is mounted on the spindle just back of the front bearing and is operated by the same lever that opens the chuck.

The carriage is gibbed to the outer edge of the bed by flat gibs extending its entire length. The bearing on the bed is not recessed, but there is a full contact from end to end. A binder is provided for securely clamping the carriage to the bed during forming or cutting-off operations. The backward movement of the carriage automatically indexes the turret the instant the tool leaves the work. The arrangement is such that the turret can be turned to any one of the six positions without making any other stops.

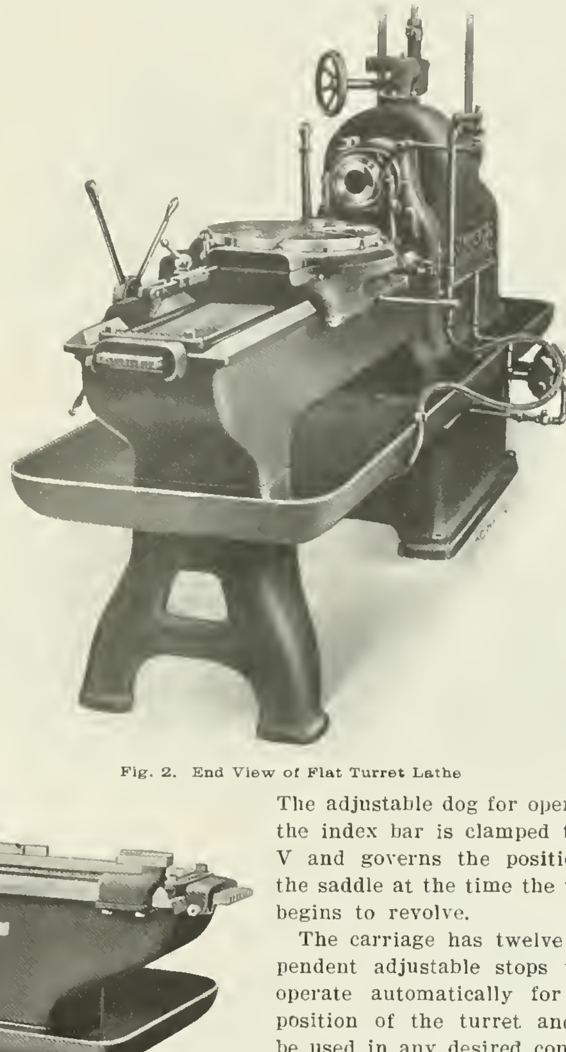


Fig. 2. End View of Flat Turret Lathe

The adjustable dog for operating the index bar is clamped to the V and governs the position of the saddle at the time the turret begins to revolve.

The carriage has twelve independent adjustable stops which operate automatically for each position of the turret and can be used in any desired combination when two or more are needed for any position of the turret. The turret is a flat circular table 18 inches in diameter, and has T-slots for clamping the tools in position. The tools can be attached to the turret for turning several diameters simultaneously when desired. The index is very large in diameter and the lock-bolt is located directly under the working tool, and so close to it that lost motion is eliminated.

The feed gear box is driven from the spindle. Eight feed changes are available for each of the twelve spindle speeds, and a graduated plate shows the amount of feed for different positions of the change gear levers. All gearing is covered.

The machine has a mechanical belt shifter which is operated by a handwheel located at the front of the head. This wheel operates two shifting arms, one of which is located above the cone pulley on the machine and the other near the cone pulley on the countershaft. Connection is made between the upper and lower arms by a vertical shaft. By means of this mechanical shifter, the position of the belt can be changed quickly and without danger to the operator.

Bar stock up to 2¼ inches in diameter can be fed through the automatic chuck and lengths up to 26 inches can be turned. The swing over the bed is 20 inches, and over the carriage, 16 inches. The net weight of the machine is 4500 pounds. This lathe is manufactured on the unit system and the parts are interchangeable. The plain bearings are scraped to master surface-plates and straightedges, whereas shaft bearings are ground and fitted with removable bushings which can be replaced when worn, without disturbing the shaft alignment. Efficient means for lubrication are provided.

WILMARTH & MORMAN CUTTER, REAMER AND DRILL GRINDER

The cutter, reamer and drill grinder manufactured by the Wilmarth & Morman Co., 580 Canal St., Grand Rapids, Mich., has been re-designed to make it more universal than the former machine. With the old-style grinder, the table of the cutter grinding attachment was permanently bolted to the column and the small wheel-head was bolted to the table. With the new machine, the table and its slide is mounted on a knee so that it can be swiveled with relation to the grinding wheel, approximately 180 degrees, which permits using a cup wheel and makes it possible to apply the work to either side of a plain wheel.

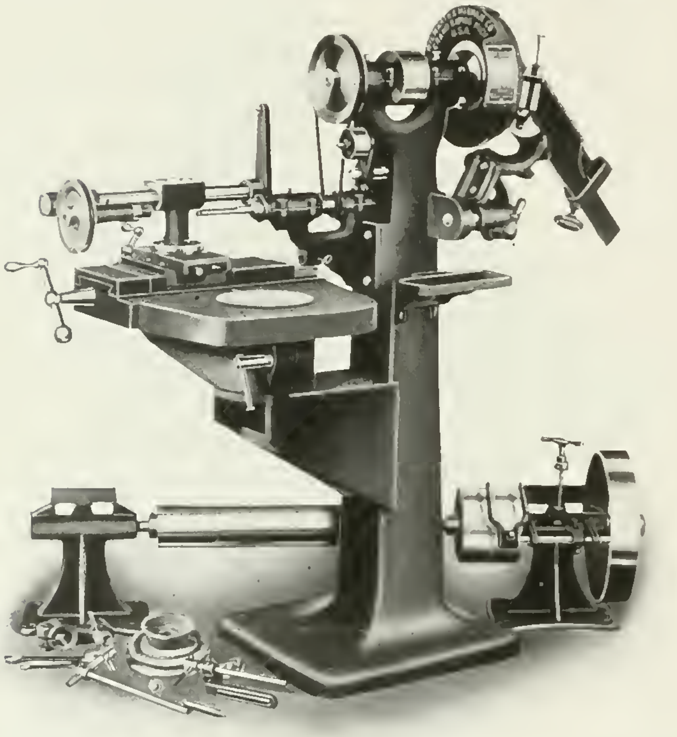


Fig. 1. "Yankee" Cutter, Reamer and Drill Grinder with Cylindrical and Internal Grinding Attachment

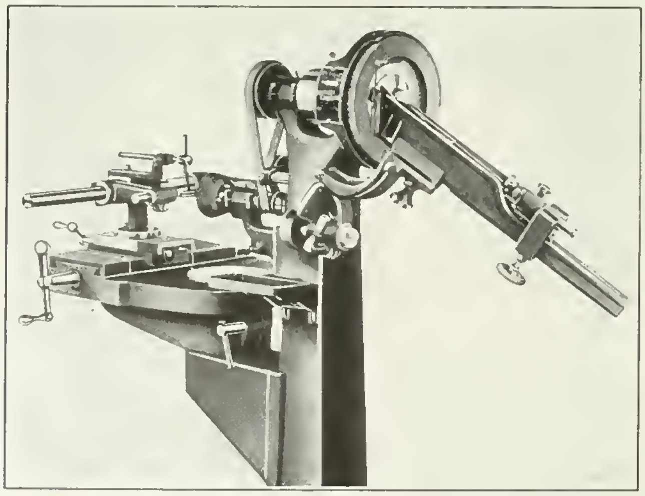


Fig. 2. Grinding Reamer with Face of Cup Wheel

Fig. 1 shows the machine complete, with a cylindrical and internal grinding attachment, in addition to the regular drill grinder. The way the machine is arranged for grinding reamers when using the face of a cup wheel, is illustrated in Fig. 2. This particular reamer is straight, but taper reamers are ground in the same way, except that the standard carrying the reamer, is swiveled to the required angle. In case it is desired to grind a reamer by using the periphery of a plain wheel instead of a cup wheel, this can be done by swinging the table around to bring the slide parallel with the wheel spindle. The table can be swiveled to either side, so that the wheel will grind either up or down, with relation to the teeth.

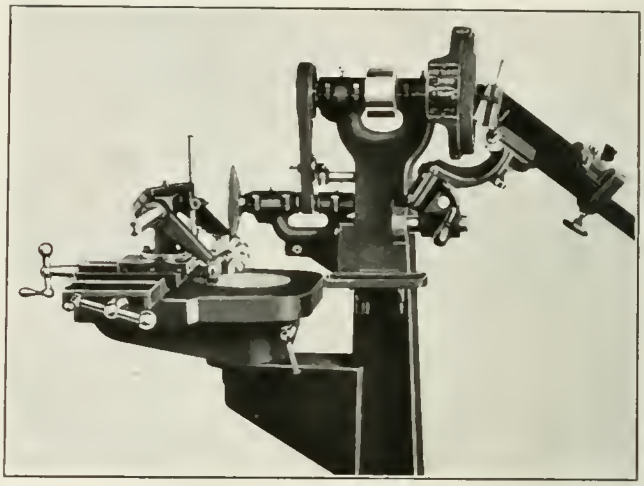


Fig. 3. Grinding Formed Cutter

Fig. 3 illustrates the grinding of a formed cutter. The work is mounted on a suitable arbor which is placed between the centers, as shown, and the teeth are ground by passing the cutter under a saucer-shaped wheel. The feed is regulated by the cross-screw movement of the upper or cross-slide which carries the swivel or standard. Hobs, gear-cutters or taps can also be ground in the same way. When grinding the flutes of a tap, the latter is, of course, held by its own centers and no arbor is needed. Fig. 4 shows the method of grinding a plain, spiral-tooth milling cutter by using the periphery of a straight wheel. A cup wheel can also be employed by setting the machine as illustrated in Fig. 2.

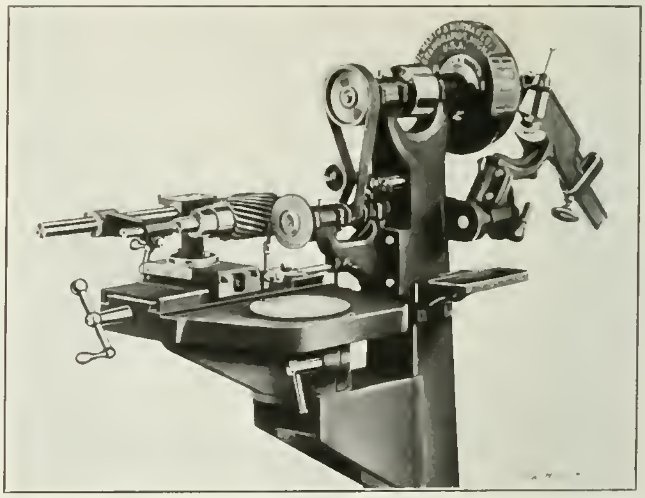


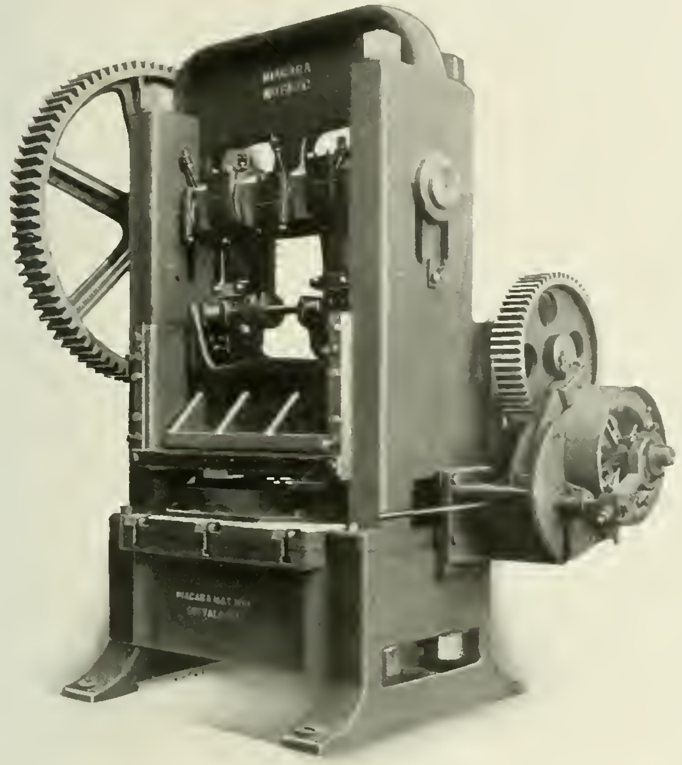
Fig. 4. Grinding Cylindrical Cutter

This machine is also adapted to the grinding of angular cutters, as well as face or side mills. When grinding angular cutters, the table is swiveled to the required angle as indicated by the graduated base. A vise can be furnished with this machine in case it is to be used for surface grinding. This vise is interchangeable with the regular swivel standard and has a graduated base which can be swiveled for angular grinding. The vise can also be tilted in a vertical plane, from a 45-degree position to a point slightly beyond the perpendicular, and provision is made for securely locking it in position. This vise is intended for small hardened parts, such as vise jaws, small tools, cutters, keys, etc.

This machine has a capacity for side and face milling cutters up to 12 inches in diameter, and angular or plain cutters up to 8 inches in diameter. It will grind cylindrical work (straight or taper) up to 7¼ inches in diameter and 11½ inches long. The maximum distance between the centers is 17 inches.

NIAGARA DOUBLE-CRANK PRESS

The straight-sided, double-crank, power press shown in the accompanying illustration, was recently designed by the Niagara Machine & Tool Works of Buffalo, N. Y. The press was built for the manufacture of gear guards for electric traction engines, but is suitable for a general line of heavy stamping and blanking operations. The frame is of the built-up type with tie-rods, and the slide and gibs have convenient adjustments.



A Large Double-crank Press built by Niagara Machine & Tool Works

Particular attention has been given to the arrangement of the press, so as to obtain a compact design occupying a minimum amount of floor space. Outboard bearings are entirely eliminated, and all parts of the drive which require occasional adjusting, are easily accessible.

The friction clutch is of the multiple-disk type. The friction surfaces are lined with end grain hardwood blocks. The clutch is entirely encased and all projecting rotating parts which might endanger the operator when oiling the clutch, are eliminated. The clutch is operated by four sets of toggles and links, which are made of steel. The brake which works in unison with the clutch, consists of two brake levers, which are actuated by a pair of toggles. An interesting feature of this construction is that the pressure on the brake blocks is always equalized, thus avoiding transmitting the pressure of the brake arms to the shaft bearings.

These presses are built in different sizes varying from 48 inches to 12 feet between the housings, and weighing from 30,000 to 150,000 pounds.

ROCHESTER BORING, MILLING, DRILLING AND TAPPING MACHINE

A horizontal boring machine of the "table type," which embodies many interesting features, has been brought out by the Rochester Boring Machine Co., Rochester, N. Y. This machine, besides performing the usual operations of boring, milling, and drilling, can also be arranged for tapping, splining oil grooves or thread cutting. The control of the machine is centralized, it being possible to make feed or speed changes, operate the rapid traverse movements, or start, stop and reverse the machine from one position convenient to the operator. No two feeds can be engaged at the same time, and it is also impossible to engage simultaneously the rapid traverse for different directions.

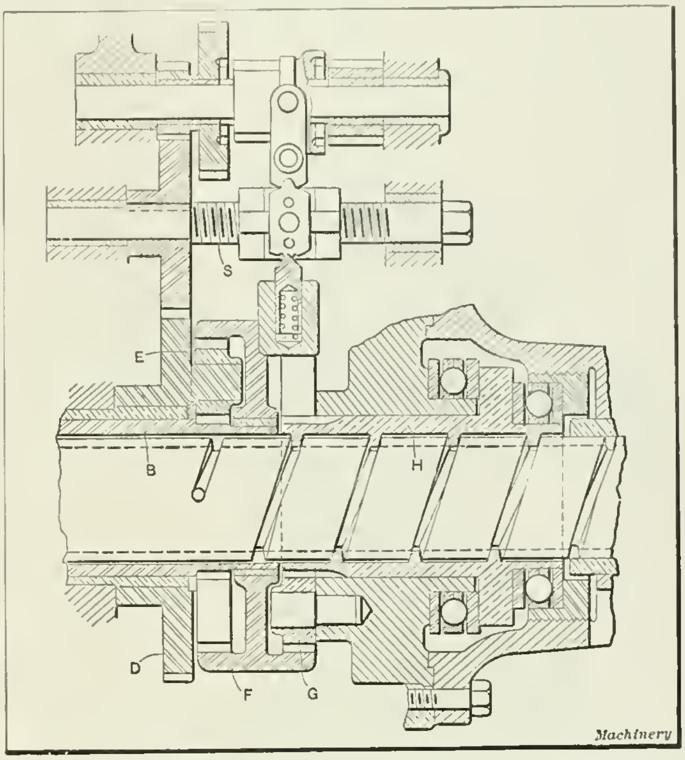


Fig. 1. Differential Feed Mechanism and Automatic Limit Stops for Spindle of Machine shown in Fig. 2

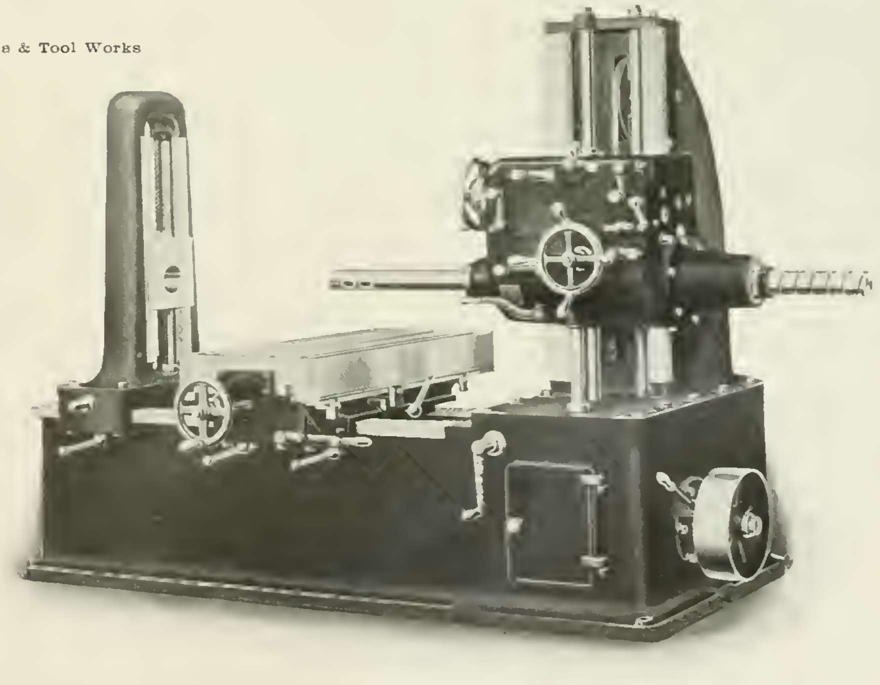


Fig. 2. Rochester Boring, Milling, Drilling and Tapping Machine

The main drive through the bed to the operating mechanism is simple and direct. The pulley shaft can be arranged either parallel to the machine, as shown, or at right-angles to the bed. The single, constant-speed driving pulley has a friction clutch for starting or stopping, which is controlled by the small lever seen to the left of the pulley in Fig. 2. The horizontal lever on the lower left-hand corner of the saddle, can also be used for starting, stopping or reversing. This machine can be equipped with a motor drive, if desired. For a standard electric drive, the motor is mounted at the top of the column and connects direct with the vertical driving shaft. The motor can, however, be applied to the driving pulley shaft, if desired. Constant-speed motors for either alternating or direct currents are used, as all speed changes are obtained mechanically.

The bed has a continuous web construction and is closely ribbed in both directions. Chutes are provided in the bed for removing chips at the rear, and there is also a reservoir in one end for cutting oils or lubricants. The upright column upon which the saddle travels, is bolted and doweled to the bed and has a deep section with large surface bearings.

The mechanism for feeding the main spindle operates on the same principle as the feed mechanism illustrated in MACHINERY for July, 1910, in connection with a description of the floor-type machine built by this company. The feeding movement is transmitted from the change-gear mechanism to a differential geared drive which rotates a long bronze nut mounted directly on the spindle and engaging a square thread. The driving gears for the spindle are mounted on a sleeve *B* (see detail sectional view, Fig. 1) which has its own independent bearings. Clearance is provided between the sleeve and spindle and the latter is rotated by long splined keys fitted in the driving sleeve and engaging double splines, thus giving a balanced drive. Sleeve *B* has gear teeth cut on the end shown in Fig. 1, which mesh with three pinions *E* mounted on studs that form part of the differential feed-driving gear *D*. By means of a double internal gear *F* and three other pinions *G*, which mesh with the spindle feed nut *H*, the latter is positively rotated at the same speed and in the same direction as the spindle, so long as gear *D* remains stationary, which is the case when the feeds are disengaged. When the feed is applied, the spindle nut either rotates faster or slower than the spindle and this differential movement between the nut and spindle, gives a feed in one direction or the other.

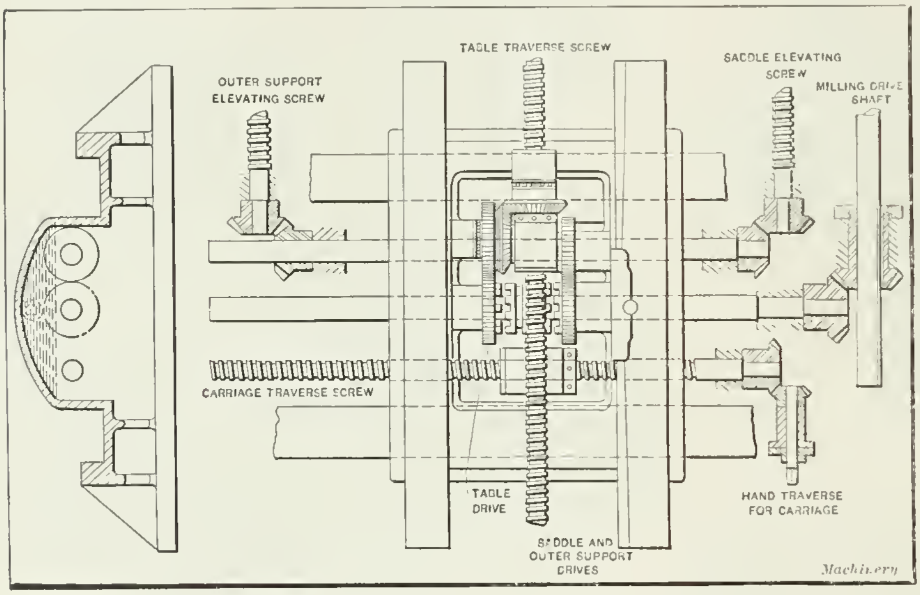


Fig. 3. Diagrammatical View showing Table, Carriage and Power Distribution

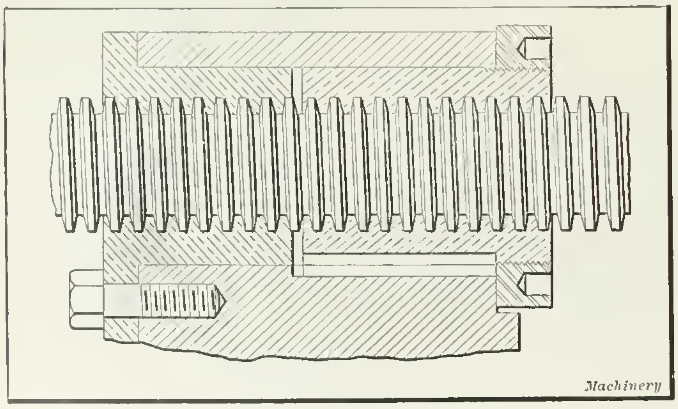


Fig. 4. Two-part Nut for Taking up Wear

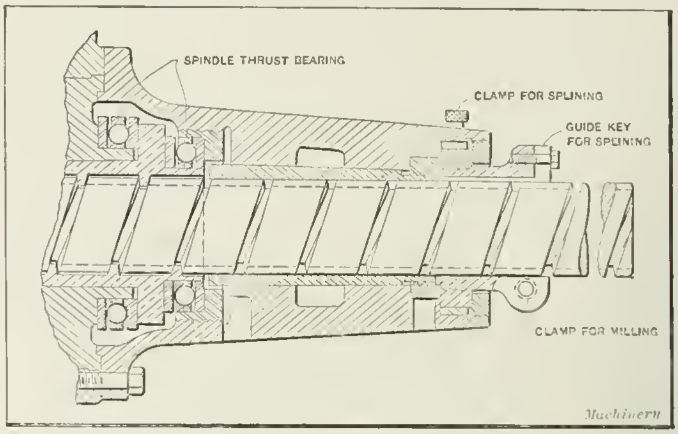


Fig. 5. Rear Spindle Bearing

The nut makes contact with the sides of the thread only, and the end-thrust is taken direct by the large ball bearings shown. The end-thrust for milling is taken by a bronze thrust bearing independent of the end-thrust for boring. All feeds, before being applied to the different parts, are transmitted through a friction clutch which enables instantaneous engagement or disengagement and provides a yielding point when desired. The reverse mechanism is located at the source of power and the feed can be reversed without stopping the machine.

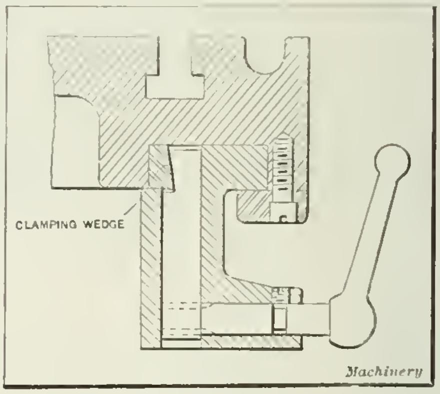


Fig. 6. Locking Clamp for Table

Sixteen boring and drilling feeds are provided and a similar number of different milling feeds for the saddle and table. These feeds and the rapid power traverse, are applicable to the spindle, saddle, table and carriage. Automatic limit stops are arranged for movements in either direction, in addition to adjustable knockouts for the table feeds. It is impossible to engage two feeds, speeds or traverses at the same time. The driving and feed gearing is enclosed and runs in oil. The lubricant is forced to a reservoir at the top of the saddle by a pump and from there it is distributed by leaders to the different bearings, and the overflow runs over the gears.

The feeding and traversing movements are transmitted to the table through a vertical shaft in front of the saddle and a shaft in the bed. At the table the feed is distributed either for the cross-wise movement or for elevating the saddle and outer support. Fig. 3 shows a diagrammatical plan view of the carriage for the table and illustrates the arrangement of the mechanism. A power cross feed is provided for the table and also a power lateral traverse for the carriage, when specified. The nuts for the screws are made in two parts, as shown in Fig. 4, for taking up wear or backlash. One section of the nut has a flange, as shown, and the other part can be adjusted longitudinally by a threaded collar, but is held against rotation.

The bearings for the spindle are located at the extreme ends of the saddle, thus giving a rigid support. A sectional view of the rear bearing is shown in Fig. 5. These bearings are of phosphor-bronze and can be easily adjusted from the outside, in case of wear. The knockout or limit stop for the extreme travel of the spindle is shown in Fig. 1. An intermediate gear located between the feed change gears and the feed driving gear, rotates screw *S*. A nut on this screw is moved a certain predetermined distance, representing the maximum travel of the spindle. At the extreme travel of the nut, a lever segment is automatically actuated, which disengages the feed back-gear clutch and throws it to the neutral position, thereby stopping the feed.

When the machine is used for splining, the spindle is moved in and out without rotating, by the rapid power traverse. The spindle gear clutch is set in the neutral position, thus disengaging the spindle driving gears, and a guide key (see Fig. 5) is inserted in the milling clamp collar at the end of the saddle. This key engages one of the splined ways in the spindle, and the collar is held against rotation by a friction band which is tightened by a thumb-screw on the outside of the bonnet. Both the collar and spindle are held in this way against rotation, and the spindle is guided, as it moves lengthwise, by the key previously referred to. Spiral oil grooves of different pitches can also be cut by using the rapid power traverse in conjunction with the rotary movement of the spindle. When cutting spiral grooves, the clamp collar used for straight grooving is, of course, disengaged.

Graduated dials reading to thousandths of an inch are provided for all movements, and precision screws are used throughout. On the front end of the saddle there is an "indicator" corresponding to the center of the spindle, which is convenient for adjusting to a given height with a surface gage, when boring. The table is clamped directly under the spindle and the form of locking binder used is shown in Fig. 6.

These machines are built in two sizes at the present time, the principal dimensions of which are, respectively, as follows: Spindle diameter, 3 and 3½ inches; longitudinal traverse of spindle, 32 and 40 inches; spindle speed changes, 12 for both machines; feed changes, 16; vertical traverse of saddle, 21 and 25 inches; maximum height from table to spindle, 22 and 26 inches; maximum distance between saddle and outer support, 5 feet and 6 feet; table cross-feed, 30 and 36 inches; lateral traverse of table, 36 and 42 inches. These machines are so constructed that the standard range can be varied easily to suit special requirements, when necessary.

GARVIN AUTOMATIC-INDEX MILLING MACHINE

The milling machine shown in Fig. 1 is an automatic-indexing type, especially adapted to tap manufacturing plants. This machine is built by the Garvin Machine Co., Spring and Varick Sts., New York. In addition to the automatic fluting of taps and reamers, the machine can be used for cutting gears, ratchets or for repetition work of a similar nature. The modifications introduced in this design comprise quick-acting work-holding apparatus, automatic indexing, automatic feed with a quick return effected by a long spring and checked by an air cushion, and automatic stopping of the machine when the work is completed.

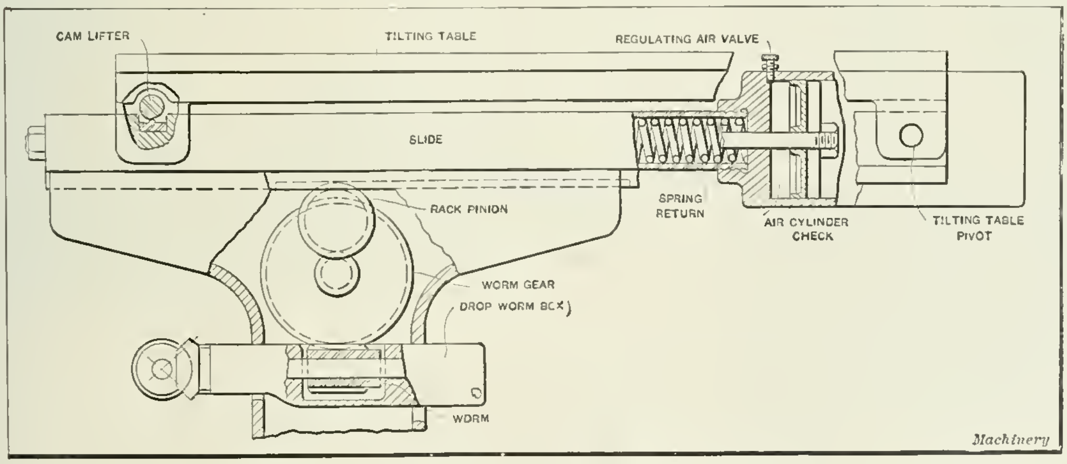


Fig. 2. Feeding and Quick-return Mechanism of Garvin Machine

When a cut is finished, the table is tripped by the dog seen to the left, which releases a latch and allows the feeding worm to drop out of mesh with the worm-gear. As the table is then disengaged from the power feed, it is moved rapidly to the other end of its travel by a spring enclosed in a tube at the end of the table. The arrangement of the feed gearing and quick-return mechanism is shown in Fig. 2. The rapid motion of the table is checked before the fixed stop is reached, by an air cushion formed in the cylinder shown by the section to the right.

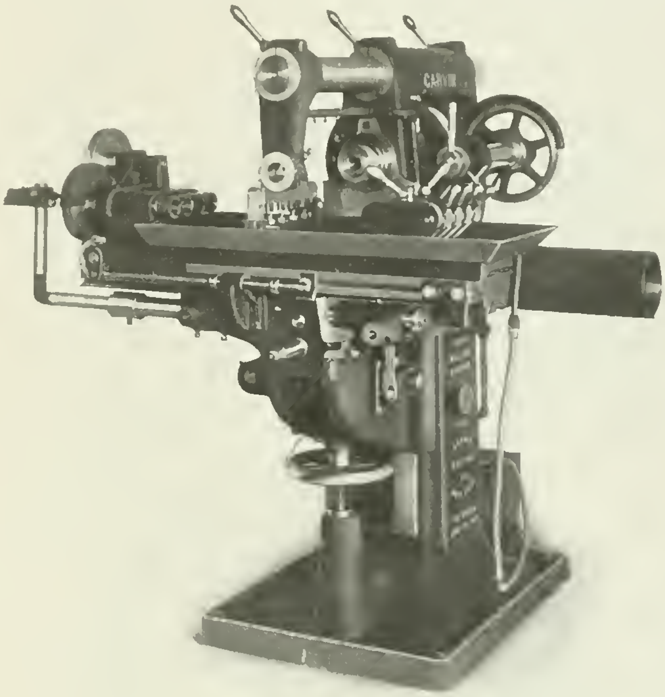


Fig. 1. Garvin No. 13 1/2 Automatic-index Milling Machine

At the same moment that the dog trips the table, the left-hand stop-collar on the screw seen in front of the machine to the left, Fig. 1, comes in contact with a stationary bracket; this trips the tilting table of the machine by means of a cam shown to the left in Fig. 2, the shaft carrying this cam being operated by the longitudinal movement of the screw on which the stop-collar is mounted. As the cam is turned, the table swings downward slightly, the swiveling movement being around a pivot at the right-hand end. This prevents the cutter from dragging when the work is being returned for another cut. As the table approaches its extreme position on the return stroke, the right-hand dog at the front strikes a stop-plunger, thus shifting the worm back into mesh with the worm-gear at the same moment that the table comes to rest. As the table reaches the end of its travel, the right-hand stop-collar on the screw previously referred to, strikes a stationary bracket and operates the cam lifter, thus tilting the table back to its working position. The index pawl is also lifted so that the dial can index, after which it falls back instantly.

The machine is now ready for another cut, and this operation of feeding forward, returning rapidly and indexing, continues until the work is finished. The machine then trips again and, on indexing, a projecting pin on the index dial pushes a sliding pin on the telescope bar seen to the left of the machine, and releases a rope connecting with a spring on the countershaft, thus stopping the machine.

The maximum distance between the centers is 16 inches, and a cut 7½ inches long can be taken anywhere within this distance. The centers have a capacity for holding work on all four spindles up to 2 inches in diameter, and diameters up to 4 inches can be handled, when only the two outer spindles are used. The weight of the machine is 2200 pounds.

HOSKINS RECORDING PYROMETER

A new recording pyrometer which is now being built by the Hoskins Mfg. Co., 459 Lawton Ave., Detroit, Mich., is shown in Fig. 1. The record chart of this pyrometer is always visible, thus making the instrument "indicating" as well as recording, and the electrical movement, as well as the clock and marking device, is at all times entirely enclosed, even when changing charts. In designing this pyrometer, the principal points aimed at were accuracy, reliability and simplicity.

The electrical movement of the pyrometer is a finely built milli-voltmeter of the D'Arsonval type. It is sensitive to a fraction of a milli-volt and was especially designed for this pyrometer. It is claimed that this milli-voltmeter is much less susceptible to outside temperature conditions than the ordinary types. It is actuated by the electro-motive force set up by a base metal thermo-couple which is connected by wire leads to the binding posts shown at the bottom of the meter case. This thermo-couple, when subjected to heat, is said to generate an electro-motive force four times as great as that of the ordinary platinum-rhodium couple, for a corresponding temperature; the additional power thus gained adds to the accuracy and reliability of the pyrometer.

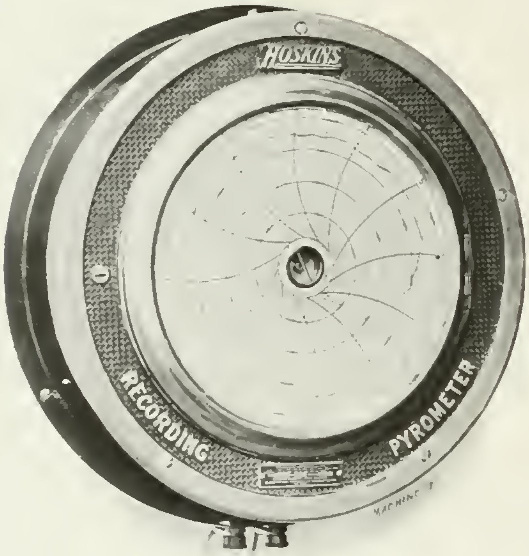


Fig. 1. Recording Pyrometer made by Hoskins Mfg. Co.

The record chart is caused to revolve by a clock movement contained within the meter case. The chart is a circular disk of paper which is thin and translucent but strong and durable. It is clamped in place on the revolving clock shaft by a small thumb-screw. A circular disk of carbon paper of the same size as the chart, is also clamped on the shaft, back of the chart and with the carbon side toward it. When a chart is being put in place, as shown in Fig. 2, it is held temporarily against a stationary dial-plate which completely covers the electrical and clock movements.

The clock also actuates an arm which is curved to correspond to the arc through which the end of the recording pointer travels. At half-minute intervals the curved arm momentarily brings a small stylus or metal point, carried at the end of the recording pointer, against the carbon paper, thus making a dot on the back of the chart. As the chart revolves, these dots, which are plainly visible from the front, continue to be made, giving the appearance of a continuous line, as shown in Fig. 1. The location of the dots relative to the concentric circles printed on the chart, indicates the temperatures to which the thermo-couple has been subjected. The charts are made to indicate degrees Centigrade or Fahrenheit, or milli-volts, as desired, and to cover periods of twelve or twenty-four hours.

This method of making records permits two records to be made at the same time, just as duplicate letters are made on the typewriter. When a considerable number of copies of any particular record are wanted, blueprints may be made directly from the chart. On the margin of the chart, a place is provided upon which to mark the date and time at which the record was started and the name of the furnace or operation. This pyrometer is especially desirable when it is necessary to intrust it to the care of an unskilled workman, as there is no exposed mechanism which the operator can put out of order. There are no pens or other inking devices to look after, and when the chart is removed from the meter, it is complete and ready for use, and requires no "fixing" solution as in the case of sensitized charts. As one sheet of carbon paper is sufficient for twenty records, the cost for carbons is very small. With the exception of the clock movement, which is a Seth Thomas standard eight-day movement, every part of the pyrometer is made by the Hoskins Mfg. Co.

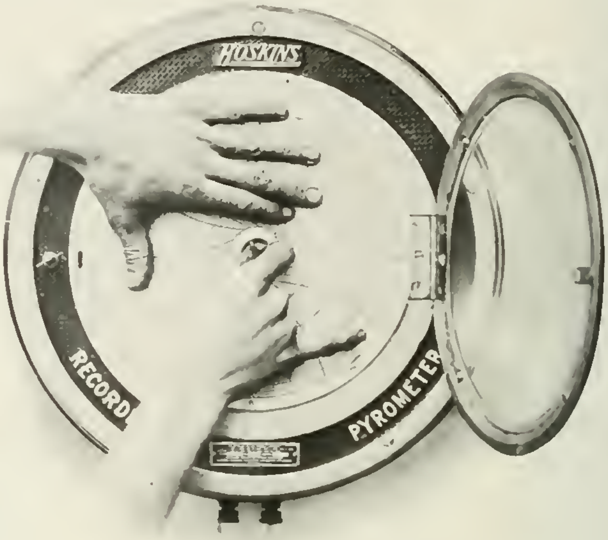
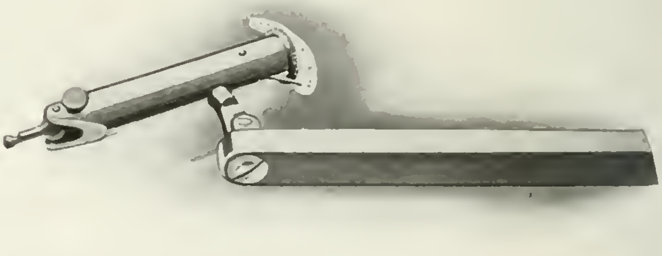


Fig. 2. Placing a New Chart in Hoskins Pyrometer

UNIVERSAL TEST INDICATOR

The universal test indicator illustrated below is made by the Alvan Mfg. Co., Newark, N. J. This indicator has hardened cone-pivot bearings which are kept in constant uniform adjustment by spring thrusts that prevent lost motion and consequently errors in reading. These cone bearings also make the indicator very sensitive, and it is claimed that no adjustment is ever required.



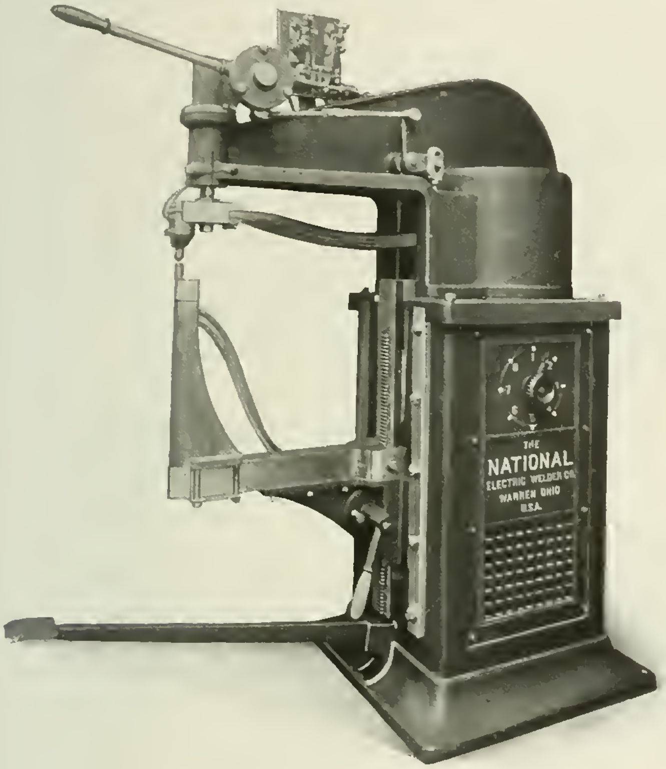
Universal Test Indicator

The indicator proper is attached to the toolpost holder by a universal joint, which is frictionally held in any desired position. By means of this joint the indicator can be set at any angle with relation to the shank. Either side of the contact point can be used, and the spring tension is reversed by half a turn of a button on the end of the barrel. This indicator multiplies error in the ratio of 50 to 1, and has a capacity up to 0.020 inch.

NATIONAL DROP-ARM SPOT WELDER

The National Electric Welder Co., Warren, Ohio, has recently placed on the market a new electric spot-welding machine which has been designed to combine the advantages of the regular horizontal machines with those of the special swing and drop-arm types. In designing this welder, the idea was to so construct it that such work as welding the side seams of a box or tube, a well as the bottom of a box or can, could be accomplished.

The lower arm was made adjustable to adapt the welder to a wide range of work. The front face of the column is machined and carries gibs, one of which is held in place by studs and nuts. By loosening the nuts, the supporting bracket with the low tension leads and welding point can be adjusted to any convenient height with relation to the upper point. The movement is effected by the wrench shown just below the horizontal arm, which operates a pinion mounted inside the bracket. This pinion meshes with a rack on the inside of the bed-plate, and has ratchet teeth on the side which are engaged by a spring-pin on the adjusting handle.



National Drop-arm Spot Welder

The current is conducted to the lower bar and welding point by the heavy copper conductor shown. This conductor is machined to fit into the end of the movable bar, and a solid and efficient contact is made at this point. The upper overhanging arm is of cast iron and is designed to resist springing or deflection, when subjected to the pressure required for making satisfactory welds.

This welder is known as the drop-arm type, and it is built in three sizes, having distances between the center of the welding points and the face of the machine of 12, 24 and 36 inches, respectively. The movable arm on all of these sizes can be dropped 25 inches from the highest point at which it can be used.

These machines have a combination hand and foot lever control. If the work being welded is of such a nature that the operator can use both hands to advantage in holding it, the welding points and switch can be operated by the foot lever, and, if desired, the hand lever can be removed. The machine can be also hand operated, in which case the foot treadle can easily be removed.

The machines are equipped with an automatic switch which operates only after the welding points are brought firmly into contact with the work. The act of releasing the pressure, whether using the foot- or hand-lever control, causes the switch to open, which prevents injury to the work or welding points by separating them after the welding current is broken. The copper contacts are cooled by a stream of water which is conducted to within ¼ inch of the faces bearing on the heated metal. In this way the parts are kept cool and the burning or "mushrooming" of the copper points is avoided.

TOLEDO ELECTRIC WELDERS

The Toledo Electric Welder Co., Langland & Knowlton Sts., Cincinnati, Ohio, has brought out a new welding machine designed especially for welding flat tires varying from ¾ by ¼ inch up to 2 inches by ¼ inch, or 1¾ by ⅜ inch. This is a power-driven machine and it will electrically weld a 1¼- by ¼-inch tire in 13 seconds.

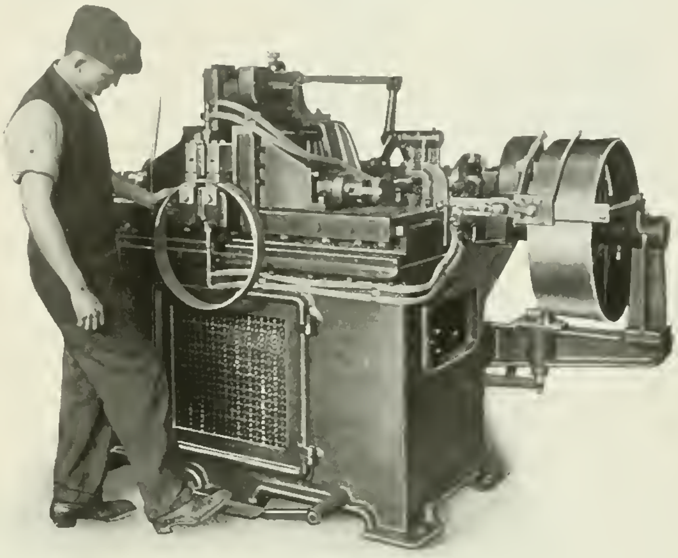


Fig. 1. Toledo Power-driven Machine for Welding Flat Tires

In the operation of the machine the tire is placed in the jaws of the welder, as shown in the illustration; the workman then presses a foot lever, the clamping jaws close on the stock and the ends are brought together. The current is automatically turned on, and in a few seconds the iron is raised to the welding temperature. When the heat is just right a second pressure on the foot lever automatically turns off the current and forces the ends of the stock together. At the same time two steel dies located between the clamping jaws come together and reduce the fin or projection that is raised, thus leaving the welded portion practically the same thickness as the rest of the stock so that grinding or hammering is not necessary. At the end of this second operation the

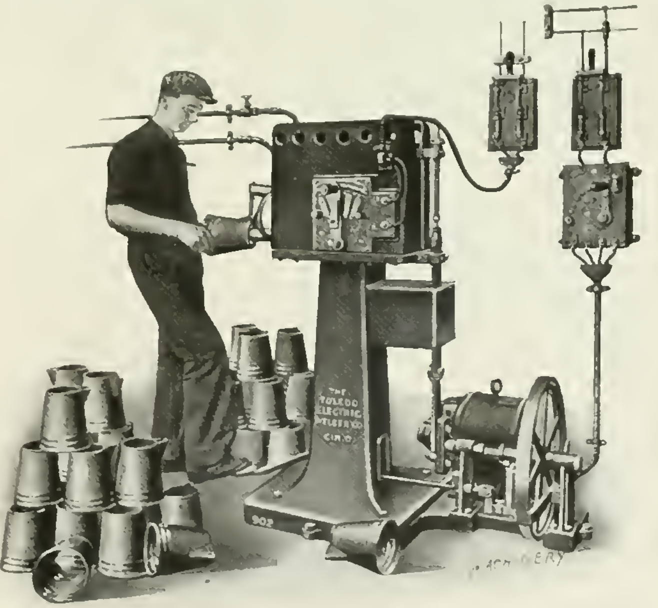


Fig. 2. Power-driven Spot Welder

clamping dies automatically open, after which the tire is removed and the next one is inserted. From 1800 to 2000 tires can be welded per day of 10 hours.

Alternating current is required to operate the welder, and it can be arranged for any standard voltage from 110 to 550 volts. A special transformer in the base of the welder reduces the voltage to from 3 to 5 volts, which is all that is used in the machine. This low voltage makes the machine absolutely safe, as the operator cannot get the slightest shock under any condition. A regulator is furnished to control the current, thus allowing the operator to vary the heat according to the size of stock to be welded. The dies are water cooled, and a very small amount of water is required. Adjustments are provided to vary the pressure of the welding heads, according to the size of stock to be welded.

This company has also added a new power-driven spot welder to its line. This machine is illustrated in Fig. 2, which shows an operator welding spouts on coffee pots. A small variable-speed motor furnishes the power for driving the machine, and welds are made at the rate of 80 to 150 per minute. The machine works on the same principle as the ordinary power-driven punch press. The operator presses down on a foot treadle which engages a clutch and starts the machine. When the foot pressure is released the machine stops, and when it stops the dies are open ready for the next weld. One weld or any number can be made. The welding dies move up and down like a sewing machine, as long as the treadle is held down.

When the dies are brought down on the stock the current is turned on to make the weld, and at the instant the melted metal is forced together the current is turned off. The current is controlled automatically and there is no possibility of drawing an arc and burning the stock when the die points are moved apart. The machine is easy to operate as a punch press, and there is no danger, either from the mechanical operation or the welding current. Like all welding machines, it is necessary to have a single-phase, alternating current. Where a two- or three-phase current is used, one phase of the multiphase system can be connected to the welder.

FOOTE-BURT MUD-RING AND FLUE-SHEET DRILL

The large two-head drilling machine illustrated herewith was designed primarily for drilling the mud rings and flue sheets of locomotive boilers but it is also suitable for a general line of heavy work. It is built by the Foote-Burt Co., Cleveland, Ohio. By referring to the front view, Fig. 1, it will be noted that each of the two heads is an independent and self-contained unit, thus permitting the feeds and speeds for each spindle to be regulated according to the size of the hole. The heads have an in-and-out adjustment of 8 inches on the knee, which, in combination with the 24-inch lateral adjustment of the table, makes it possible to cover a large lay-out at one setting of the work.

The saddles carrying the heads and motors are very heavy and have a four point bearing on the massive box-section cross-rail. The saddles are traversed along the rail by ratchet wrenches, and, owing to a suitable gear reduction, adjustment is easily made. The end view of the machine (Fig. 2) gives an idea of its massive construction and also shows the position of the driving motors. By mounting the motors as shown, a simple form of drive is secured. The primary drive from the motor is through a rawhide pinion and a coarse pitch spur gear to a horizontal shaft which transmits the motion through bevel and spur gearing to the spindle. The bevel gears are made of forged steel, have planed teeth and are carefully heat-treated and hardened. These gears run in extra-long bronze bushings, thus insuring alignment.

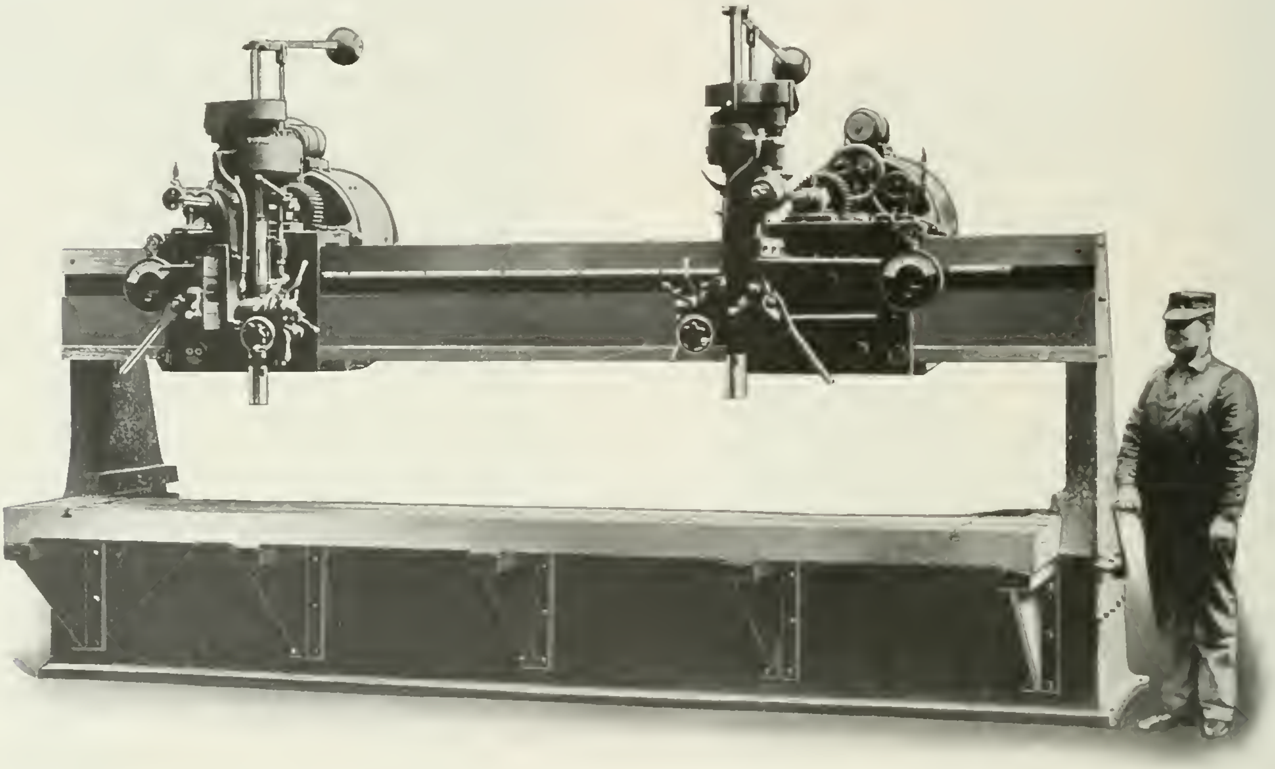


Fig. 1. Foote-Burt Mud-ring and Flue-sheet Drill with Reliance Speed Dial and Automatic Speed and Starting Control

Each spindle has an individual clutch, so that it can be started and stopped at will, without stopping the motor. With this arrangement, the motor can be adjusted for a single speed and need not be disturbed in case it is necessary to stop the spindle. The feed changes are obtained through a quick change gear device operated by a conveniently located lever. The power feed has an automatic stop, in addition to the usual hand trip and clutch, and there is a quick-return movement operated by the spider handwheel shown. The spindle and feed worms have ball thrust bearings of the company's own design. Each head is equipped with an individual oil pump and tank.

When drilling mud rings, the brackets supporting the table are removed and special mud-ring chucks are placed on the table, which is run back between the housings. The brackets are doweled in position, and can be removed and replaced readily.

The possibility of eliminating gear changes and using wide-range motors in conjunction with a direct drive is well illustrated by this equipment. Adjustable-speed, 7½-horsepower motors of the armature-shifting type are used. These are made by the Reliance Electric & Engineering Co., and have a speed range of from 200 to 1600 R. P. M. The shifting of the armature for obtaining the speed changes is effected by a small motor which is mounted on top of the main driving motor, as shown in Fig. 2, connection being made with the shifting mechanism through a chain and sprockets. To adjust the speed, the operator simply presses the "fast" or "slow" button of a small speed control "station" conveniently located at the front of each head.

This machine is equipped with a Reliance speed dial similar in principle to the one illustrated and described in the department of New Machinery and Tools, for March, 1912. This particular dial has two scales, the upper one of which is graduated to show the cutting speeds in feet per minute, and the lower one, the various sizes of drills. The dial is first set for the cutting speed desired, by turning a small knurl in front of the case; the speed of the motor is then adjusted until the pointer is opposite the size drill to be used.

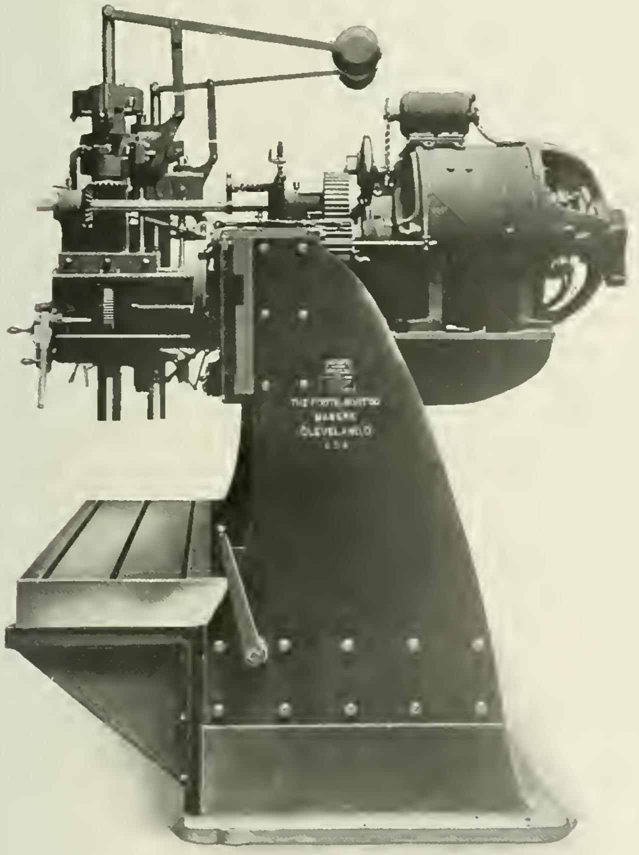


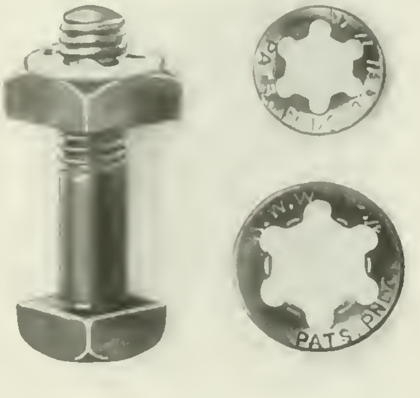
Fig. 2. End View of the Foote-Burt Machine

The starting and stopping of the motor is controlled through automatic starters operated by push buttons. These starters are located on each head close to the speed control station. This combination of automatic starting and speed control enables the operator to give his entire attention to the work in hand.

This machine has a width between the housings of 14 feet 4 inches, and the maximum distance from the end of the spindle to the table is 21½ inches. There is a 12-inch power feed and three feed changes varying from 0.006 to 0.020 inch. The maximum and minimum center distances between the spindles are, respectively, 10 feet and 18 inches. The spindle speeds range from 37 to 347 R. P. M. The table has a working surface of 14 feet 4 inches by 24 inches, and the weight of the machine is 28,000 pounds.

WORTH WEDGE-WASHERS

There are many different ways of locking a nut on a bolt, but comparatively few of the innumerable devices designed for this purpose have come into general use. Either the expense of manufacturing the device has been prohibitive, or its application to a bolt or nut has required too much time. The Steel Specialties Co., Boston, Mass., has placed on the market a very simple device which, it is claimed, effectively prevents a nut from jarring off a bolt. This nut fastener is in the form of a washer which, as shown by the illustration, has a scalloped inner edge with projections or prongs which point outward before the washer is applied to a bolt. After the washer is placed over a bolt, it is straightened or flattened by driving it down with a punch or larger size nut, which causes the prongs to wedge tightly between the threads of the bolt and the body of the nut. A washer has been applied in this way to the bolt shown in the illustration. After a washer is in place, the nut can be screwed off with a wrench, but it will not jar off. The "wedge-washer" can be removed easily by severing one side with a chisel, and it is said to leave the thread uninjured.



Wedge-washers to prevent Nuts from Jarring Off

NEW BRITAIN PORTABLE STEEL TOOL-RACK

The portable tool-rack or work-stand shown herewith is made of steel instead of cast iron, which gives a light but strong construction. The corners of the drawn-steel trays are rounded to facilitate cleaning, and the trays are stiffened by return flanges on the edges, which also contain the corner braces. The legs are screwed into the braces attached to the upper tray and pass through the lower ones. The lower pans can be fastened to the legs at any desired height. In all trays, the holes for the brace rivets or legs are at the top edge of the pan, so that oil cannot leak through them.

These tool-racks are made in two sizes. The size illustrated is 26 by 32 inches, and there is a smaller size measuring 20 by 26 inches. The casters have ball-bearing swivels and the balls are in a retainer cage and can be handled as a unit. These racks are manufactured by the New Britain Machine Co., New Britain, Conn.

Tool-rack or Work Stand made of Steel

NEW MACHINERY AND TOOLS NOTES

Boring Tool. R. M. Clough, Tolland, Conn. Adjustable boring tool for sizing holes either to standard diameters or slightly under, when a finishing reamer is to be used. This tool has blades which are clamped in position with a square-ended wrench.

Tool Grinder. J. G. Blount Co., Everett, Mass. Wet tool grinder similar in construction to machines previously built by this company, but considerably heavier. The bearings are self-oiling, and the wheel is 30 by 3 inches. The machine is equipped with a vertical, centrifugal pump.

Toolpost Grinder. American Electric Tool Co., West Newton, Mass. Portable electric grinder carrying a 6 by ⅜-inch wheel, which operates at a speed of 3500 R. P. M. This grinder can be applied to a lathe toolpost and is applicable to the grinding of lathe centers, milling cutters, etc.

Tool Grinders. Northampton Emery Wheel Co., Leeds, Mass. Wet tool grinders having wheels 16, 20 and 24 inches in diameter, respectively. Water is thrown up against the wheel from a tank in the base, by an endless chain, and the quantity can be varied by a conveniently located lever.

Die Milling Machine. Harrington Machine Co., Erie, Pa. The spindle of this machine is at right-angles to the work-table, and clearance in the dies is obtained by using angular mills. Both the table and spindle can be tilted to an angle either to the right or left to secure better light or to suit the convenience of the operator.

Riveting Machine. C. W. Meadowcroft, Sr., 4702 Large St., (Frankford), Philadelphia, Pa. Rotary riveting machine built in the following styles: As a bench machine with foot control, as a column foot-lever type, and as a dial feed machine, the latter taking the place of the foot-lever designed for certain classes of work.

Electric Furnace. Multiple Unit Electric Co., 136 Liberty St., New York. Electric muffle-furnace with special controller built in the furnace case. Temperatures varying from 200 to 1800 degrees F. can be maintained indefinitely, and the furnace will operate on a 100 or 220 direct or alternating-current circuit, but cannot be used with both circuits, as the controller is built with reference to the voltage.

Band Finishing Machine. Gardner Machine Co., Beloit, Wis. Motor-driven band finishing machine, the wheels of which are mounted directly on the armature shaft. Adjustable, cast-iron dust-hoods nearly enclose the wheels, and there is an opening at the bottom for exhaust connection. The band wheel is so arranged that the band is kept taut under a constant spring tension. This machine is also made for a belt drive.

Tube Cleaner. Joseph T. Ryerson & Son, Chicago, Ill. Tube-cleaning attachment designed to be used in connection with this company's tube-cutting machine. The principal parts are a friction wheel, and adjustable twin-roller cleaning burrs which are built of hardened serrated steel disks. These cleaning burrs are assembled in a unit, which is readily interchanged with the roller tube support employed when the machine is used for cutting tubes.

Cylinder Boring Machine. Newton Machine Tool Works, Inc., Philadelphia, Pa. Locomotive cylinder and valve chamber boring and facing machine, so designed that the valve chamber can be bored without resetting the work. The table has a vertical adjustment and the spindle, which is 7 inches in diameter, has a rapid power traverse in either direction, in addition to the hand adjustment. The minimum distance between the center of the spindle and the top of the table is 16 inches and the maximum, 40 inches.

Gear-cutting Machine. E. J. Flather Mfg. Co., Nashua, N. H. Forty-inch automatic gear-cutting machine arranged with a bevel gear attachment and equipped with a motor drive. The power is transmitted through an endless leather belt, the tension of which is varied by adjusting the base of the motor. The indexing mechanism is enclosed and mounted in a detachable bracket. The machine is built on the unit system, and the indexing, feed, and speed mechanisms, as well as other parts, are finished and tested before being assembled.

Gang Drill. W. F. & John Barnes Co., 231 Ruby St., Rockford, Ill. 20-inch, sliding-head gang drill made with from two to six spindles. This machine can be equipped with either a plain lever feed, a combined lever and worm feed, or a self-feed and automatic stop. The automatic stop mechanism is so designed that it can be set to disengage the worm from the worm-gearing, thus permitting the drill spindle to be returned quickly, or it can be arranged to disengage the miter feed gears, which stops the feed but leaves the worm-gearing in mesh for accurate facing operations.

Drilling Machine. Langelier Mfg. Co., Providence, R. I. Special drilling machine intended for drilling and countersinking two holes on the opposite sides of jewelry beads. The machine is also applicable to many other uses. It is equipped with two vertical spindles which are opposed, one being below and the other above the part to be drilled. These spindles are actuated through rack and pinions and both move toward the work simultaneously. To cases where it is necessary to drill two holes on the same axis and part way through the work, this machine is especially adapted.

Turret Drilling Machine. Turner Machine Co., Danbury, Conn. Four-spindle turret drilling machine intended for work requiring more than one operation at one setting. The spindles are mounted in a vertical turret and are driven through spur gears. By means of an indexing device, any one of the four spindles can be quickly located and locked in the operating position. The maximum distance from the operating spindle to the table is 28 inches. The over-all height is 6 feet 2 inches, and the weight 700 pounds. This machine is also built in other styles and sizes to suit different classes of work.

Loxograph. The Loxograph Instrument Co., Wilmington, Del. The loxograph is a triangular straightedge as well as a true 45-degree angle, and the ruling edges are supported out of contact with the paper by hardened steel knife-edged wheels. As these wheels do not pick up ink, the instrument can be moved over wet ink lines without blurring or smearing them, so that the work of making ink drawings can proceed rapidly, as it is unnecessary to wait for the ink to dry. Flooding is also impossible, even though the ink wets the ruling edges. The loxograph is made in 5¾- and 10-inch sizes, respectively. The instrument has been thoroughly tested, and is said to effect a considerable saving in time.

Tool-Grinding Machine. Brown & Sharpe Mfg. Co., Providence, R. I. Universal and tool-grinding machine which will take work up to 18 inches in length and swing 12 inches. It is especially adapted to the grinding of milling cutters, straight or taper reamers, etc. This machine can also be used for straight or taper cylindrical grinding, and, by means of attachments, internal and surface grinding can also be done. The base and column are cast in one piece, thus giving a rigid support for the wheel spindle. The spindle head has a traverse adjustment of 1½ inch, a vertical adjustment of 4 inches, and a radial movement to any position. The sliding table is operated by a crank at the front of the saddle, and can be swiveled to 45 degrees either side of the central position. Sixteen changes of work speeds are obtained through a multiple, friction-disk speed mechanism. Provision is made for wet grinding.

* * *

THE TRAINING OF DRAFTSMEN

In a paper read before the American Society of Engineer Draftsmen, Mr. F. G. Higbee gave a brief summary of the particularly important subjects in which a draftsman ought to be proficient in order to fill his position in life to the best advantage to himself and his employer. Primarily, a draftsman must know how to draw; that is, he must have mastered the technique of drawing and must be able to execute a neat and clear drawing with legible letters and dimensions. This, of course, is merely a foundation upon which to build. A good draftsman must have a good grasp of shop methods and should have a fair conception, both by observation and actual practice, of patternmaking, foundry practice, forging and machining operations. Next, a good draftsman and designer must have a grasp of the theoretical principles of mechanisms. Pulleys, belting, gearing, mechanical movements, fastenings, bearings, and lubrication are the elements which he should take up in turn and study and discuss with those who could give him practical pointers.

It is also necessary in order to be a fair draftsman and designer to have some knowledge of the properties of the various materials used in engineering work and machine construction. He must also have a fair knowledge of the mathematical and mechanical principles involved in calculations of the strength of materials. Mathematics is ever an important subject and one on which many draftsmen fall short. The so-called higher mathematics are, perhaps, seldom required, but trigonometry and logarithms and a fair portion of plane and solid geometry will never fail to prove useful. The good machine designer also needs an understanding of the principles of physics and chemistry; the practical application of electricity and magnetism; the laws of vapors and gases; hydrostatics, and in general, of the fundamental physical laws which are the foundation of all engineering work. Last, but not least, the study of English should never be overlooked or neglected by one who expects to hold anything but a subordinate position. Its proper use is essential to every man who would win the respect and confidence of his associates and superiors, and no training in engineering is complete without a knowledge of how to convey ideas correctly in written form.

This outline gives the necessary foundation for any draftsman who hopes to be able to advance, and it provides a foundation upon which any man may build, no matter to what aspirations his ambition may have inspired him.

DRILLING MACHINES FOR PANAMA CANAL GATES

Sixteen electrically operated machines of special construction are being used for drilling and reaming rivet holes in the enormous lock gates of the Panama Canal. Each of these machines weighs about six tons. They are mounted on broad adjustable scaffolds which are suspended on chains attached to brackets on top of the gate, as shown in Fig. 3. On each scaffold there is a standard gage track along which the machine is moved for drilling the horizontal rows of rivet holes. This movement is effected by the inclined handwheel seen in Fig. 1, which is a front view of one of the machines. This handwheel operates through a train of gears, and the adjustment can readily by made as roller bearings are used.

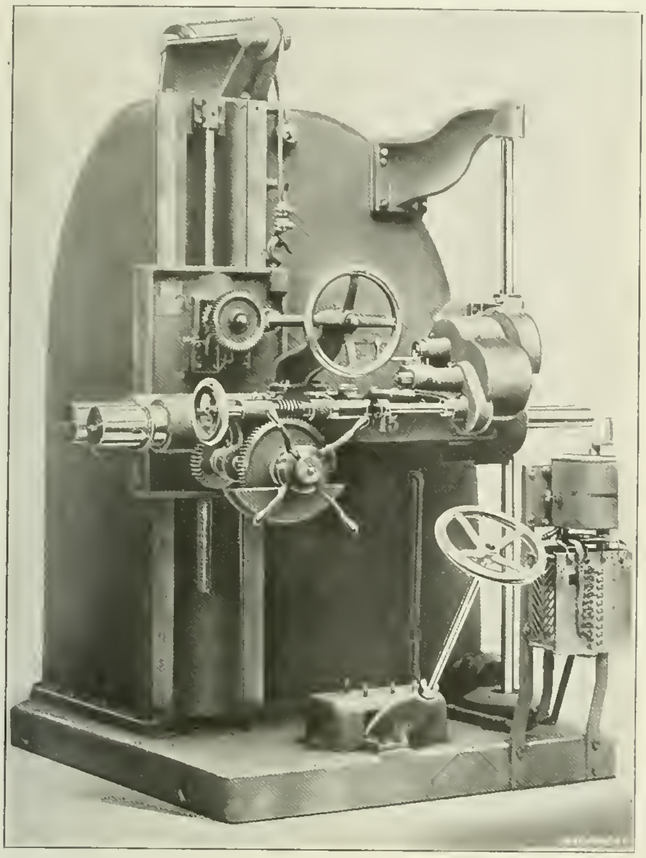


Fig. 1. Foote-Burt Special Drilling Machine for Canal Gates

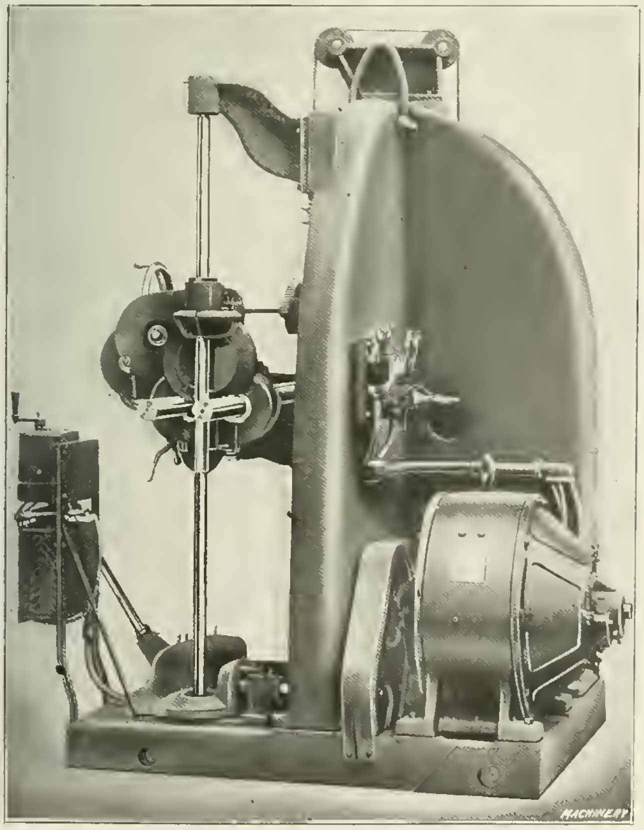


Fig. 2. Side View showing Motor Drive

All of the controlling mechanism is centrally located as the illustration shows. The horizontal shaft and handwheel above the spindles, actuates, through suitable reduction gearing, a screw which raises and lowers the drilling head. This head is counterbalanced so that vertical adjustment is easily made. The spindles have a quick-return movement effected by any one of the four levers of the spider-wheel shown.

Each machine has four changes of power feed which are obtained through a quick change gear mechanism. The length of the power feed is 16 inches and either of the spindles can be fed independently. The clutch lever for engaging either spindle is located just above the No. 15 seen on the head of the machine, and the feed changing lever is just above this clutch lever. There are nine speeds varying from a very slow speed for heavy drilling, to very high speeds for lighter work. The spindles are arranged to suit the uniform spacing of the rivet holes in the lock gates. During a test made at Gatun, one of the machines drilled 1 1-16 holes through 1-inch plates in four seconds, or at the rate of 15 inches per minute.

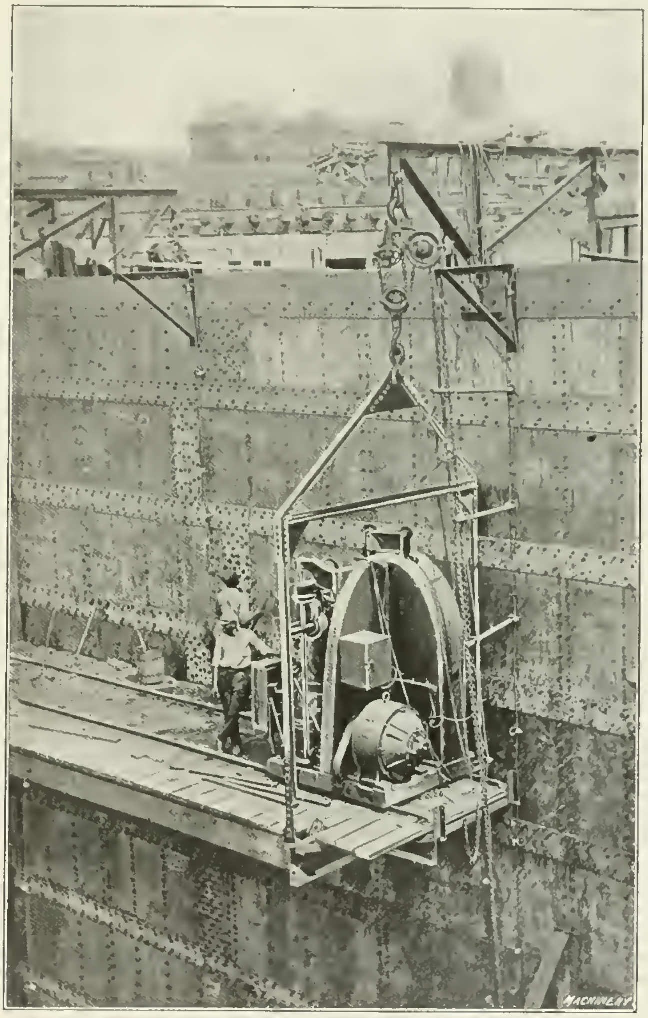


Fig. 3. Drilling Machine on Scaffold for Drilling Rivet Holes in Panama Canal Lock Gates

These machines are driven by Westinghouse direct-current, adjustable-speed, shunt-wound motors rated at 10 horsepower. The motor is mounted directly on the base, as shown in Fig. 2, and connection is made with the spindles through the gearing shafts, as shown.

These machines were placed in operation in February of this year, on the main gates at Gatun, and they are to be used on all the gates in the three locks. They were designed and built by the Foote-Burt Co., Cleveland, Ohio, especially for use on the Panama Canal.

* * *

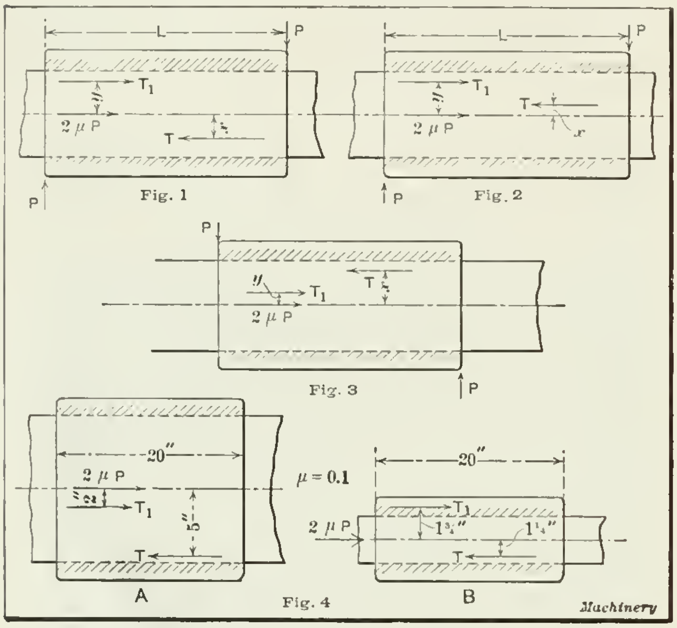
The third and last installment of "Watch Movement Manufacture" will appear in a future number.

THE ADVANTAGE OF THE NARROW GUIDE

By JOSEPH JEWSBURY*

The recent articles on the "narrow guide" which have appeared in MACHINERY have called attention to facts which have not been recognized hitherto by many designers of machinery. The writer, in common with others, had instinctively accepted as an axiom that the narrow guide did reduce "cross-wind," and had never attempted a mathematical analysis of the conditions. In the catalogues of some leading makers of machine tools, it is stated that one of the advantages of the narrow guide is that it reduces "cross-wind."

In the present article the writer intends to deal with the question of the relative locations of the guide center, feeding force, and the main resistance. This will, in a way, supplement the analysis given by Mr. H. T. Millar in the May number of MACHINERY, engineering edition. Five arrangements of positions of guide center line, feeding force, and resistance of cut are possible. Three of these are indicated in Figs. 1, 2 and 3.



Analysis of the Action of Forces involved when Moving a Slide against the Resistance of a Cut

In Fig. 1, the guide center line is located between the feeding force T and the resistance T_1. Fig. 2 shows T and T_1 on the same side of the guide center, T_1 having the greater eccentricity, and in Fig. 3, T acts at a greater distance from the guide center than T_1 and on the same side of it. The two remaining conditions are when the feeding force is in the same line as the cutting resistance, either eccentric to the guide center or on the same line.

Using the notation shown in the accompanying engraving, we have from Fig. 1:

$$P\,L = T\,x + T_1\,y \qquad (1)$$

$$2\,\mu\,P = T - T_1$$

$$\text{Hence, } P = \frac{T - T_1}{2\,\mu} \qquad (2)$$

From (1) and (2):

$$\frac{L\,(T - T_1)}{2\,\mu} = T\,x + T_1\,y$$

$$T = \frac{T_1\,(L + 2\,\mu\,y)}{L - 2\,\mu\,x} \qquad (3)$$

In Fig. 2, $P\,L = T_1\,y - T\,x$, and by proceeding as before, we find:

$$T = \frac{T_1\,(L + 2\,\mu\,y)}{L + 2\,\mu\,x} \qquad (4)$$

Similarly for Fig. 3, $P\,L = T\,x - T_1\,y$, and

$$T = \frac{T_1\,(L - 2\,\mu\,y)}{L - 2\,\mu\,x} \qquad (5)$$

In the other two cases T is equal to T_1, neglecting other resistances.

Comparing the results (3) and (4), and (3) and (5), it is obvious that, with the same values for L, T, x and y, the feeding force is greatest with the arrangement shown in Fig. 1. The dimensions of x and y determine whether the arrangement in Fig. 2 or Fig. 3 is more efficient. As an example, assume that $T_1 = 2000$ pounds, $L = 20$ inches, $x = 4$ inches, $y = 6$ inches, and $\mu = 0.1$.

In Fig. 1, Equation (3),

$$T = \frac{2000\,(20 + 2 \times 0.1 \times 6)}{20 - 2 \times 0.1 \times 4} = 2208 \text{ pounds.}$$

In Fig. 2, Equation (4),

$$T = \frac{2000\,(20 + 2 \times 0.1 \times 6)}{20 + 2 \times 0.1 \times 4} = 2038 \text{ pounds.}$$

Hence, the feeding force is 170 pounds greater in the former case.

From (3) and (4) we find that the feeding force in Fig. 1 is to that in Fig. 2 as $L + 2\,\mu\,x$ is to $L - 2\,\mu\,x$. From (3) and (5) we find that the feeding force of Fig. 1 is to that of Fig. 3 as $L + 2\,\mu\,y$ is to $L - 2\,\mu\,y$. This shows that it is best, whenever possible, to have the feeding force act on the same side of the guide center as the cutting resistance. As pointed out in the article on this subject in the May number, the advantages of the narrow guide are dependent mainly on its correct location. That this is true, and that this is in fact the deciding factor, is proved by the expressions (3), (4) and (5), and can be strikingly illustrated by an example. Comparing the relative values of the feeding forces in cases A and B, Fig. 4, it will be found that for this particular case no advantage is gained by the adoption of the narrow guide, owing to the unfavorable location of the feeding force and the resistance.

$$\text{Case A, Equation (5), } T = \frac{T_1\,(20 - 2 \times 0.1 \times 2)}{20 - 2 \times 0.1 \times 5} = 1.03\,T_1$$

$$\text{Case B, Equation (3), } T = \frac{T_1\,(20 + 2 \times 0.1 \times 1.75)}{20 - 2 \times 0.1 \times 1.25} = 1.03\,T_1$$

Hence, T is practically the same in both cases.

Two well-known examples from practice may be pointed out where the feeding force acts on the same side of the guide center as the main resistance, *viz.:* the cutter slide of the Brown & Sharpe gear cutter illustrated in the article referred to in the May number of MACHINERY, and the side shaper of English design when arranged with a narrow guide.

* * *

NEW ELECTROPLATING PROCESS

Consul Horace Lee Washington, of Liverpool, England, reports that a new electroplating process has recently been developed by two Italian chemists. A description of this process recently appeared in *Chambers Journal.* The process is creating considerable interest, as it comprises a means of depositing metals of any character upon any insoluble surface by electrical energy. It is claimed that china, wood, glass, celluloid, paper and other substances which have hitherto been regarded as beyond the electroplater's art can be coated as easily as metals generally electroplated. The plating enters the fabric of the material so treated and becomes practically an integral part of it. If an attempt, for instance, is made to chip the plating from a glass vase the glass will come away with the metal coating. When plating china, the article must be in its unglazed condition, and glass which is to be treated must first be roughened by sandblasting to remove the polish, so as to enable the metal to secure a firm grip. The process, which is known as the Marino process, is also of considerable hygienic value in the household, where many articles may now be used plated with suitable metals. The possibility of being able to deposit a coating upon aluminum, for example, thus saving it from oxidation, will popularize the use of this metal in the home and in many industries where it is now excluded on account of the fact that it rapidly corrodes in the presence of acids.

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M. C. B. AND A. R. M. M. ASSOCIATIONS CONVENTIONS

The forty-sixth annual convention of the Master Car Builders Association and the forty-fifth annual convention of the American Railway Master Mechanics Association were held at Atlantic City, N. J., June 12 to 19, inclusive. The Master Car Builders convention was held June 12, 13 and 14, and the Railway Master Mechanics convention June 17, 18 and 19, on Young's new pier.

The technical program of the Master Car Builders Association included the following papers and discussions:

June 12—"Train Brake and Signal Equipment"; "Brake Shoe Equipment"; "Car Wheels."

June 13—Discussion of reports on "Safety Appliances"; "Rules of Interchange"; "Prices for Labor and Materials"; "Rules for Loading Materials"; "Damage to Freight Equipment by Unloading Machines"; "Overhead Inspection"; "Coupler and Draft Equipment"; "Car Trucks"; "Springs for Car Trucks"; "Train Lighting and Equipment."

June 14—Discussion of reports on "Train Pipe and Connections for Steam Heat"; "Tank Cars"; "Specifications for Tests of Steel Truck Sides and Bolsters"; "Capacity Marking of Cars"; "Lettering Cars."

The following officers were elected for the Master Car Builders Association:

President, C. E. Fuller, Union Pacific Ry.
First vice-president, M. K. Barnum, Illinois Central R. R.
Second vice-president, D. F. Crawford, Pennsylvania Lines.
Third vice-president, D. R. MacBain, L. S. & M. S. Ry.
Treasurer, John S. Lentz, Lehigh Valley R. R.
Executive Committee—R. E. Smith, Atlantic Coast Line; C. E. Chambers, Central R. R. of New Jersey; and Henry LaRue, Chicago, Rock Island & Pacific R. R.

The program of the American Railway Master Mechanics convention was as follows:

June 17—Discussion of reports on "Mechanical Stokers"; "Revision of Standards"; "Specifications for Cast Steel"; "Locomotive Frames."

June 18—Discussion of reports on "Main and Side Rods"; "Safety Valves"; "Safety Appliances"; "Design, Construction and Maintenance of Locomotive Boilers"; "Contour of Tires"; individual paper on "Increased Power Obtained with Superheat as Compared with the Maximum Power Obtained with Saturated Steam," by Prof. C. H. Benjamin and Prof. L. E. Endsley; "Steel Tires."

"June 19—Discussion of reports on "Flange Lubrication"; "Minimum Requirements for Headlights"; "Standardization of Tinware"; "Maintenance of Superheated Locomotives"; "Engine Tender Wheels."

The following officers were elected for the American Railway Master Mechanics Association:

President, D. F. Crawford, Pennsylvania Lines.
First vice-president, T. Rumney, C. R. I. & P. R. R.
Second vice-president, D. R. MacBain, L. S. & M. S. Ry.
Third vice-president, F. F. Gaines, Central of Georgia Ry.
Executive Committee—G. W. Wildin, N. Y., N. H. & H. R. R.; C. F. Giles, L. & N. Ry.; and William Schlafge, Erie R. R.

The Railway Supply Manufacturers Association holds an annual exposition of railway car and locomotive parts, supplies, apparatus, etc., on the pier simultaneously with the conventions. The exhibit this year was larger than ever before, the space having been increased by extending the pier, thus making 7400 square feet additional space available, and increasing the total area to 83,500 square feet. Among the manufacturers exhibiting were the following:

Ajax Mfg. Co., Cleveland, Ohio Scrap reclaiming rolls and forgings.

American Infusion Steel Process Co., New York. Compound for casehardening and converting low-grade steel into high-grade steel.

American Tool Works Co., Cincinnati, Ohio. Motor-driven machine tools comprising 24-inch geared head lathe, 16-inch relieving lathe, 2-foot geared radial drill, 6-foot plain radial drill, 16-inch shaper and 24-inch shaper.

American Vanadium Co., Pittsburg, Pa. Vanadium steel, iron, brass and bronze locomotive parts, vanadium steel forgings, etc.

Baker Bros., Toledo, Ohio. Automatic drilling machine.

Baush Machine Tool Co., Bethlehem, Pa. Hydro-pneumatic radial drill.

Bullard Machine Tool Co., Bridgeport, Conn. Forty-two-inch vertical turret lathe.

Carborundum Co., Niagara Falls, N. Y. Carborundum and Aloxite grinding wheels.

Chisholm & Moore Mfg. Co., Cleveland, Ohio. Chain hoists, and I-beam trolleys.

Davis Boring Tool Co., St. Louis, Mo. Line of Davis expansion boring tools.

Davis-Bournonville Co., New York. Oxy-acetylene welding and cutting apparatus, including the "oxygraph," a device working on the pantograph principle.

Duff Mfg. Co., Pittsburg, Pa. Track jacks and screw jacks.

Gilbert & Barker Mfg. Co., Springfield, Mass. Apparatus for storing and handling oils.

Goldschmidt Thermit Co., New York. Thermit products and exhibits showing the application of the thermit process for welding.

Gould & Eberhardt, Newark, N. J. Twenty-four-inch shaper and model showing construction of sixteen-inch shaper.

Edwin Harrington Son & Co., Inc., Philadelphia, Pa. I-beam trolleys and spur geared and screw hoists.

Higley Machine Co., New York. Cold metal saw.

International Oxygen Co., New York. I. O. C. generators for producing oxygen and hydrogen, etc.

Landis Machine Co., Waynesboro, Pa. Double head bolt cutters.

Lucas Machine Tool Co., Cleveland, Ohio. Precision horizontal, boring, drilling and milling machine.

Manning, Maxwell & Moore, Inc., New York. Hendey lathes, Gridley automatic machines, Cincinnati gear cutters, Cincinnati crank planers, Reed engine lathes, National Co.'s forging and heading machines, etc.

Newton Machine Tool Works, Philadelphia, Pa. Cold saw cutting-off machine of the internal type.

Niles-Bement-Pond Co., New York. Niles new model car wheel boring machine and Pond reversing motor drive planer.

Norton Co., Worcester, Mass. Grinding wheels and floor grinders.

Norton Grinding Co., Worcester, Mass. Ground car axles and car wheels.

Oxweld Acetylene Co., Chicago, Ill. Oxy-acetylene and oxy-hydric welding apparatus.

C. F. Pease Co., Chicago, Ill. Automatic blueprinting and washing machine.

Wm. Sellers & Co., Inc., Philadelphia, Pa. Locomotive injectors, parts of high power car wheel lathes, etc.

Standard Roller Bearing Co., Philadelphia, Pa. Roller bearings, car journal boxes and other anti-friction bearings.

Tabor Mfg. Co., Philadelphia, Pa. Inserted tooth saws.

Van Dorn & Dutton Co., Cleveland, Ohio.. Portable electric drills and reamers.

Vixen Tool Co., Philadelphia, Pa. Vixen files and machine for testing files.

Warner & Swasey Co., Cleveland, Ohio. Hollow hexagon turret lathe.

Watson-Stillman Co., New York. Hydraulic jacks.

Wilmarth & Morman Co., Grand Rapids, Mich. Surface grinders, lathe center grinders, drill grinders, etc.

Yale & Towne Mfg. Co., New York. Chain blocks, electric hoists, trolleys, locks, etc.

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SPRING MEETING OF THE A. S. M. E.

The Spring meeting of the American Society of Mechanical Engineers was held in Cleveland, Ohio, May 28-31. Past president Ambrose Swasey, chairman of the executive committee, opened the meeting with a speech of welcome. Dr. A. C. Humphreys, president of the society, spoke on the economic relations of the engineer and society. The professional sessions were held in the Chamber of Commerce, as was also the membership reunion and informal reception. The registration of members of all grades was the largest of any Spring meeting in the history of the society, being nearly 600. The technical program included the following papers and lecture:

"A New Analysis of the Cylinder Performance of Reciprocating Engines," J. Paul Clayton.

"Equipment of a Modern Flour Mill on a Gradual Reduction System," John F. Harrison and W. W. Nichols.

"Design and Mechanical Features of the California Gold Dredge," Robert E. Cranston.

"Problems in Natural Gas Engineering," Thomas R. Weymouth.

"Sound Waves—How to Photograph Them and What They Mean," Dr. Dayton C. Miller of the Case School of Applied Science.

"New Processes for Chilling Cast Iron," Thomas D. West.

"Strength of Steel Tubes, Pipes and Cylinders Under Internal Flume Pressure," Reid T. Stewart.

"On the Control of Surges in Water Conduits," W. F. Durand.

"Speed Regulation in Hydro-electric Plants," Wm. F. Uhl.

"The Present State of Development of Large Steam Turbines," A. G. Christie.

"A Discussion of Certain Thermal Properties of Steam," G. A. Goodenough.

"The Reduction in Temperature of Condensing Water Reservoirs Due to Cooling Effect of Air and Evaporation," W. B. Ruggles.

"Results of Tests on the Discharge Capacity of Safety Valves," E. F. Miller and A. B. Carhart.

An informal reception for the members was held at the home of Mr. and Mrs. Ambrose Swasey, Tuesday afternoon, May 28, and a reception and dance at the Colonial Club Thursday evening, May 30.

The plants of Warner & Swasey Co., Brown Hoisting Machinery Co., Winton Motor Co., Peerless Motor Car Co., National-Acme Mfg. Co., White Co., American Steel & Wire Co., Wellman-Seaver-Morgan Co., Akron; Goodrich Rubber Co., and the Diamond Match Co., at Barberton, were open to members.

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AEROPLANE EXPOSITION IN BERLIN

An International Aeroplane Exposition was held in Berlin, Germany, during the month of April. The most interesting fact brought out during the exposition was that so large a number of firms exist in Germany that are directly interested in the aeroplane industry. At the exposition there were 176 exhibitors in all, of which twenty-two were firms exhibiting aeroplanes. There are twenty-seven German firms building aeroplanes exclusively, and twelve more constructing aeroplanes in addition to other products. Many of these aeroplane factories are, of course, very small. Several, however, are organized wth a considerable capitalization—for example, one company is capitalized at $375,000, another at $150,000, another at $62,500, while three are capitalized at $25,000 each. There are between 400 and 500 aeroplanes in use at the present time in Germany. Of the forty aeroplanes shown at the exposition, thirty were monoplanes, nine biplanes, and one a triplane. The proportion of the various types, however, is somewhat misleading as regards the relative popularity of the various types, as the biplanes were exhibited by several of the German firms who had been most successful, while many of the monoplanes shown were experiments by unknown firms. For military purposes, and in general when the greatest speed is not essential, the biplane seems to have proved most satisfactory in Germany.

In general, the designs followed closely the various French types, and there was an absence of freak machines such as are generally seen at expositions of this kind. Consul General A. M. Thackara of Berlin, from whose report to the Department of Commerce and Labor the facts above are abstracted, states that, at the present time, America has little to learn from Germany as regards actual designs of aeroplanes, as the ideas in prominence at the Berlin exposition were largely of French and American origin. This condition, he states, will, however, probably not obtain much longer, as the aeroplane problem is now being attacked in Germany from every side both by the aviator in the field and the scientist in the laboratory.

The most powerful aeroplane exhibited was the Boris Loutzkoy monoplane which was fitted with two 100-horsepower "Argus" motors, each driving an independent propeller, revolving around the same axis. With both motors, the aeroplane, it is claimed, can attain a speed of ninety-three miles an hour. The machine can fly, however, with either motor alone. The weight, with pilot, one passenger, and supplies for a six-hours' flight is about 3000 pounds. The width of the machine is 62 feet, the length about 50 feet and the supporting surface, 560 square feet. The "Argus" motor used in this aeroplane is of the four-cylinder type, making 1250 revolutions per minute, and having a weight of 288 pounds or slightly less than 3 pounds per horsepower. Hilz of Dusseldorf exhibited a motor of 120 horsepower, the weight of which was only 2.2 pounds per horsepower.

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PERSONALS

Frank Salomon, president of the Otto Gas Engine Works, Philadelphia, Pa., will sail on the *Cincinnati* July 4 for a six weeks' trip in Germany.

Ehrich Krell, vice-president of the Otto Gas Engine Works, Philadelphia, Pa., will return July 1 from a three months' business trip to Germany and England.

C. E. Coolidge, Western representative of the Niles-Bement-Pond Co., has resigned to take charge of the manufacturing equipment in the various plants of the U. S. Motor Co.

Frederick J. Benjamin, advertising manager of the Pawling & Harnischfeger Co., Milwaukee, Wis., has resigned to become advertising manager of the *Iron Trade Review*, Cleveland, Ohio.

W. H. Shafer, for several years superintendent of the Cincinnati-Bickford Tool Co., Cincinnati, Ohio, has resigned to take the position of general manager of the Rivett Lathe Mfg. Co., Boston, Mass.

Charles A. Moore, president of Manning, Maxwell & Moore, Inc., New York, has returned from Europe, improved in health, after an absence of nearly two years, and has resumed attention to business.

John Johannigman, for the past ten years secretary of the Oesterlein Machine Co., Cincinnati, Ohio, resigned his position April 15. Mr. Johannigman intends to enter the machine tool manufacturing business.

H. Cadwallader, Jr., recently with the Isthmian Canal Commission at Panama, is now efficiency engineer with the Continental Motor Mfg. Co., of Muskegon and Detroit, Mich., installing the Taylor planning system.

Phil A. La Brie, formerly with the Gisholt Machine Co., Madison, Wis., has taken a position as salesman for New England with the Fitchburg Machine Works, Fitchburg, Mass., manufacturers of "Lo-swing" lathes.

J. E. Fries, engineer with the Crocker-Wheeler Co., Ampere, N. J., has been transferred to the San Francisco office as Pacific Coast engineer, where he will be able to render prompter service to the rapidly growing business of the company on the Pacific Coast.

Clarence A. Hills, who was lately made superintendent of the Abbott-Detroit Motor Co., Detroit, Mich., was presented by the employes of the Hupmobile Co., with whom he had been associated for the past two years, with a gold watch and diamond stickpin upon leaving to take his new position.

Dwight N. Lane has been made superintendent of the works of the Bantam Anti-Friction Co., Bantam, Conn. Mr. Lane, who was connected for ten years with the New Departure Mfg. Co., Bristol, Conn., is well equipped with long shop experience in connection with the manufacture of ball bearings for his new position.

Marion A. Morris has been appointed superintendent of the J. H. Sessions & Sons Co.'s plant at Bristol, Conn., succeeding Mr. Frank Garrigus, resigned. Mr. Morris was formerly connected with the Scovill Mfg. Co., and was superintendent for the Blake & Johnson Mfg. Co., from which position he recently resigned.

Joseph V. Woodworth, consulting engineer at the New York office of the Taft-Peirce Mfg. Co., Woonsocket, R. I., has resigned, and taken the position of consulting engineer and New York representative of the Boston Pressed Metal Co., Worcester, Mass., with offices in the Tribune Building, 154 Nassau St., New York.

J. P. Thompson, who has been employed as general superintendent of the Van Norman Machine Tool Co., Springfield, Mass. (formerly Waltham Watch Tool Co.), assumed his duties June 5. Mr. Thompson was until lately general superintendent of the Cameron Steam Pump Co., New York, and formerly was with the Pond Machine Tool Co., Plainfield, N. J.

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OBITUARIES

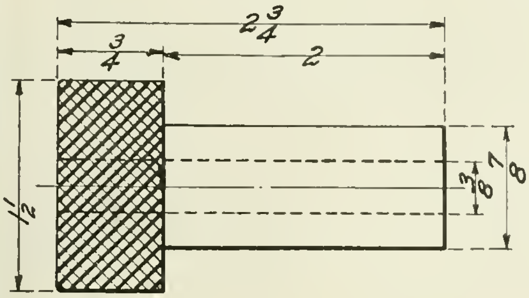
Gilbert Hart, inventor and patentee of safety emery wheels, in the manufacture of which he made a fortune, died May 31 in Detroit, Mich., aged eighty-four years.

Col. Francis A. Walker, the oldest employe of the E. & T. Fairbanks Co., St. Johnsbury, Vt., died April 26, aged eighty-seven years. Col. Walker entered the employ of the company at the age of twenty to learn the molders' trade, and for sixty-two years was a foreman.

Valdemar F. Lassoe died May 22 at his home, 83 Decatur St., Brooklyn, N. Y., aged seventy-six years. He was born in Copenhagen, Denmark, where he received an engineering education, and came to this country at the age of twenty-four. He was associated with Capt. John Ericsson in designing the *Monitor*, and subsequently worked with him for twenty-eight years. After Mr. Ericsson's death he became consulting engineer for the American Hawaiian Steamship Co., for which he designed twenty-eight steamships. He was also, for eighteen years, consulting engineer for the North German Lloyd Co., and was the originator of the system now employed for using oil as fuel on steamships. He was a frequent contributor of engineering articles to technical journals. Mr. Lassoe is survived by a widow and one daughter.

Wilbur Wright, who, with his brother Orville, was the first to accomplish mechanical flight, died of typhoid fever at Dayton, Ohio, May 30, aged forty-five years. Wilbur and Orville were bicycle repairers in Dayton when they became

A correct feed for every operation on this piece without shifting a belt



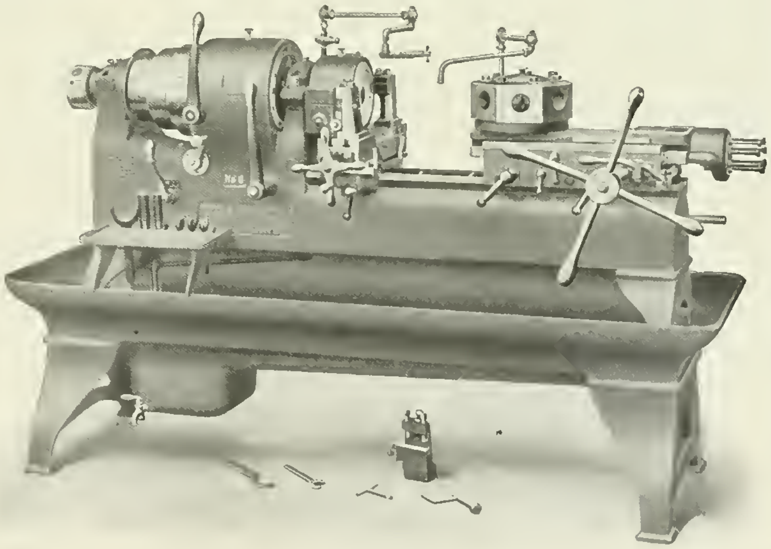
Selecting a feed for the fastest cutting tool and using it for all the others, or an alternative of shifting a belt for each operation are both unsatisfactory from the view points of economy and handiness. That is why

B. & S. Wire Feed Screw Machines

have wide ranges of self-contained feeds for the turret slide

The piece in question requires five turret operations consisting of roughing and finishing the smaller diameter, drilling and reaming the hole, and knurling the larger diameter. These operations necessarily call for a wide variation in feeds. It is possible to obtain a correct feed for each operation on the No. 6 Machine, in which this piece was produced, by the movement of one or both of two levers, one on the turret slide and the other at the headstock. Furthermore **the operator makes these feed changes without stopping the machine or moving from his position.**

Investigate these self-contained turret slide feeds on our Wire Feed Machines.



No. 6 Wire Feed Screw Machine

Write for further information about these machines.

BROWN & SHARPE MFG. CO.

PROVIDENCE, RHODE ISLAND, U. S. A.

interested in aviation. The first experiments were made with gliders, and the first flight with a motor propelled aeroplane was made at Kitty Hawk, N. C., December 7, 1903. This flight of 852 feet was made in 59 seconds. Numerous short flights followed, and on September 26, 1905, a flight of 11⅛ miles was made at Dayton in 38 minutes, 3 seconds, this one being longer than all previous flights put together. The Wright brothers were notable for modesty, reticence and perseverance. They worked under most discouraging circumstances for years before the world recognized that they had actually solved the problem of navigating the air.

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COMING EVENTS

July 9.—Annual convention of the American Railway Tool Foremen's Association in Chicago. H. L. Miller, secretary of the supply association, 835 Monadnock Bldg., Chicago, Ill.

August 20.—Annual convention of the International Railroad Master Blacksmiths' Association at Hotel Sherman, Chicago, Ill. J. E. Carrigan, Rutland Railway, Rutland, Vt., chairman of the executive committee.

September 2-7.—Sixth congress of the International Association for Testing Materials at the Engineering Societies Building, 29 W. 39th St., New York. H. F. J. Porter, secretary, 1 Madison Ave., New York.

September 24-26.—Annual convention of the American Foundrymen's Association and allied bodies, in Buffalo, N. Y.; Hotel Statler, headquarters. Richard Moldenke, Watchung, N. J., secretary.

October 4-26.—International Machinery Exhibition at Olympia, London, England, organized by the Machine Tool and Engineering Association, Ltd.

October 7-11.—Annual convention of the American Electric Railway Association and allied associations in Chicago, Ill. The exhibit will be at Dexter Pavilion, 43d and Halstead Sts. H. C. Donecker, secretary-treasurer, 29 W. 39th St., New York.

SOCIETIES, SCHOOLS AND COLLEGES

Cornell University, Ithaca, N. Y., opened Rand Hall May 23 with appropriate exercises. The building, 50 by 170 feet and three stories high, is a memorial to Jasper R. Rand, Jasper R. Rand, Jr., and Addison C. Rand.

New Haven Manufacturers' Exhibit Association, New Haven, Conn., has been organized by the manufacturers of New Haven for the purpose of making a permanent industrial exposition. About eighty per cent of the manufacturers have taken space and installed exhibits in the Auditorium Bldg., 671-673 Chapel St.

National Metal Trades Association, New England Bldg., Cleveland, Ohio. Proceedings of the fourteenth annual convention of the association at the Hotel Astor, New York City, April 11, 1912. The proceedings include a number of valuable technical papers on industrial education, employers' liability and workmen's compensation laws, safeguarding machinery, etc.

University of South Carolina, Columbia, S. C. Catalogue for the year 1911-12, together with announcements for the year 1912-13. This catalogue contains the usual information relating to the courses of study, the requirements for admission, and the departments of instruction, together with a list of students. It is illustrated with unusually fine halftones showing the various buildings of the university.

American Museum of Safety, 29 W. 39th St., New York. Paper entitled "Boat Installations and other Life-saving Devices for Safety at Sea," prepared by Mr. Axel Welin, of London, England, and read at a meeting under the auspices of the museum at New York, May 9, 1912. The paper is well illustrated with halftones and line engravings showing the arrangement of life boats and davits.

Polytechnic Institute of Brooklyn, Brooklyn, N. Y. Catalogue of the college of engineering 1912-13. This catalogue gives a list of the faculty and instructors, and general information relating to the courses, admission requirements, fees, scholarships, etc. Some interesting information relating to the history of the Polytechnic Institute, its equipment, administration, regulations, and student organizations, is also given, together with a roster of students for 1911-12.

American Museum of Safety, 29 W. 39th St., New York. No. 3 of the "Manuals of Safety," covering foundry practice, by Wm. H. Tolman, director of the museum. This little book, consisting of forty 4½- by 7-inch pages, reviews especially the dangers of the foundry and the departments connected with it, and suggests a number of remedies to avoid accidents and injurious effects on the health of the workers. The book is profusely illustrated, and sells at 25 cents.

University of Wisconsin, Madison, Wis., announces that the twelfth annual six weeks' summer school of its College of Engineering opens June 24. Courses of instruction and laboratory practice are offered in electrical, hydraulic, steam and gas engineering, mechanical drawing, applied mechanics, testing of materials, machine design, shop work and surveying, in addition to which, subjects may be taken in the College of Letters and Science. Further information may be obtained from Dean F. E. Turneaure, University of Wisconsin, Madison, Wis.

NEW BOOKS AND PAMPHLETS

The Evolution of Vertical Lift Bridges. By Henry Grattan Tyrrell, bridge and structural engineer, Evanston, Ill., reprinted from *Applied Science*, 1912.

Bolts, Base Plates and Plating for Steel Stacks. By Arthur M. Green, Jr. 16 pages, 6 by 9 inches. Published by the Rensselaer Polytechnic Institute, Troy, N. Y.

An Analytical Study of the Action of the Vacuum Dashpot. By Karl Nibecker. 22 pages, 6 by 9 inches, and one folding chart. Published by the University of Pennsylvania Mechanical and Electrical Engineering Department, Philadelphia, Pa.

Twenty-Third Annual Report on the Statistics of Railways in the United States, for the year ending June 30, 1910. 898 pages, 6 by 9 inches. Published by the Interstate Commerce Commission, Washington, D. C.

Proceedings of the Thirty-first Annual Convention of the American Water Works Association. Held at Rochester, N. Y., June 9-10, 1911. 490 pages, 6 by 9 inches. Published by the secretary of the society, 47 State St., Troy, N. Y.

Starting Currents of Transformers. By Trygve D. Yensen. 43 pages, 6 by 9 inches. 18 illustrations. 6 tables. Published by the University of Illinois, Urbana, Ill.

This is bulletin No. 55 issued by the Engineering Experiment Station of the University of Illinois, and deals with the starting currents of transformers with special reference to transformers with silicon steel cores, in which the current may rise to more than seven times the full load current—a phenomenon which is fully explained in the bulletin.

Constructing Concrete Porches. By A. A. Houghton. 62 pages, 5 by 7¼ inches. 18 illustrations. Published by Norman W. Henley & Son, New York. Price 50 cents.

This book is No. 9 in a series of reference books for concrete workers and contains a treatise illustrating and describing the construction of monolithic concrete and concrete block porches, taking up the molding of columns, balusters, lattice work and railings, as well as plain and reinforced types of porch floors. The book is concise and direct in the treatment of its subject.

Tests of Columns. By Arthur N. Talbot and Arthur R. Lord. 44 pages, 6 by 9 inches. 20 illustrations. Bulletin No. 56 of the University of Illinois, Urbana, Ill.

This bulletin contains an investigation of the value of concrete as reinforcement for structural steel columns. The tests recorded show that structural steel columns having a filling of concrete, if properly made, develop nearly all the strength of both the steel and concrete. The tests also show that up to the point of failure of the column, the fireproofing shell of the concrete adheres tightly to the remainder of the column.

Electrical Injuries. By Charles A. Lauffer. 77 pages, 4 by 6½ inches. Published by John Wiley & Sons, New York. Price 50 cents.

The author of this book is medical director of the relief department of the Westinghouse Electric & Mfg. Co., East Pittsburg, Pa., and is well qualified to treat the subject here dealt with. The book covers the causes, prevention and treatment of injuries with which workmen and others may meet in connection with electric currents. The book is intended to be of use to practical electrical men, and treats the subject in clear and simple language.

Concrete Bridges, Culverts, and Sewers. By A. A. Houghton. 58 pages, 5 by 7¼ inches. 14 illustrations. Published by Norman W. Henley & Son, New York. Price 50 cents.

This book is No. 8 in a series of reference books for concrete workers and contains a treatise illustrating and describing the various types of solid and reinforced arch, slab, and girder concrete bridges, and the molding of concrete culverts, drains and sewers. The book is written in a clear and concise manner and will prove useful also to persons who are not following concrete work as an occupation, but who wish to get a general idea of the methods and principles involved.

American Exporter's Export Trade Directory. Compiled by B. Olney Hough. 267 pages, 6 by 9 inches. Published by the Johnston Export Publishing Co., New York City. Price $3.00.

This book contains lists of foreign buying agencies in the United States, manufacturers' export agents, New York bankers engaged in foreign exchange business, foreign exchange dealers and brokers, marine insurance companies and export trucking companies in New York City, and foreign freight forwarders. Detailed information of steamship services to foreign parts, a list of consuls of foreign countries in the United States, and of American consulates in foreign countries are also given.

Rubber Hand Stamps and the Manipulation of Rubber. By T. O'Conor Sloane. 167 pages, 5 by 7 inches. Published by Norman W. Henley & Son, New York. Price $1.00.

This is a new, revised and enlarged edition in which chapters on the use of rubber in surgery and dentistry and the construction and repairing of rubber tires have been added. The object of the book is, in general, to present in the simplest form the subject of the manipulation of India rubber. Among other subjects the book deals with the making of rubber stamps, rubber type, sheet rubber goods, solution of India rubber, ebonite, vulcanite and gutta-percha, etc.

Brazing and Soldering. By James F. Hobart. 51 pages, 5¼ by 8 inches. 18 illustrations. Published by Norman W. Henley & Son, New York. Price, 25 cents.

This is the fifth revised and enlarged edition of Mr. Hobart's book, treating of the subject of brazing and soldering. It covers, in general, the same field as the previous editions, giving specific information regarding brazing alloys, and solders, and methods used in brazing and soldering. One chapter is devoted to special methods of soldering and covers electrical work, and tin plate, galvanized iron and zinc, lead and aluminum soldering. Compositions of various solders and fluxes are also given.

Coalfields and Collieries of Australia. By F. Danvers Power. 412 pages, 6 by 8½ inches. 231 illustrations. Published by Critchley Parker, Melbourne, Australia. Price 25s.

While coal mining plays a large part in the mining operations of Australia, this is the first work devoted to this important branch of the commercial activities of the commonwealth. The author, who is a member of the American Institute of Mining Engineers, as well as of the corresponding British and Australian societies, is well equipped to handle this subject, and the book will prove of value to those who are interested in the development of the Australian commonwealth and its mining industries.

Knots, Splices and Rope-work. By A. Hyatt Verrill. 102 pages, 4¾ by 6¾ inches. 148 illustrations. Published by Norman W. Henley & Son, New York. Price, 60 cents.

This book is a practical treatise giving complete and simple directions for making the most useful and ornamental knots commonly employed. The book is well illustrated to show the exact methods used in making knots and splices. The contents of the book will be best understood from a review of the chapter headings: Cordage; Simple Knots and Bends; Ties and Hitches; Nooses, Loops, and Mooring Knots; Shortenings, Grommets, and Selvagees; Lashings, Seizings, Splices, etc.; Fancy Knots and Rope Work.

Superheated Steam in Locomotive Service. By W. F. M. Goss. 66 pages, 6 by 9 inches. 51 illustrations. Published by the University of Illinois, Urbana, Ill.

This is bulletin No. 57 of the Engineering Experiment Station of the University of Illinois. It gives the results of a study of recent German practice in the use of superheated steam as well as of an elaborate series of tests made upon an American locomotive. The conclusions are to the effect that the use of superheated steam introduces no serious difficulties; that it brings about a material saving in the use of coal and water; and that the power capacity of American locomotives can be readily increased by this means.

Diary of a Roundhouse Foreman. By T. S. Reilly. 158 pages, 5 by 7 inches. Published by Norman W. Henley & Son, New York. Price $1.00.

This book contains a number of articles published some years ago by the author in the *Railway and Engineering Review*, under the title "Diary of a Roundhouse Foreman." It is in compliance with many requests that these articles are now put in book form. The author has attempted to give a general idea of the nature and range of problems that a roundhouse foreman has to meet. For this purpose it has been assumed that a typical young machinist has been placed in charge of a roundhouse, and his experiences are set forth in a manner which indicates that the author is a good story teller.

House Wiring. By Thomas W. Poppe. 103 pages, 4½ by 6½ inches. 74 illustrations. Published by Norman W. Henley & Son, New York. Price, 50 cents.

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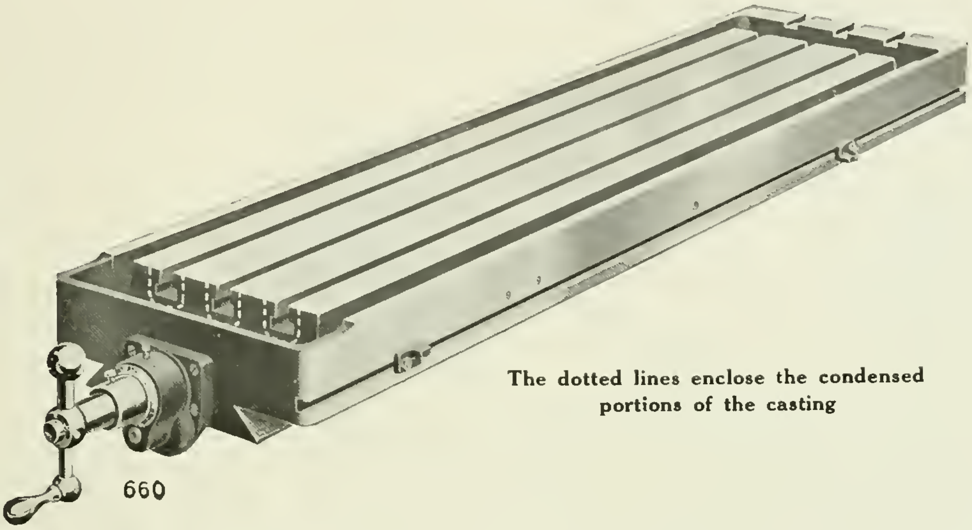

The dotted lines enclose the condensed portions of the casting

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This book is a treatise describing and illustrating up-to-date methods of installing electric light wiring and is intended primarily for persons of limited experience who wish to obtain a practical knowledge of the installation of electric lighting systems. The subject is treated in a simple and concise manner and illustrations are used throughout the book to clearly convey the ideas presented. The book consists of seven chapters headed as follows: Showing the Plans and Layout of the Electrical Work; Flexible Metallic Wiring Systems; Installing Rigid Conduit; Combining Flexible and Rigid Conduit; Wiring and Switch Diagrams and Connections; Grounding Metallic Conduit Systems; Knob and Tube System.

Farm Gas Engines. By H. R. Brate. 195 pages, 5 by 7 inches. 37 illustrations. Published by the Gas Engine Publishing Co., Cincinnati, Ohio. Price $1.00.

This book is intended to present, in a simple way, the methods used in the successful running of gas engines. Examples are given of various troubles met with in the manipulation of these engines, the book being intended especially for persons who use small units for agricultural work on small industrial plants. Special attention has been called to the troubles met with in the ignition system. The language used is clear and simple and well adapted to the class of readers for which the book is intended. The various chapters of the book discuss two- and four-cycle gas engines, fuels, carburetion, compression, ignition, magnetos, batteries, coils, lubrication, cooling, gas tractors, portables, farm pumping plants, farm lighting plants, farm machinery operated by gas engines, and marine engines.

Primer of Scientific Management. By Frank B. Gilbreth. 108 pages, 5 by 7½ inches. Published by D. Van Nostrand Co., New York. Price $1.00.

In the early part of 1911 the *American Magazine* published a series of articles by Frederick W. Taylor, entitled "The Principles of Scientific Management." As a result of the publication of these articles, hundreds of letters were sent to the magazine requesting further information on the subject. These letters were all handed to the author of the present book and are answered in it. Hence, the book is not a complete treatise on scientific management, but gives in a catechism form a comprehensive idea of the main principles of the subject. The book is divided into five chapters headed as follows: Definitions of Terms of Scientific Management; Laws, or Principles, of Scientific Management; Application of the Laws of Scientific Management; The Effect of Scientific Management on the Worker; and Relation of Scientific Management to Other Lines of Activity.

Elementary Internal Combustion Engines. By J. W. Kershaw. 171 pages, 5¼ by 7¾ inches. 117 illustrations. Published by Longmans, Green & Co., New York. Price, 90 cents.

The author of this book, who is a lecturer in engineering at the University of Sheffield, England, states in the preface that it is intended to give an elementary account of the construction and working of internal combustion engines and power gas producers, and thus to serve as an introduction to the more advanced books dealing with the subject. The explanations have, for this reason, been made as simple as possible, but within its scope the book is thorough and comprehensive and provided with a great number of sectional illustrations showing the exact workings of the various parts of the gas engine. The contents by chapters are as follows: The Gas Engine; Large Gas Engines; Gas Engine Governing; Ignition; The Indicator and Indicator Diagrams; Calorific Power; Gas Producers; Theory of Gas Producers; Oil Engines; Petrol Engines; Oil Engines for Ships; Other Combustion Motors; Engine Efficiency.

Concrete Costs. By Frederick W. Taylor and Sanford E. Thompson. 709 pages, 5 by 8 inches. 82 illustrations. Published by John Wiley & Sons, New York. Price, $5.00.

This book is designed to meet the needs of both the contractor and the engineer and architect in making rough and approximate as well as accurate and detailed estimates. It is also intended to make possible an economical layout and a scientific management of the work in combination with task and bonus systems. The book contains an immense amount of data relating to all phases of concrete work and it is impossible in a brief review to give more than a general idea of its contents. It has twenty-three chapters which are headed as follows: Approximate Costs of Miscellaneous Concrete Work; Approximate Cost Data on Concrete Structures; Approximate Costs of Reinforced Concrete Buildings; Determination of Labor Cost; Task-work in Construction; Proportioning Concrete; Tables of Quantities of Materials for Concrete and Mortar; Cost of Concrete Materials; Excavating and Crushing Stone for Concrete; Handling and Transporting Materials; Labor of Hand Mixing; Machinery Plants for Mixing and Handling Concrete; Labor Costs of Machine Mixing; Forms for Mass Concrete; Arch Centers; Forms for Reinforced Concrete; Tables of Concrete Volumes; Tables of Steel Areas and Quantities; Tables of Times and Costs Bending and Placing Steel; Tables for Designing Forms; Tables of Quantities of Lumber for Forms; Tables of Times and Costs of Labor on Forms; Estimates for Reinforced Concrete Construction.

Practical Thermodynamics. By Forrest E. Cardullo. 411 pages, 6 by 9 inches. 224 illustrations. Published by McGraw-Hill Book Co., New York. Price $3.50.

While this book is intended primarily as a textbook for the use of classes in mechanical and electrical engineering, it is written in a manner which will appeal especially to the practical man. The author has presented his subject so that any person who would like to obtain a general understanding of thermodynamics without going into the subject deeply enough to analyze the mathematical deductions, will be able to do so without difficulty. The book has been prepared with a clear view of both practical and theoretical considerations, and the laws which underlie the action of thermodynamic apparatus are so presented that the reader will not only be able to comprehend the principles involved, but also to correctly design apparatus based upon these thermodynamic principles. The book has a pleasing and refreshing touch of originality, and as the writer himself states in the preface, he has not hesitated to present new methods whenever these methods seemed simpler and better than the older ones. Many of the definitions given, therefore, differ radically from those found in other textbooks, and the whole subject has, as a result, become more simple and also more logical. Such items as can only be fully comprehended and satisfactorily studied by more advanced students have been printed in smaller type, so as to distinguish them from the remainder of the text. In this way, it is possible for students who have advanced further to deal with the subject in a most thorough manner, while beginners may read only such parts as are especially intended for them at their present stage of development. A great number of problems for exercises are presented, these problems being given at the end of each chapter. The answers accompany the problems in each case. The general scope of the work will be best understood from a review of the headings of the chapters of the book: The Nature and Measurement of Heat; The Thermal Properties of Gases; The Expansion of Gases; Thermodynamic Processes and Cycles; The Thermal Properties of Vapors; Wet and Superheated Vapors; Mixtures of Gases and Vapors; The Steam Engine; Steam Cycles; Losses in the Steam Engine; Notes on the Design and Testing of Steam Engines; The Steam Turbine; Condensing Machinery; Combustion; The Steam Boiler; Boiler Plant Auxiliaries; Water-cooling Apparatus; Hot-air Engines; The Internal Combustion Engine; Notes on the Design and Performance of Internal Combustion Engines; Gaseous Fuels; Compressed Air; Refrigeration; Heating, Ventilation, Evaporation and Drying; Entropy Diagrams; The Kinetic Theory of Heat.

NEW CATALOGUES AND CIRCULARS

Nelson Valve Co., Chestnut Hill, Philadelphia, Pa. Catalogue S on steel valves and fittings made of acid open-hearth steel.

National Tube Co., Frick Bldg., Pittsburg, Pa. Circular describing the N. T. C. regrinding globe and angle valves with union bonnet.

Davis-Bournonville Co., 97 West St., New York. Booklet No. 4 on autogenous welding and cutting of metals by the oxy-acetylene process.

Wayne Oil Tank & Pump Co., Fort Wayne, Ind. Circular of oil storage outfits for gasoline, gasoline lubrication oils, paint oils and varnishes.

Deane Steam Pump Co., 115 Broadway, New York. Bulletin D-171 on horizontal duplex piston pumps, operated by direct-connected vertical gasoline engines.

Joseph Dixon Crucible Co., Jersey City, N. J. Booklet on Joseph Dixon, comparing his work with that of others who have made great inventions and discoveries.

McEwen Bros., Wellsville, N. Y. Booklet illustrating and describing pumps for steam turbine drive. Complete description and tables of necessary data are given.

Taylor Iron & Steel Co., High Bridge, N. J. Bulletin No. 114 briefly describing the application of "Tisco" manganese steel to crusher and pulverizer parts.

C. W. Meadowcroft, Sr., 4702 Large St., Frankford, Philadelphia, Pa. Circular illustrating the ball high-speed rotary riveting hammer, with foot lever, bench style.

O. N. Beck, 11 Queen Victoria St., London, E. C., England. Circular of elastic corrugated tubes for expansion joints, heating and smoke tubes, superheaters, condensers, etc.

Detroit Fuse & Mfg. Co., Detroit, Mich. Bulletin No. 25 descriptive of "Detroit" switches for motor-operated machinery which are "foolproof, fireproof and fumeproof."

Peters Bros. Mfg. Co., Algonquin, Ill. Circular of "Peters" abrasive metal saw for cutting high-speed steel, brass, copper, iron pipe tubing, and all metals; price, $16.50.

National Scale Co., Chicopee Falls, Mass. Folder advertising the National counting machine for parts such as bolts, screws, nuts, etc., used in quantities in manufacturing establishments.

Ingersoll-Rand Co., 11 Broadway, New York. Bulletin No. 7004 illustrating and describing Cameron steam pumps, remarkable for the small number of working parts used in their construction.

Treadwell Engineering Co., Easton, Pa. Booklet on steel castings, defining what steel castings are. The information contained will be useful to any user or prospective user of steel castings.

Bethlehem Steel Co., S. Bethlehem, Pa. Catalogue of crucible steel products comprising high-speed steel, carbon steel, die products, forged disks and blanks, special alloy steel, spring steel, etc.

Hess-Bright Mfg. Co., 2111 Fairmount Ave., Philadelphia, Pa. Catalogue on the Hess-Bright DWF ball bearing hangers for lineshafting, illustrating installations and giving data on power saving.

Wells Bros. Co., Greenfield, Mass. Circular of the "Little Giant" tap grinder which provides means for sharpening taps up to 12 inches in length and, with special arm, to 15 inches in length; price, $75.

Westinghouse Electric & Mfg. Co., East Pittsburg, Pa. Descriptive leaflet No. 2496 on Westinghouse outdoor type OISC transformers; circular No. 1194, on Westinghouse type Q direct current generators.

National Automatic Tool Co., Richmond, Ind. Catalogue of automatic adjustable multiple spindle, vertical and horizontal drilling machines with variable spindle speeds, for drilling, reaming and tapping.

Shepard Electric Crane & Hoist Co., Montour Falls, N. Y. Bulletin descriptive of the Shepard line of cage controlled monorail electric hoists for use in steel mills, foundries, machine shops and factories.

Crocker-Wheeler Co., Ampere, N. J. Bulletin No. 141, illustrating and describing alternating current motors, Form R, induction type, designed for operating from 25 cycle polyphase alternating current circuits.

Pennsylvania Railroad Co., Philadelphia, Pa. Booklet on the subject of corn culture, intended for farmers, students in agricultural schools and others interested in the promotion of higher agricultural efficiency.

Standard Pump & Engine Co., Cleveland, Ohio. Catalogue No. 12 of "Standard" pumping engines, and "Standard" water supply systems adapted to shallow wells, cisterns, lakes, rivers, etc.; also to deep wells.

S. F. Bowser & Co., Fort Wayne, Ind. Catalogue of the Bowser oil filtration and circulating systems which filter the oil, precipitate impurities, separate and automatically eject water and provide for the storage and use of refuse oil, etc.

Deane Steam Pump Co., 115 Broadway, New York. Catalogue of duplex horizontal double acting power pumps, giving brief descriptions of various types of these pumps, together with complete tabular data relating to capacity and sizes.

General Electric Co., Schenectady, N. Y. Bulletin No. 4931, "Electricity in the Shoe and Leather Industry"; bulletin No. 4939, "Electric Hoists"; bulletin No. 4947, "Edison Mazda and Gem Lamps for Standard Electric Railway Service."

Alvan Mfg. Co., Newark, N. J. Leaflet illustrating and describing the "Rex" universal test indicator for the use of toolmakers, machinists, etc., on bench lathes, engine lathes, planers, shapers or milling machines. The error is multiplied fifty times, and the capacity is 0.020 inch.

Wells Bros. Co., Greenfield, Mass. Tables of tap drill sizes for U. S. standard, S. A. E. standard and machine screw threads. The tap drill sizes are based on the formula $X = N - \frac{3}{4}(2D)$ in which X equals tap drill diameter, N, diameter of tap over top of thread, and D depth of thread.

B. F. Sturtevant Co., Hyde Park, Mass. Catalogue No. 190 of steam turbines, describing the new type Sturtevant turbine and calling attention to its advantages. Catalogue No. 200 describing the Sturtevant aeronautical motor which is of the four-cycle type with four and six cylinders arranged vertically.

Brown Hoisting Machinery Co., Cleveland, Ohio. Catalogue "J," 1912, covering pillar cranes, hand wrecking cranes, mast jib cranes, pillar jib cranes, bracket jib cranes, hand bridge cranes, and transfer tables. The catalogue is profusely illustrated, showing cranes installed in various industrial plants and for various services.

Wisconsin Engine Co., Corliss, Wis. Circular of the Adams Wisconsin kerosene gas engines, built in sizes from 50 to 200 H. P., under the M. Rumely Co. patents. These engines use kerosene instead of gasoline, being provided with special carburetors that gasify cold kerosene the same as gasoline is gasified in an ordinary carburetor.

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The best is the only thing worth having. If you don't
already know the

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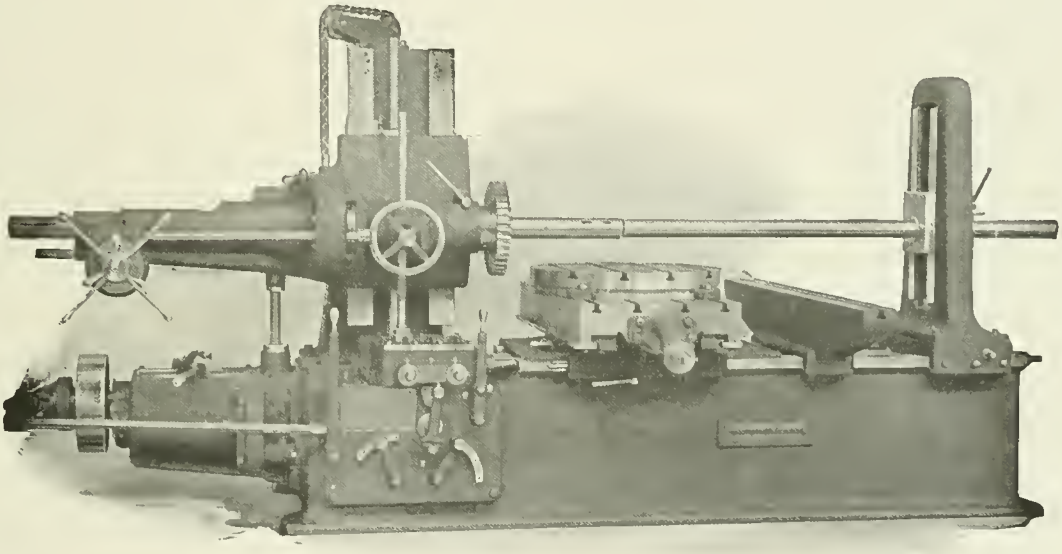
BORING, DRILLING and MILLING MACHINE

go after it, (that is) INVESTIGATE.



The more you investigate, the better we like it. One customer who sent a **mail order** said: **"I have seen your machines in places where I know they would not be if they were not ALL RIGHT."**

LUCAS MACHINE TOOL CO., NOW AND ALWAYS OF CLEVELAND, O., U.S.A.

AGENTS—C. W. Burton, Griffiths & Co., London. Alfred H. Schutte, Cologne, Berlin, Brussels, Paris, Milan, Barcelona, Bilbao. Donauwerk Ernst Krause & Co., Vienna, Budapest, Prague. Overall, McCray, Ltd., Sydney, Australia. Andrews & George, Yokohama, Japan. Williams & Wilson, Montreal, Can.

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Industrial Instrument Co., Foxboro, Mass. Bulletin No. 62 descriptive of Dr. Th. Horn's tachometers and tachographs, covering a great variety of styles, ranges and purposes for practically all conditions of industrial and engineering service and including precision tachographs for recording minute variations in speeds of machinery.

Stow Mfg. Co., Binghamton, N. Y. Catalogue of flexible shafts and other portable apparatus for drilling, tapping, reaming, counterboring, etc.; also center grinders, portable grinders, scratch brushes, universal joints, multi-speed electric motors, electric grinders of the floor and portable types, track drills, rail grinders, band buffers, electric bench grinders, electric breast drills, etc.

Thomson Electric Welding Co., Lynn, Mass. Catalogue of electric welding machines operating by the resistance or Thomson process which is principally employed in butt welding, T- and angle-welding, cross welding, lap welding, seam welding, etc. A line of machines adapted to a large variety of welding operations is illustrated, and data on size, weight, capacity, etc., are given.

American Tool Works Co., Cincinnati, Ohio. Pamphlet describing methods employed in the manufacture of lathes, planers, shapers and radial drills in Cincinnati, by the company. The tests applied are shown. The pamphlet should be found of much general interest to superintendents, foremen, mechanics and all interested in any way in machine tools.

Westinghouse Electric & Mfg. Co., E. Pittsburg, Pa. Descriptive leaflet No. 2458 on Westinghouse type-T direct current turbo-generator, consisting of a steam turbine and generator mounted on a common base. The leaflet gives a description of the various characteristics and construction in detail of the steam turbine, and views of the component parts of the various elements, etc.

John M. Rogers Works, Inc., Gloucester City, N. J. Catalogue of measuring instruments of precision, manufactured after the Richards system; also solid adjustable blade reamers, solid reamers, adjustable blade hollow mills, adjustable thread cutting tools, steel mandrels, etc. The catalogue includes complete metric sizes and prices of all tools manufactured by the company.

Modern Machine Tool Co., 4657 Spring Grove Ave., Cincinnati, O. Circular of the "Modern" flat turret lathe embodying improved automatic chuck, automatic roller feed, novel belt clutch, improved friction clutch and improved feed box. The lathe has a capacity for bar stock up to 2¼ inches diameter, and 26 inches length. The swing over the bed is 20 inches and over the carriage, 14 inches.

Fahrig Metal Co., 34 Commerce St., New York. Circular of "Fahrig" anti-friction metal, composed of tin and copper combined by a special process. This metal is especially valuable for the bearings of automobiles and gas engines. It has superior anti-friction qualities and can be used in the form of die castings, sand castings or poured bearings, as may be required to suit the condition of manufacture.

Pennsylvania Railroad Co., Philadelphia, Pa. Booklet entitled "The Pennsylvania Railroad and Industrial Safety," containing extracts from the proceedings of the American Museum of Safety, New York, January 17, 1912, when the Traveler's Insurance Co's medal was awarded to the Pennsylvania Railroad, "as the American employer who, in 1911, did the most to protect the lives and limbs of its employes."

Van Dorn & Dutton Co., Cleveland, Ohio. Circular illustrating uses of the Van Dorn & Dutton Co., hard-service portable electrically-operated drills and reamers, the examples showing application to car work, structural work, manufacture of steel furniture, motor cars, drilling armor plate, erecting lineshafts, boring holes in timber, drilling staybolt holes in boilers, erecting elevators, repairing stationary engines, etc.

General Electric Co., Schenectady, N. Y. Bulletins No. 4880, on railway signal volt ammeters; 4910, on oil break switches; 4925, on combined unit-series mercury arc rectifier outfit; 4938, on Type H transformers; 4949, on direct-current portable instruments; 4950, on Washington, Baltimore & Annapolis 1200-volt direct-current railroad installation; 4951, on street lighting with Edison "Mazda" series lamps; and 4952, on series incandescent street lighting systems.

Hoskins Mfg. Co., 459 Lawton Ave., Detroit, Mich. Bulletin No. 10 descriptive of the "Hoskins" electric muffle furnaces, type FC, for the efficient heat-treatment of tool steels, made in two sizes having chamber dimensions 6½ inches wide by 5 inches high by 12 inches deep, and 12 inches wide by 8 inches high by 18 inches deep, respectively. Among the advantages claimed are even heating, accurate temperature, atmospheric control, absence of oxidizing gases, rapid heating, high thermal efficiency, etc.

Busch-Sulzer Bros.-Diesel Engine Co., St. Louis, Mo. Pamphlet entitled "The Present Status of the Diesel Engine in Europe and a Few Reminiscences of the Pioneer Work in America," by Dr. Rudolf Diesel, the contents comprising a lecture delivered before the Associated Engineering Societies of St. Louis, April 13, 1912. The growing importance of the Diesel internal combustion engine makes the pamphlet of much interest to engineers and others concerned with the economical generation of power.

American Swiss File & Tool Co., 24 John St., New York. Catalogue, fifth edition, of "American Swiss" files, fully illustrated, with price list in distinctive heavy type. A separate sheet accompanying the catalogue compares "American Swiss" list and "American Standard" list, this comparison being important to buyers of high-grade files. The inside front cover concerns trademarks, and the inside back cover briefly takes up the three epochs in file making beginning with a well-known quotation from the Bible. The engravings of files are carefully made showing the kind of cutting exactly. File users generally will find the catalogue interesting and valuable for reference.

Bristol Co., Waterbury, Conn. Catalogue No. 1000 on Bristol's recording gages for pressure and vacuum, containing 64 pages, 8 by 10½ inches. The catalogue lists all of the Bristol recording pressure and vacuum gages except round form models 50, 52 and 56. These gages are furnished with charts graduated in pounds per square inch, in ounces per square inch, in inches head of water, in feet head of water, in atmospheres, in inches head of mercury, in centimeters head of water, in decimeters head of water, in tons, in kilograms per square centimeter, in millimeters head of mercury, in millimeters head of kerosene, in centimeters head of water, in millimeters head of water, etc. The preceding partial list gives some idea of the extent of development of the recording gage, exemplified by the product of the company.

International Oxygen Co., 115 Broadway, New York. Bulletins on the I. O. C. oxy-hydrogen platinum melting processes; the Holder pressure generator for generating acetylene gas; welding torches for welding metals; high-pressure cylinders for gas, made in 100, 150 and 200 cubic feet capacities, respectively; report of tests of cells for the electrolytic production of oxygen and hydrogen made by the Electrical Testing Laboratories, New York; oxy-hydrogen and street railway construction, being extracts from paper read by Mr. Henry Mozley before the convention of the Municipal Tramways Association held at Glasgow, September 27-29, 1911; and bulletin containing tables on weights of gases, variation of pressures in cylinders with variation of temperature, quantity of gas remaining constant; quantity of gas in cylinders under various pressures, temperature constant; purity of oxygen; and calculation of thermometer readings, etc.

TRADE NOTES

Crocker-Wheeler Co., Ampere, N. J., opened an office in the Title Insurance Bldg., in Los Angeles, Cal., April 1.

Morrow Mfg. Co., Elmira, N. Y., is building a one-story brick addition, 50 by 180 feet for an automatic turret lathe department.

Superior Machine Tool Co., Kokomo, Ind., is building an addition to its plant to afford necessary facilities for its increasing business.

THE TRUTH
ABOUT
HOLLOW SET SCREWS

Pioneers in the promotion of new things are to be pitied. The study, the anxiety, the worry and expense of marketing anything new may bring their measure of success, but surely will bring (on any article of merit) competition, fair and unfair.

Many years ago we began the sale of Hollow Set Screws and while a Hollow Set Screw is not new, yet our method of producing them was new and produced a very much better screw than can be made from the solid bar, drilled and broached. In these solid bar screws, the surplus metal at the point at first appears to be advantageous, but in reality it is disadvantageous for the reason that the uniform thickness of our screws made from flat steel "died" out, permits a longer hold on the wrench and, therefore, a far better opportunity for tightening, while in the solid screw which is drilled and broached, it is necessary to turn in the surplus metal (resulting from the broaching) to the bottom of the hole, thereby partially filling the hole with nothing but waste material which has absolutely no holding power at all.

The H.S.&Co. Screws are made from sheet steel, stamped or "drawn up." Proper tests prove beyond a doubt that this method makes a stronger and tougher screw than one milled from the solid bar, owing to the position of the fibres of the steel. Well known proof of this is found in the comparative values of semi-finished nuts—those milled from solid rod not being as strong as the stamped goods; the same is illustrated also in wood, the plank grain being infinitely stronger than the cross grain product.

We invite comparative tests of the H.S.&Co. Hollow Set Screws with any other screws made having a hole or socket, and will supply FREE SAMPLES for this purpose, to reputable concerns.

SEND FOR CIRCULAR No. 3055.

HAMMACHER, SCHLEMMER & CO.

HARDWARE, TOOLS AND SUPPLIES

New York, Since 1848 **4th Ave. and 13th St.**

Blakeslee Forging Co., Southington, Conn., will erect a new forge shop 30 by 160 feet, three stories high; also an annealing shop 32 by 72 feet, one story high.

Waterbury Farrel Foundry & Machine Co., Waterbury, Conn., has awarded the contract for the construction of a new machine shop 68 by 184 feet, one story high.

Frevert Machinery Co., 38 Vesey St., New York, the business of which has been conducted since its inception in 1906 by H. F. Frevert, has been enlarged and papers for incorporation under the laws of the State of New York have been filed.

Lumen Bearing Co., Buffalo, N. Y., is making an addition of 1800 square feet to its plant to take care of aluminum casting work. The company reports a prosperous year up to date, orders received being in excess of those reported for corresponding periods in the past.

H. W. Johns-Manville Co., Madison Ave. and 41st St., New York, has moved its Winnipeg branch offices into new quarters at 92 Arthur St. The new place is a six-story and basement building, and will be occupied throughout by the company's offices and store-rooms.

Brown & Sharpe Mfg. Co., Providence, R. I., announces that its works will be closed from August 2 to 19 for the annual vacation. During this time the offices will be open as usual and orders for machine tools, machinists' tools and cutters will receive the same attention as at any other period of the year.

Wells Bros. Co., Greenfield, Mass., manufacturer of taps and dies, has opened a store in Boston at 163 Oliver St. A comprehensive stock of all screw-cutting tools is carried, and quick deliveries will be made, thus affording better service to the trade in Boston and vicinity. Mr. John E. Chipman is manager of the new store.

Watson-Stillman Co., 192 Fulton St., New York, announces that the following officers were elected at a directors' meeting, May 15: President, E. A. Stillman; vice-president and secretary, A. F. Stillman; treasurer, J. P. Bird; chief engineer, Carl Wigtel; superintendent, Frank Lary. A new branch office is to be opened at Philadelphia soon and the shop facilities are being improved to meet increasing business.

Baldwin Chain & Mfg. Co., Worcester, Mass., has appointed Mr. Charles D. Schmidt its local representative in Greater New York City. An office and storerooms have been established at 416 Broadway, and Mr. Schmidt will give his attention to the prompt delivery of orders for the local trade. The company makes sprockets as well as chains, and Mr. Schmidt is prepared to furnish sprockets and chains for replacements on standard commercial cars.

Universal Machine Screw Co., Hartford, Conn., recently opened a New York office in charge of Mr. C. D. Schmidt, manager, corner Broadway and Canal St. (entrance 276 Canal St.) which will expand the facilities required for the increasing business of the company. The company manufactures the "Universal" five-spindle automatic screw machine and also operates a large number of these machines in its own plant, producing standard and special screw machine products from steel or brass. Mr. Schmidt, the New York manager, has been an important factor in the machine screw product field for a number of years.

E. F. Lake, Bayonne, N. J., has merged his consulting metallurgical business with the metallurgical engineering firm of Nixon & Raab under the name of Lake, Nixon & Raab, 156 Fairview Ave., South Orange, N. J. Die-casting machinery alloys and processes, and heat-treatment and carbonizing of steel will be specialized on. All kinds of physical tests and chemical analyses will be given to various metal products, and advice will be given as to the best methods and machinery used in the melting of all alloys, casting alloys, galvanizing, coloring and plating, or otherwise working and treating either ferrous or non-ferrous metals or alloys.

Van Dorn & Dutton Co., Cleveland, Ohio, has opened several new agencies for the sale of its portable tools only. Stock will be carried in the following places: 67 Main St., San Francisco, Cal., W. B. Wilson, district manager; Security Bldg., Los Angeles, Cal., J. L. Davidson, district manager; Candler Bldg., Atlanta, Ga., W. F. Davis, district manager; Alfred Herbert & Co., Ltd., England, Ireland, Scotland, Wales, France, Belgium, Spain and Portugal; Frank Saunders, Sydney, Australia, Australia and New Zealand. The company reports a largely increased business. A full line of electric grinders will be brought out in the near future.

Newark Gear Cutting Machine Co., Newark, N. J., has again found it necessary to enlarge its works, to take care of increasing business. The assembly room has been enlarged so that the main building now extends from 66-68 Union St. through to 67-69 Prospect St. The three-story brick building at 69 Prospect St. is now occupied by the offices, drawing-room, and pattern-shop; while such portions of the main building as were formerly occupied by these departments will now be given over to the machine shop. The address of the office is now 69 Prospect St., Newark, N. J. Mr. Henry E. Eberhardt, president of the company, reports that at present the plant is running at normal time, with full working force. The demand for gear-cutting machines has been increasing, especially for the Eastern trade.

MISCELLANEOUS

Advertisements in this column, 25 cents a line, ten words to a line. The money should be sent with the order. Answers addressed to our care will be forwarded. Original letters of recommendation should not be enclosed to unknown correspondents.

AGENTS IN EVERY SHOP WANTED to sell my sliding calipers. Liberal commission. ERNST G. SMITH, Columbia, Pa.

DESIGNING, DETAILING and Blue Printing at reasonable rates. E. B. STAUFFER, Ephrata, Pa.

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DRAFTSMEN AND MACHINISTS.—American and foreign patents secured promptly; reliable researches made on patentability or validity; twenty years' practice; registered; responsible references. EDWIN GUTHRIE, Corcoran Building, Washington, D. C.

DRAWING.—I am thoroughly equipped to make mechanical, electrical, structural and ornamental iron drawings at reasonable rates. Submit sketches and data for rock bottom prices. Life long experience. Reference, First National Bank, Evansville, Ind. D. A. BRADING, M. E., 208 Upper 4th Street, Evansville, Ind.

ENGINEERING DATA.—Send for monthly list of shop and drafting-room data. S. C. CARPENTER, 153 Homestead Ave., Hartford, Conn.

ENGINEERS, SUPERINTENDENTS, Designers, Draftsmen, Engineering Salesmen, Production Engineers and Mechanical Foremen will find it to their advantage to investigate our method of securing employment. Unless record can stand investigation don't bother about answering this ad. THE ENGINEERING AGENCY, INC. (Est. 1893), Monadnock Block, Chicago.

FOR SALE.—ALL or a CONSIDERABLE PART of a $200,000.00 MANUFACTURING BUSINESS, largely in the metal line. Location the best, good buildings, well equipped with up-to-date machinery, excellent staff of skilled workmen. Unusually good relations with employees; never an hour of labor troubles. Business on a prosperous, money-making basis, built up in a few years from a very small beginning from its own profits, and capable of rapid increase in capacity and value.

Reason for selling, old age of the principal owner. On certain conditions would retain large or small part of ownership, in which case it would be deemed an advantage to have the purchase divided among a number, especially if all or part of the investors were qualified to take an active part in the work or management. Address Box 462, care Machinery, 49 Lafayette St., New York.

FOR SALE—NEWMAN WATCHMAN'S CLOCK or time detector fitted complete for nine stations. Just as good as new. THE GIER & DAIL MFG. CO., Lansing, Mich.

FOR SALE.—Small power plants, steam or gas. Send for list. J. L. LUCAS & SON, Bridgeport, Conn.

INSTRUCTORS, PROFESSORS and Assistant Professors wanted for engineering positions. Every Spring and Summer we are flooded with inquiries from the various technical colleges of America for men experienced as Instructors in Mechanical, Civil, Structural, Mining, Chemical, Electrical and Hydraulic engineering. We handle engineering exclusively. Investigate our methods. THE ENGINEERING AGENCY, INC. (Est. 1893), Monadnock Block, Chicago.

MACHINE TOOL SALESMAN FOR AUSTRIA, speaking German and Bohemian, capable of demonstrating efficiency of modern Machine Tools. Give details of past experience, state references, nationality, age, salary, etc., in applying to Box 463, care Machinery, 49 Lafayette St., New York.

MACHINISTS, TOOL-MAKERS, new vest pocketbook, most needed rules, tables, general and economic information. List of shops, 16 colored maps. Blank memoranda. 120 pages. In leather finished covers, 35c. WM. CUTHBERTSON, 37 Springside Avenue, Pittsfield, Mass. Agents wanted.

PARTNERSHIP.—GERMAN MACHINIST, with technical education, and practical experience of many years in building machinery and in tool making, would like to put small amount of capital into partnership with reliable firm. Address Box 469, care Machinery, 49 Lafayette St., New York.

PATENTS.—H. W. T. JENNER, patent attorney and mechanical expert, 608 F St., Washington, D. C. Established 1883. I make a free examination and report if a patent can be had and the exact cost. Send for full information. Trade-marks registered.

POSITION WANTED. As superintendent of machine shop foundry, etc. Capable of handling a large shop on high grade work. Address Box 461, care Machinery, 49 Lafayette St., New York.

PRODUCTION MAN, now employed, wants place to stimulate output and quality. Engineering training. Several years' experience in design and manufacture of high-grade steam machinery. Can take charge of shop if desired. Address Box 465, care Machinery, 49 Lafayette St., New York.

SITUATION WANTED.—Assistant Superintendent or Foreman, 30 years' experience on tool and machine work. 20 years in charge of men. Address P. O. Box 2081, Bridgeport, Conn.

SITUATION WANTED—FOREMAN, 30 years of age, executive, all-round mechanic. Engines, electrical and general machinery, medium and heavy work; understands Taylor system. Address Box 468, care Machinery, 49 Lafayette St., New York.

SITUATION WANTED.—GENERAL FOREMAN, practical experience, thoroughly familiar with all kinds of machine work, expert mechanic, capable of handling a good sized job and get results, hold men and keep them satisfied; used to piecework. References, permanent position. Address Box 466, care Machinery, 49 Lafayette St., New York.

SPECIAL MACHINERY and tools designed and detailed. Terms reasonable. S. C. CARPENTER, 153 Homestead Ave., Hartford, Conn.

SUPERINTENDENT with several years' experience on high-grade machine work under the Premium Plan, seeks place as assistant to successful superintendent working on the Bonus System. Engineering Graduate, age 32, energetic. Address Box 464, care Machinery, 49 Lafayette St., New York.

TEST INDICATORS.—H. A. LOWE, 1374 East 88th St., Cleveland, Ohio.

WANTED.—Agents, machinists, toolmakers, draftsmen, attention! New and revised edition Saunders' "Handy Book of Practical Mechanics" now ready. Machinists say, "Can't get along without it." Best in the land. Shop kinks, secrets from note books, rules, formulas, most complete reference tables, tough problems figured by simple arithmetic. Valuable information condensed in pocket size. Price postpaid $1.00, cloth; $1.25, leather with flap. Agents make big profits. Send for list of books. E. H. SAUNDERS, 216 Purchase St., Boston, Mass.

WANTED.—By large pump manufacturer, draftsmen with several years' experience, capable of detailing from layouts and doing simple designing under direction of leading men. State fully experience, education, age, reference, pay expected, etc. Write DRAFTSMAN, care Machinery, 49 Lafayette St., New York.

WANTED.—Experienced B. & S. automatic screw machine operator, preferably also familiar with the Hartford automatics. Address Box 470, care Machinery, 49 Lafayette St., New York.

WANTED—INSTRUCTORS in Mechanical Engineering and in Mechanical Drawing at an Eastern Institution. Applicants must be graduates of technical schools, preferably with one or two years' practical experience. Give full details of education, experience and salary expected. Address Box 467, care Machinery, 49 Lafayette St., New York.

WANTED.—TOOL DESIGNER, man with experience in Designing and Machinery. Reply to EMPLOYMENT, Box 911, Pittsburg, Pa.

WELLES TOOLS are different. Get a catalogue and price list. WELLES CALIPER COMPANY, Milwaukee, Wis.

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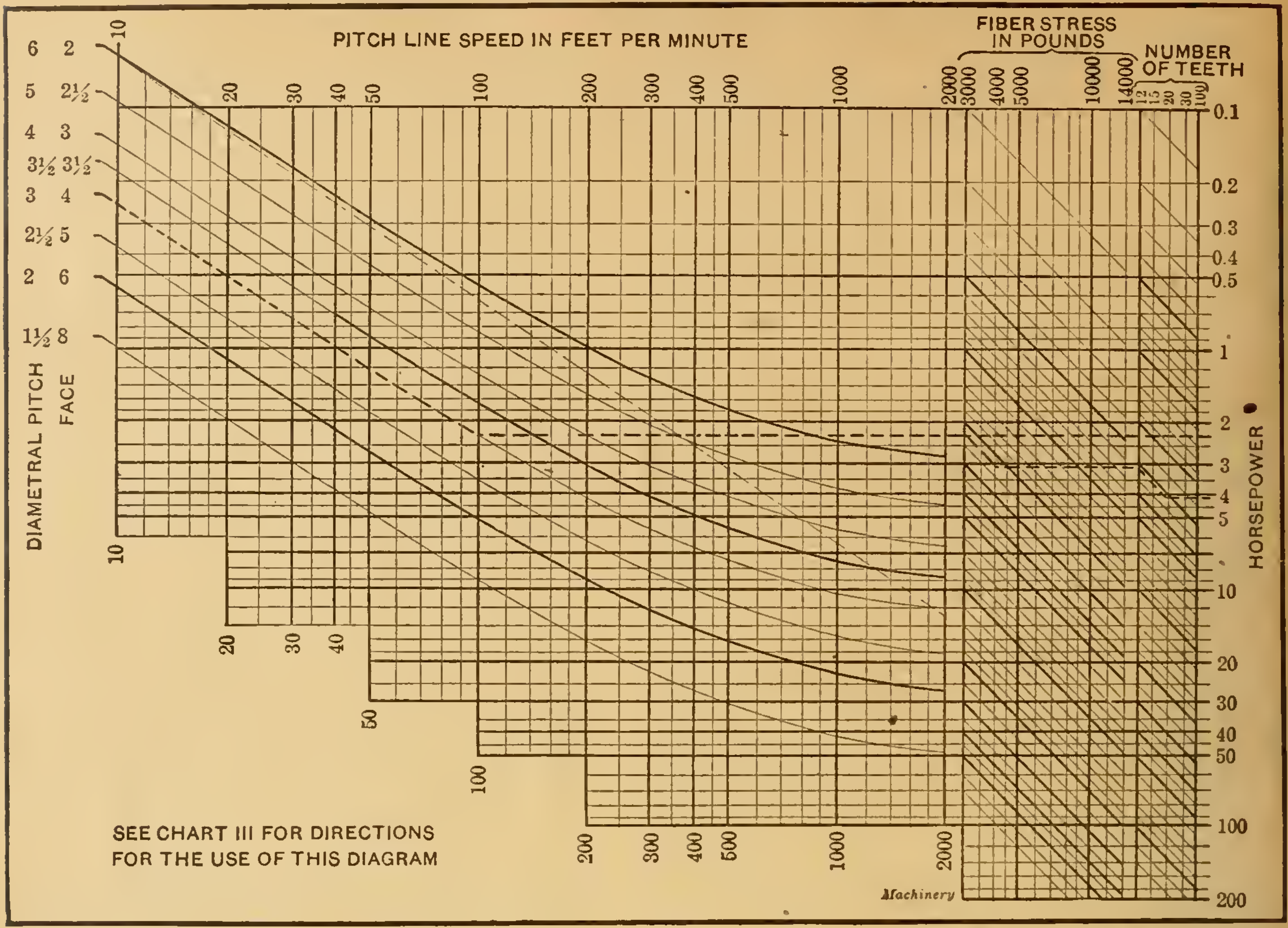
Tables for Article in this number entitled

HORSEPOWER TRANSMITTED BY SPUR GEARS—I



SEE CHART III FOR DIRECTIONS FOR THE USE OF THIS DIAGRAM

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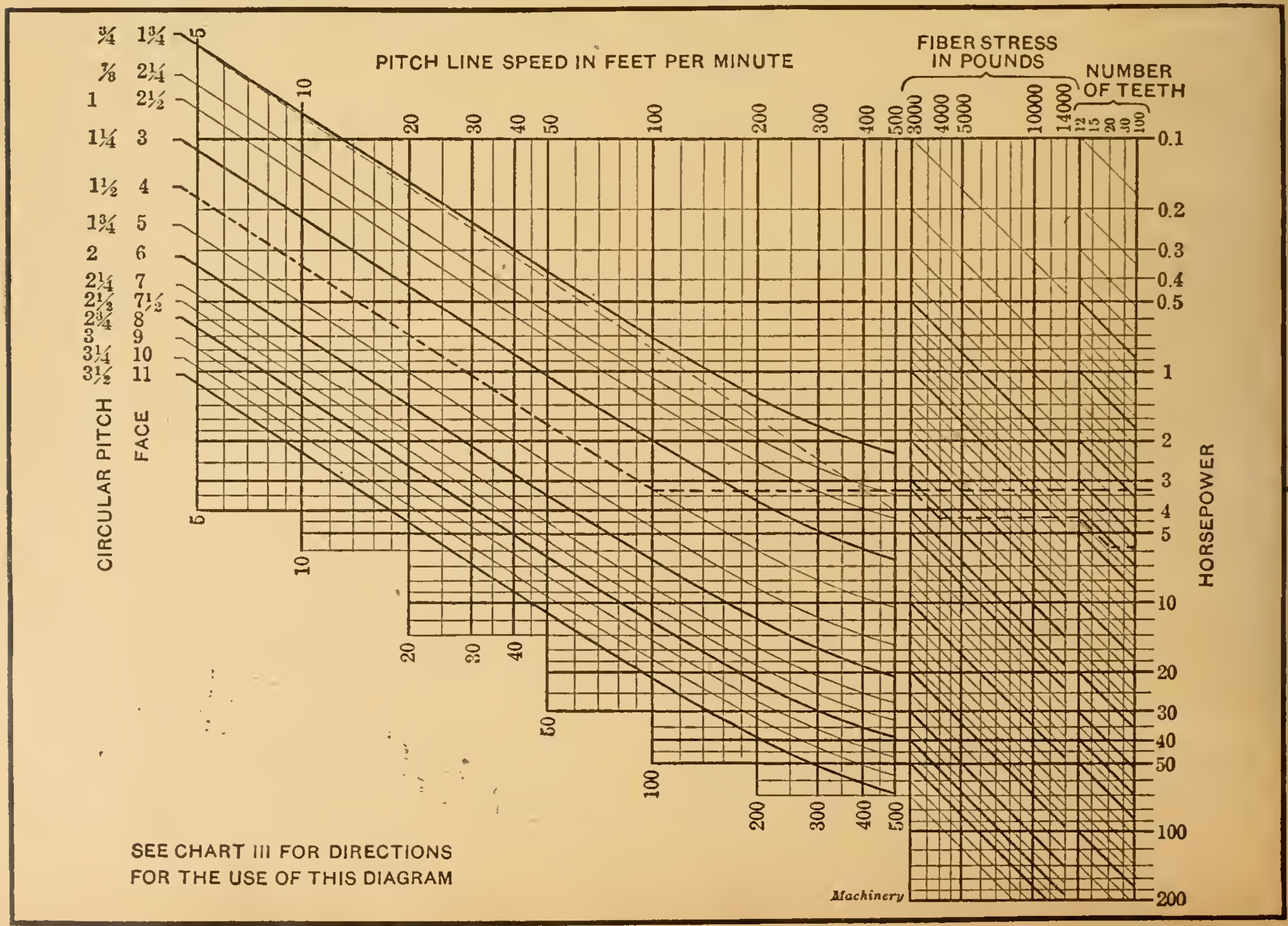
HORSEPOWER TRANSMITTED BY SPUR GEARS—II



SEE CHART III FOR DIRECTIONS FOR THE USE OF THIS DIAGRAM

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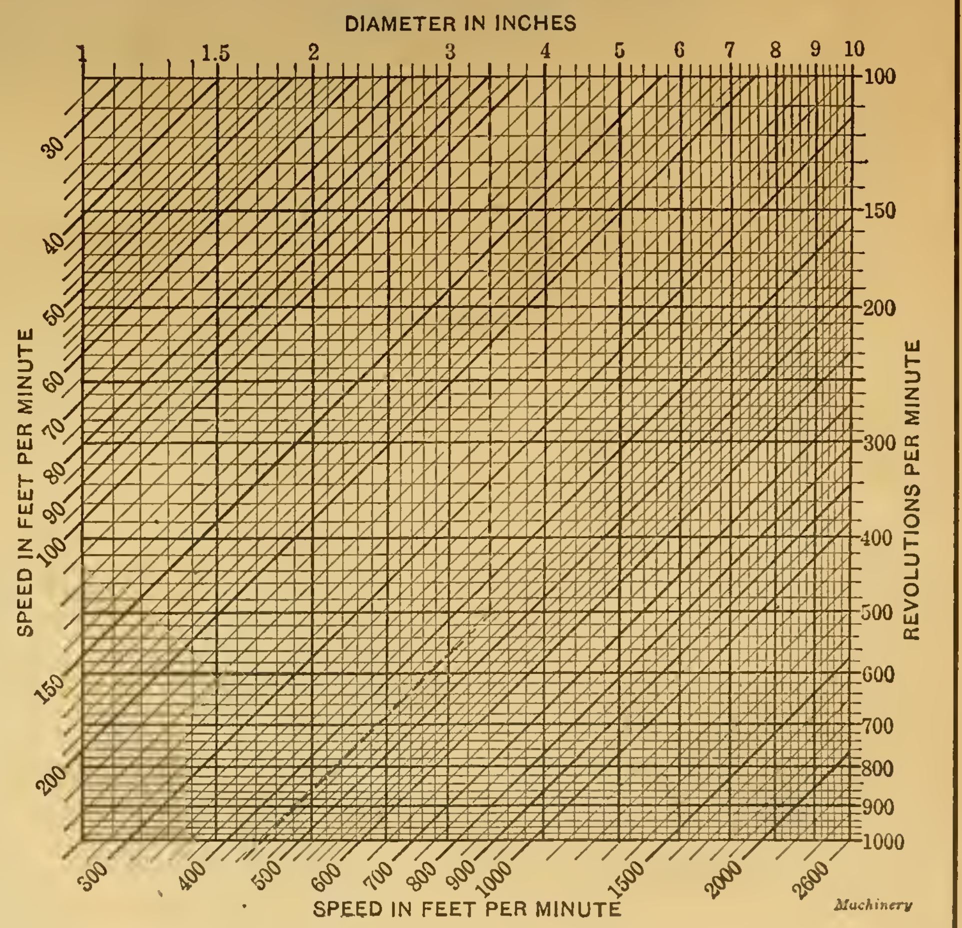
HORSEPOWER TRANSMITTED BY SPUR GEARS—III



DIRECTIONS FOR THE USE OF THE DIAGRAMS

Charts I and II give the horsepower transmitted by spur gearing for diametral pitch and circular pitch. The following examples are shown by the heavy dotted lines in Chart I: A 12-tooth pinion of 4-inch face and 3 diametral pitch, running at a pitch line speed of 100 feet per minute, will transmit 2.3 horsepower with a fiber stress of 3000 pounds per square inch.—A 20-tooth pinion of 4-inch face and 3 diametral pitch, running at a pitch line speed of 100 feet per minute, will transmit 4.1 horsepower with a fiber stress of 4000 pounds per square inch.

The following examples are indicated by the heavy dotted lines in Chart II: A 12-tooth pinion of 1½-inch circular pitch and 4-inch face, running at a pitch line speed of 100 feet per minute, will transmit 3.3 horsepower with a fiber stress of 3000 pounds per square inch.—A 20-tooth pinion of 1½-inch circular pitch and

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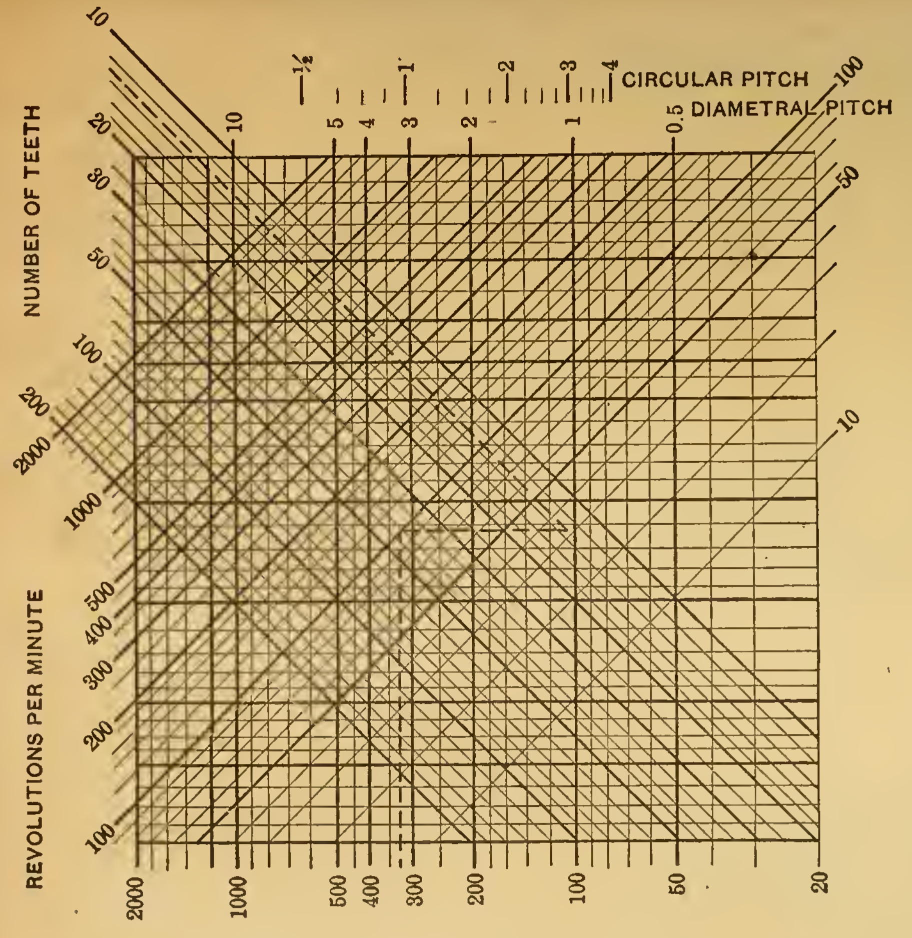
HORSEPOWER TRANSMITTED BY SPUR GEARS—IV



4-inch face, running at a pitch line speed of 100 feet per minute, will transmit 5.8 horsepower with a fiber stress of 4000 pounds per square inch.

Charts III and IV are auxiliary diagrams for finding the pitch line speed in feet per minute. Chart III is used when the diameter and the revolutions per minute are known. The example shown by the dotted line indicates that a gear having a pitch diameter of 3.4 inches and running at 500 R. P. M. has a pitch line speed of 445 feet per minute; or if the diameter is 34 inches and the speed 50 R. P. M., the pitch line speed is 445 feet per minute; in other words, the chart can be used for other dimensions than those actually given if care is taken with regard to the position of the decimal point.

Chart IV is used when the pitch, the number of teeth, and the revolutions per minute are known. The dotted line on the chart indicates that a 13-tooth pinion of 3-inch circular pitch, running at 100 R. P. M. has a pitch line speed of 325 feet per minute.

Contributed by Charles E. Evans

MACHINERY
August, 1912

TOOLS FOR PERFORATING LAMP BURNER PARTS

By CHARLES DOESCHER*

Many kinds of dies have been described by the trade papers in the past, but very little has been said of the dies used for perforating the sides of cylindrical work. The punches and dies used for this work are similar to blanking punches and dies, except for the modifications occasioned by the fact that the metal fed over the face of the blanking die is flat, while that fed over the face of the perforating die is circular in form. Circular perforating tools are used in connection with this class of work because the nature of the work is such that it cannot, on account of both commercial and mechanical considerations, be carried out in any other way.

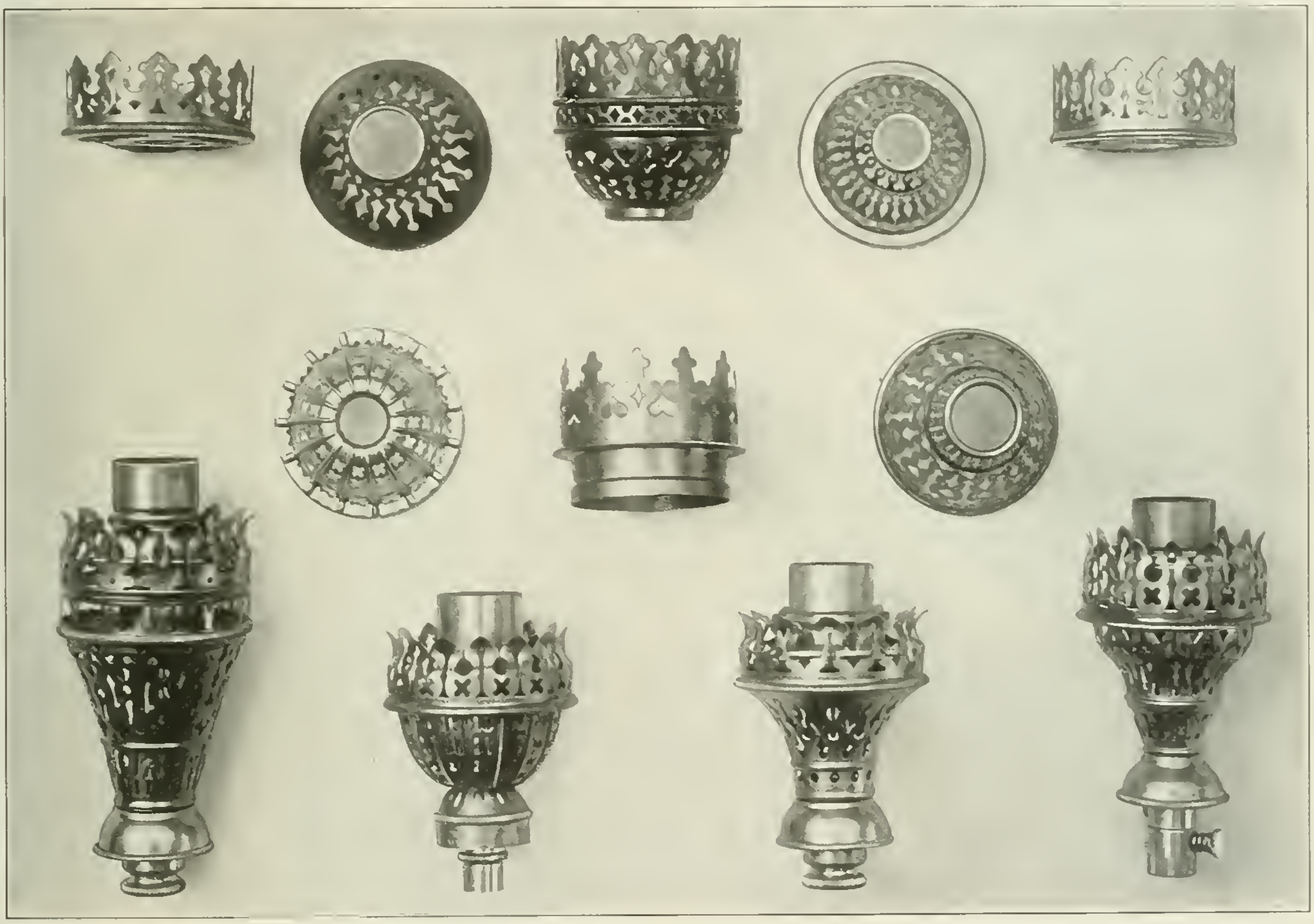


Fig. 1. Examples of Perforated Cylindrical Work, made by the Scovill Mfg. Co., Waterbury, Conn.

In describing the perforating of cylindrical work, the writer does not claim that the tools and methods in every case are the very best possible, but those in successful commercial operation at the present time are illustrated and described. The writer extends thanks to the E. W. Bliss Co., of Brooklyn, N. Y., for cooperation in the preparation of this article, and also to the Scovill Mfg. Co. of Waterbury, Conn., for the loan of the samples of perforated work shown.

Operation of the Perforating Tools

In Fig. 2 is shown a set of perforating tools together with a perforating attachment set up in a Bliss press ready for perforating a shell similar to the one shown in Fig. 4. The shell is first slipped over the die-holder (Fig. 5) in such a manner as to allow the elongated slot *A* in the bottom of the shell to engage with the projecting tongue of the driving arbor. The press is then tripped and the punches, at the first stroke of the press, cut out two of the irregular shaped perforations *B* in the shell. On the upward stroke of the press, a pawl *A*, Fig. 2, by the aid of a ratchet *B*, ratchet shaft *C* and the bevel gears, revolves the driving arbor, which rotates the shell a part of a turn. As the slot in the bottom of the shell is engaged with the tongue of the driving arbor, the shell is indexed with the arbor before the punch descends again. These operations are continued until the press, in this case, has made fourteen continuous strokes, when it is automatically stopped and the perforated shell removed. The stopping of the press is effected by cam *D*, which automatically releases the driving clutch when the required number of strokes has been made. The construction of the tools and the manner in which they are made will be treated later.

In Fig. 6 is shown another set of perforating tools for perforating the gallery fence of a lamp burner shown in Fig. 7. The gallery fence of a lamp or gas burner holds the lamp chimney or globe in place by the spring pressure exerted by the perforated part. The metal must be hard in order to impart the required spring pressure and is, therefore, on the better grade of burners, burnished before perforating, which not only hardens and toughens the metal, but also produces a brilliant finish. On the cheaper grade of burners, the shells from which the gallery fences are made are passed through an extra re-drawing operation, the shells not being annealed, but left hard. The difference in the diameter of the shell before and after re-drawing is about 1/32 inch, while the difference in the thickness of the metal is about 0.0005 inch. This treatment of the metal not only imparts the required springiness, but also makes the perforating operations easier, as hard metal is more readily perforated than soft.

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*Address: 1029 West Main St., Waterbury, Conn.

The tools used for perforating the gallery fence shown in Fig. 7 are somewhat different in construction from those shown in Fig. 2. The ratchet *C*, Fig. 6, is keyed to the driving arbor, and when the tools are set up in the press they are set with the face of the die-holder turned towards the right, instead of facing the operator. The perforating operation, however, is similar to the one already described. The effect of the successive strokes of the press is indicated in Fig. 7. At the first stroke of the press, the four shaded areas at *F* are punched out. At *G* can be seen the appearance of the shell after the second stroke. In order that no burr or fin may be left on the top points of the scallops, the die is made so that the punch will cut a trifle past the center of the point as shown at *H*. The shell is rotated towards the left by the driving arbor, and a simple holding device, not shown in the illustration, is used for holding the shell in place on the arbor.

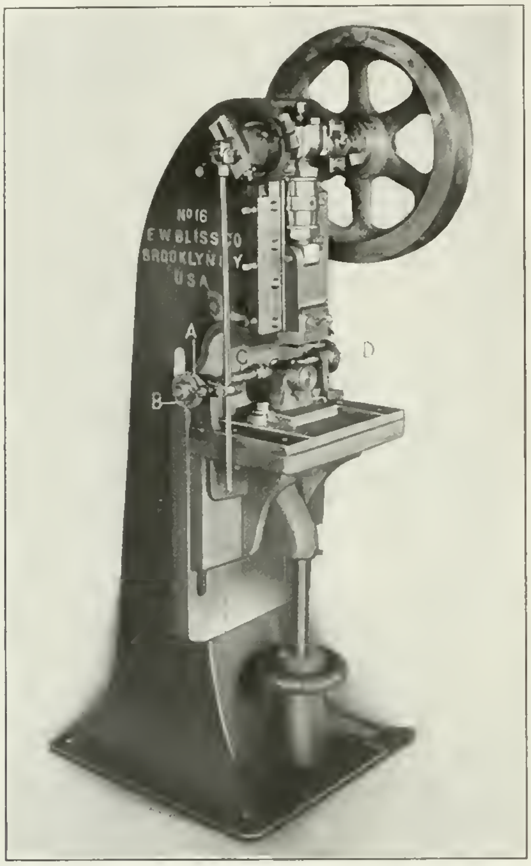

Fig. 2. Bliss Press with Attachment for Perforating Shell shown in Fig. 4

At attachment for holding work in place while it is being perforated is shown in Fig. 3. This attachment is used in connection with the tools for perforating the sides of large narrow rings. The tool equipment consists of a perforating punch *A*, and a large die-holder *B* for holding the dovetailed perforating die *C*. The die-holder is held in die-bed *D*. The perforating attachment, which rotates the shell, is placed directly back of the die-bed and is operated by the adjustable connection *E*, fastened to the gate of the press. After the ring is slipped over the die-holder, handle *F* is given part of a turn to the right which, by means of the spiral grooved arbor *G*, causes the circular disk *H* to come in contact with the ring, thus holding it in place. This circular disk rotates with the ring and is attached to arbor *G* by a pin in the hub of the disk which engages with a circular groove in the arbor.

Construction of Perforating Tools

In Fig. 8 the perforating die for the shell in Fig. 4 is shown held in a dovetail channel in the die-holder. The die-holder is preferably made of a cheap grade of tool steel, and is held in the die-bed as shown in Fig. 5. The dovetail method for holding the dies is probably the best, and is the one most commonly used. The sides of the dies are beveled at an angle of from 5 to 10 degrees. For work such as shown in Fig. 4, the die is tapered lengthwise on one side with a taper of about 1 degree, and is driven into the die-holder from the back and left flush with the shoulder of the holder, so that when in position, the die-bed prevents it from shifting back. When it is possible to do so, a pin or a fillister head screw may be used to prevent the die from shifting endwise. The shape of the shell and the design to be perforated sometimes governs the taper of the sides of the dies. This, for example, is the case where shells such as shown in Figs. 10 and 12 are perforated, when a greater angle than 1 degree must be used on account of the irregular shape of the die-holder and dies.

The longitudinal cross-section of the die-bed, die-holder and driving arbor used for the shell in Fig. 4, is shown in Fig. 5. Section *A* shows how the arbor is milled at the neck *A* in order to allow the scrap punchings to drop through. A section of the tongue of the arbor which engages the slot in the end of the shell, by means of which it is rotated, is shown at *B*. This tongue is tapered as shown, to facilitate the putting on and taking off of the work. A scrap escape hole *C* is drilled in the die-holder at an angle as shown, so as to prevent the scrap punchings from coming in contact with the shell while it is rotated around the die. An escape hole drilled in this manner can only be used on short shells and when the scrap punchings are small, or, if they are large, when they are few in number. Hole *D* in the die-bed permits the scrap punchings to readily fall out of the way.

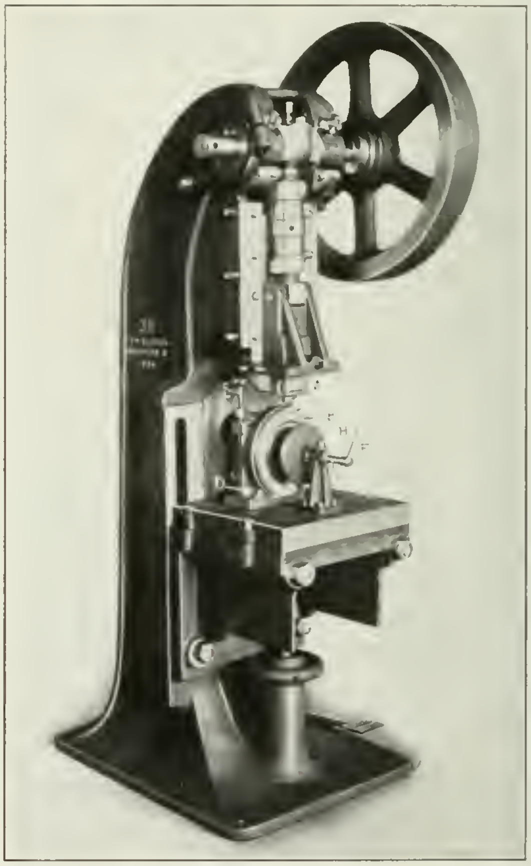

Fig. 3. Perforating Attachment with Special Device for Holding Shell in Place

The construction of the tools shown in Fig. 6 is somewhat different. Two small pins *E*, which are used in the face of the driving arbor, act as driving pins for rotating the shell. These enter into pierced holes in the bottom of the shell as shown at *B*, Fig. 7. The pawl which operates the indexing ratchet is fastened to part *B* in Fig. 6, which is made to fit the shoulder of the ratchet and works back and forth in order to provide for the required indexing. The back-and-forth motion is imparted to *B* by fastening a handle *F* to an adjustable connecting-rod which is, in turn, fastened to the crankshaft of the press. Part *D* is a brass friction which takes up the backlash of the driving arbor. This friction is fastened to the die-bed by a screw at *G*. The hole in the center of the friction fits the shoulder on one end of the ratchet. The brake or friction effect is applied by screw *H*. Part *A* acts as a steadyrest for the driving arbor, and is fastened to the die-bed by screws *J* and *K*.

The cam fastened to the end of the driving arbor causes the press to stop automatically by coming in contact with a lever connected to the driving clutch. The driving arbor is relieved at *L* to prevent the congestion of the scrap punchings. The hole for the driving arbor in the die-holder is also recessed at this place in order to give the scrap punchings, which, in this case, are rather large, ample room to pass the arbor. When the device is in operation, a shutter *M* closes up the bottom of the scrap escape hole in the die-holder. When the shell is slipped over the latter, the shutter is forced up and thus acts as a trap, preventing the punchings from dropping through into the inside of the shell. If the punchings were allowed to drop through and should cling to the perforated holes, they would cause the shell to jam and prevent it from rotating. When the perforated shell is removed from the die-holder, the shutter drops down of its own accord, thereby allowing the scrap punchings to drop out.

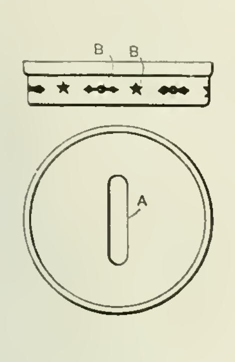

Fig. 4. Example of Shell to be perforated

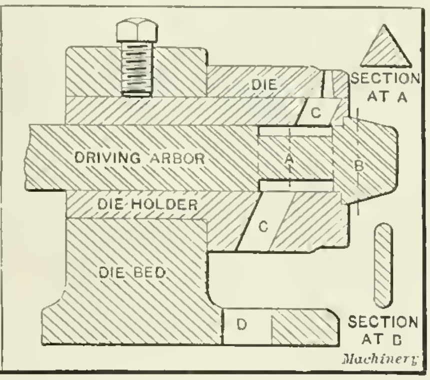

Fig. 5. Section of Die Bed, Holder and Die for Perforating Shell in Fig. 4

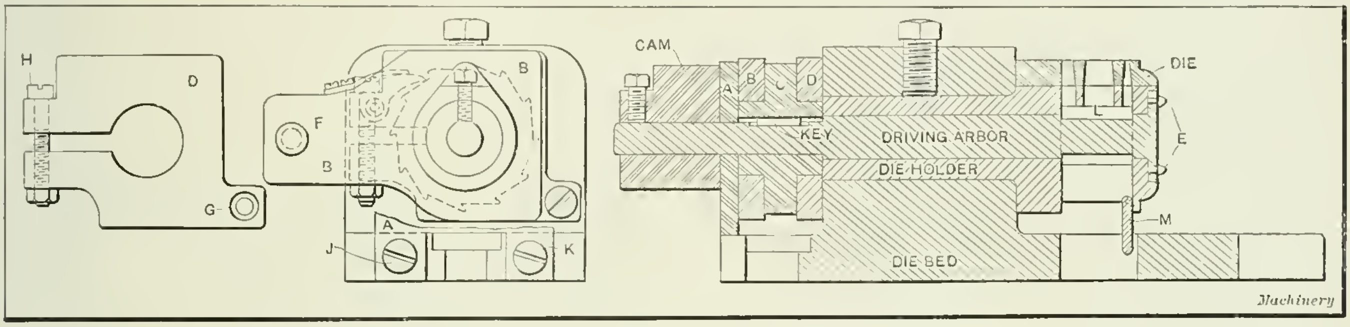

Fig. 6. Section of Die Bed, Holder and Arbor for Perforating Shell in Fig. 7

Perforating Shells of Tapered and Irregular Shapes

In perforating shells of tapered and irregular shapes the same general methods of procedure as already described are used, with the exception that the die-holder is held in the die-bed at an angle of 5 to 70 degrees or more with the bottom of the die-bed, the angle depending on the shape of the shell and the perforations to be made in it. In Fig. 9 is shown a die, die-holder and die-bed for work of this kind. The angle at which the die-holder is set should be such that if the outer ends of the two extreme holes in the perforating die are connected by a straight line, this line would be parallel with the bottom of the die-bed, as indicated in Fig. 10, where the points *A* and *B* are on the line which should be parallel with the base of the die-bed.

In Fig. 9 may also be seen the shell which is perforated by the die. The shell is rotated around the die by the tongue of the driving arbor engaging in an elongated hole in the bottom of the shell. The arbor is relieved at *A* in the usual manner to allow the scrap punchings to escape. No shutter is used, as the open end of the shell does not come near the scrap escape hole. The ratchet *B* which is operated by a pawl, not shown, is keyed to the driving arbor, while the friction used for controlling the backlash bears upon the shoulder of the ratchet as indicated. This shell has two rows of perforated holes, fifty-two holes in each row. Eight holes at a time are cut, or four holes in each row. The reason that four holes in each row are cut at each stroke, instead of five, six or eight, is, in the first place, that the number of holes cut at each stroke of the press must be such that the total number of holes in each row is a multiple of it. In the second place, it is not possible to get good results if the end punches are too far away from the center of the work, as these punches would strike a glancing blow. These holes would be somewhat elongated and "burry" instead of being clean, round and free from burrs. In this case, four holes in each row is as much as is practicable. Of course, if the holes are small in diameter and close together, a greater number can be cut at one time than when they are larger and further apart. If the diameter of the shells is large, a greater number of holes can also be cut at one time than with shells of smaller diameter, other conditions being equal.

In Fig. 11 is shown another set of perforating tools set up in a Bliss press. These are used for perforating the sides of the tube shown at *A* with a series of rows of small holes. These tools are of a somewhat different type from those already described. No driving arbor is used, but the shells are rotated direct from the ratchet which is placed in front of the die-bed. There may be several reasons for using this construction: When the bottom of the shell is to be left intact, no driving arbor can be used; sometimes the required shape of the shell is such as to prevent the use of a driving arbor; when the scrap punchings are so large and so numerous as to prevent them from dropping through if a driving arbor is used, or when that part of the shell that is to be perforated is very small in diameter, it may also be impossible to use a driving arbor.

Referring again to Fig. 11, it will be seen that another set of perforating tools similar to the one set up in the press is shown to the left. This is used for perforating the shell shown at *B*. The ratchet and pawl are shown at *C* and *D*. The latter is fastened to the dovetail slide *E* in the die-bed *F*. This slide is operated by the gate of the press by connection *G*. The holding-on attachment consists of a slotted stud in the die-bed to which a swinging arm is pinned. A circular disk which revolves with the work is fastened to this arm, as is also the small handle directly in front of the

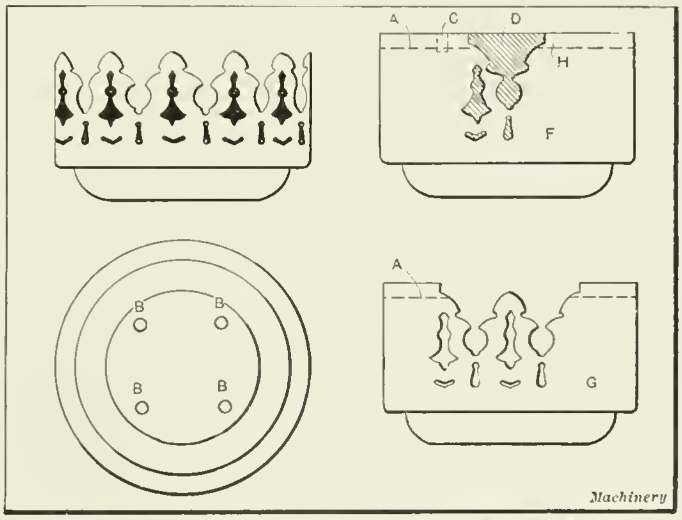

Fig. 7. Shell to be perforated, showing Successive Operations

attachment. This handle is used by the operator to swing the arm up and out of the way preparatory to removing the perforated shell from the die-holder.

A method commonly used in connection with perforating tools for rotating the shell to be perforated is the dog-notch method. A dog *C*, Fig. 10, is fastened to the ratchet by screws or dowel pins. The end of this dog fits a notch *D* in the shell, called the "dog-notch." The shell is slipped over the die-holder in such a manner as to cause the dog-notch in the shell to engage with the dog on the ratchet. In this way the ratchet can index the shell directly around the die-holder.

There are also a number of other methods used for rotating shells to be perforated. Besides those already described, one may make use of an irregular shaped hole in the bottom of the shell in connection with the driving arbor. Sometimes an irregular shaped hole is required in the bottom of the shell, and in such a case the tongue of the driving arbor may be made to fit this hole, which affords a good driving means. Sometimes use is made of a coaster brake device fastened to the ratchet. The tools used in connection with this device are similar to those already described, having the ratchet in the front of the die-bed, as shown in Fig. 10, with the exception that instead of using a dog, a device working on the principle of a coaster brake, such as is used on an ordinary bicycle, is fastened to the ratchet. With this device, no notch in the shell is required, as the open end of the shell is simply slipped into this device and given a part of a turn, causing it to be tightly gripped. The press is then tripped and the shell rotated around the die in the usual manner.

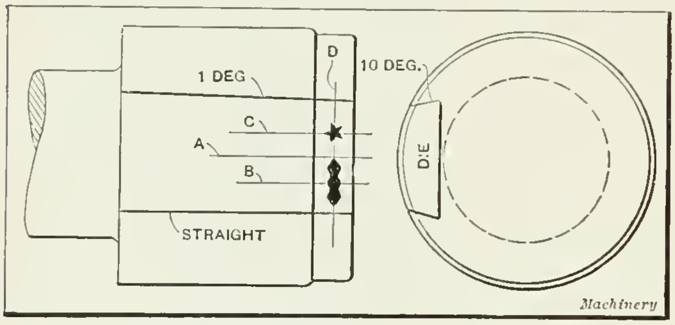

Fig. 8. Die in Position in Die Holder

In cases where a dog-notch is used and where there is a tendency on the part of the shell to slip in between the dog and the die-holder, which would prevent the shell from being properly rotated, the die-holder is turned down as shown in Fig. 10, and the dog is made to just clear the holder. This prevents the shell from slipping in under the dog.

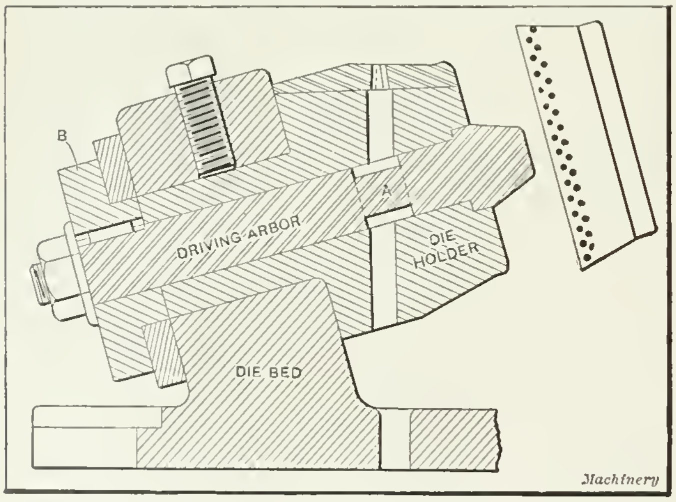

Fig. 9. Die, Die Bed and Holder for a Tapered Shell

The perforating die shown at *H* is held in the die-holder in the usual way, and is tapered lengthwise at a suitable angle as indicated. In order to afford a support for the die when in use, the bottom of the dovetail channel upon which the die rests is worked out so as to conform to some extent to the shape of the bottom of the die. This is done on dies where the holes are close together, so as to support the narrow bridges that separate the irregular shaped holes in the die. The best way to do this work is to first work out an open space under the dovetail channel. This space is used for holding the scrap punchings that are prevented from dropping through by a shutter. In working out this space enough stock is left under the dovetail channel to support the die properly, as indicated in Figs. 10 and 12, after which the openings through which the scrap punchings from the die drop are worked out. The shutter which is shown closed in Figs. 10 and 12, swings open on the shutter pin as soon as the perforated shell is removed from the die-holder.

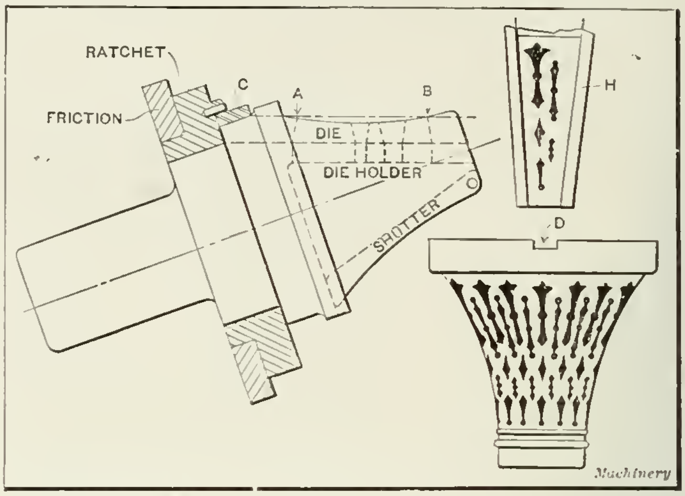

Fig. 10. Die and Holder for Perforating Shell shown to the Right

The construction of the tools in Fig. 12 is similar to that of those just described. At the right is a plan of the die, showing the manner in which the die is tapered lengthwise, which in this case is six degrees on each side. When the tools shown in Figs. 10 and 12 are in operation, two rows of holes are cut at every stroke of the press until the shell has completely rotated around the die and all the required rows of holes have been punched out. No device is used with these tools for holding the shells in place while they are rotating around the die, because the position of the die-holder in the die-bed makes it easy for the operator to keep the shell in place.

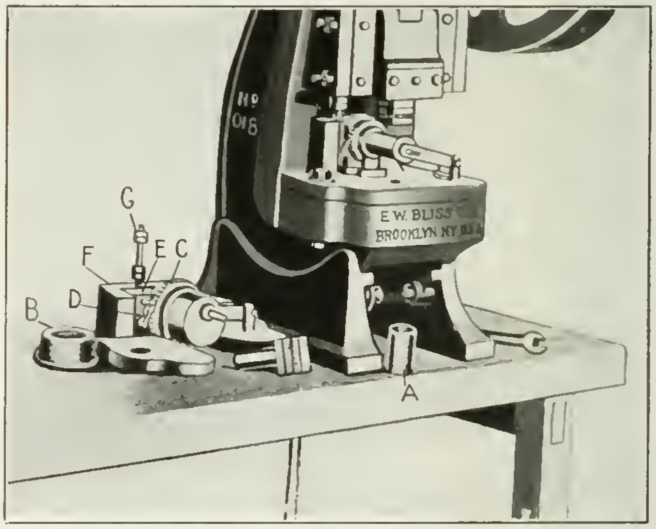

Fig. 11. Tools for Perforating Special Cylindrical Shells

It sometimes happens that a perforated shell of the general type shown in Fig. 7 is required, with the exception that the bottom is left intact and therefore cannot be used in connection with a driving arbor for rotating the shell. In such a case, the shell is dog-notched and rotated in the manner already described, with the exception that the locating of the dog on the ratchet preparatory to perforating the shell forms an important part in the successful operation of the tools. The reason for this is that when cutting out the scallops of the shell, the dog-notch *C*, Fig. 7, which is used for rotating the shell must necessarily be cut away from the shell, and must, therefore, be placed in such a position that it will come in the center of the large scrap punching which will be cut out at the last stroke of the press, completing the operation. If the shaded portion shown at *D* in Fig. 7 is the punching resulting from the first stroke of the press, and if the blank is rotating from right to left, then the dog-notch must be located at *C*, central between the two scallops completed by the last stroke of the press, after the whole shell has been perforated.

In order to prevent the punch *A*, Fig. 14, which cuts out the scrap punchings *D*, Fig. 7, from coming in contact with the dog, a short slot is milled in the center of the face of the punch at the back end near the ratchet, so that the punch will clear the dog when that part of the shell containing the dog-notch is cut out.

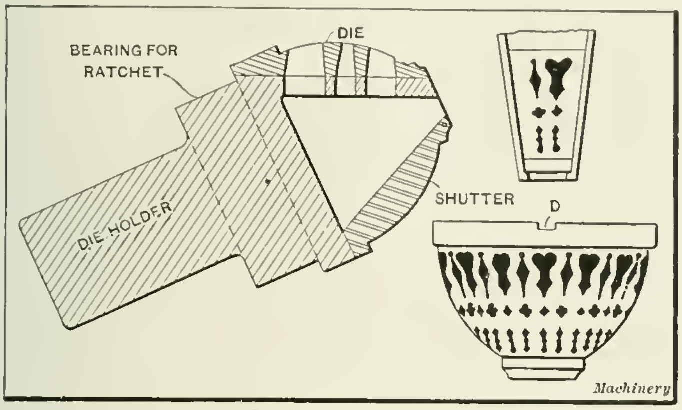

Fig. 12. Die and Holder for Perforating Shell shown

Lay-out of a Perforating Die

Preparatory to laying out the die shown in Fig. 8, the die-blank is carefully fitted to the dovetail channel in the die-holder, after which it is turned up in the lathe in place and highly polished. It is then removed from the die-holder and blued by heating, and again driven into the die-holder, after which it is ready to be laid out. The die-holder is then mounted in the milling machine, the index head in this case being set for twenty-eight divisions, as there are fourteen perforated holes of one design and fourteen of another. With a surface gage and by aid of the index head, the center lines *B* and *C* are scribed. Line *A* is merely drawn to show the center of the die, and the center of each one of the holes in the die should be an equal distance from this line. Center line *D* is next scribed the required distance from and parallel with the face of the die-holder.

In laying out the hole on the center line *B* a small circle of the exact diameter of the circular opening in the center is first scribed. The diamond-shaped ends are next laid out and scribed. The star-shaped hole on the center line *C* is laid out from a master punch which conforms to the required size and shape. In cases where the required number of shells to be perforated does not warrant the making of a master punch, the dies are laid out from the star-shaped punch that is used in connection with the die.

In working out the die, the central hole from which the star design is made is first drilled and taper-reamed from the back to the size of the teat on the master punch, which is equal to the diameter of the circle passing through the bottom of the grooves in the star. The teat of the master punch is then entered into the die and the punch set and clamped to the die so that a point of the star is on line *C*. The outline of the punch is then scribed on the face of the die, after which the die is worked out and fitted to the punch. In order to facilitate matters, the punch is used as a broach after the die is filed to shape. In working out the other hole in the die, on line *B*, a hole is first drilled and taper-reamed from the back for the circular opening in the center. Two holes are drilled and reamed in the center of the diamond-shaped ends. The surplus stock between the drilled holes is then removed and the hole filed to the desired shape.

There are two ways in which a die such as that shown in Fig. 13 may be laid out. One is to lay out the die on a milling machine in a manner similar to that already described. The other, which is most commonly used, is to lay out the die by scribing the design on its face from a master shell which is slipped over the die-holder and has the shape to be perforated upon it already worked out.

The master shell itself is laid out as follows: The shell is fastened to the die-holder by a few drops of soft solder to prevent it from moving. The die-holder is then mounted in the milling machine. The index head in this case is set for twenty-four divisions. In Fig. 13 is shown the laying-out of the die, but the same method applies to the shell. With a surface gage used in connection with the index head, the lines *A*, *B*, and *C* are scribed on the shell. Lines *A* and *C* represent the centers of two adjoining scallops, and line *A* is also the center for the two holes *I* and *H*, while line *B* is exactly in the center between two scallops and constitutes the center line for hole *G*. The lines *E* and *D* are next scribed on the shell, the former representing the height of the ears of the projecting scallops, while the latter shows the height at which the lower curved portions of the pointed scallops converge. After these construction lines are scribed on the shell, the design is readily laid out. The shape of the design is then worked out by drilling and the surplus stock is removed by means of a jewelry saw. The shell is then filed to the desired shape and when completed should be a duplicate of the portion cut out by the first stroke of the press, as shown at *F* in Fig. 7. In filing out a design, care should be taken to file out all the holes central with the center lines *A*, *B* and *C*, and also parallel with a plane passed at right angles to the center of the design, through the shell, in order that the holes may be at their exact required position on the inside of the shell.

It will be noted in Fig. 13 that the large hole *F* in the die is extended past the line *D*; this is done in order to make sure that the large scrap punching *D*, Fig. 7, will be completely cut from the shell. This is especially necessary when the shells vary in length. The dotted line *A*, Fig. 7, is drawn so as to more clearly show the length of the twelve pointed scallops, and their relation to the top of the shell.

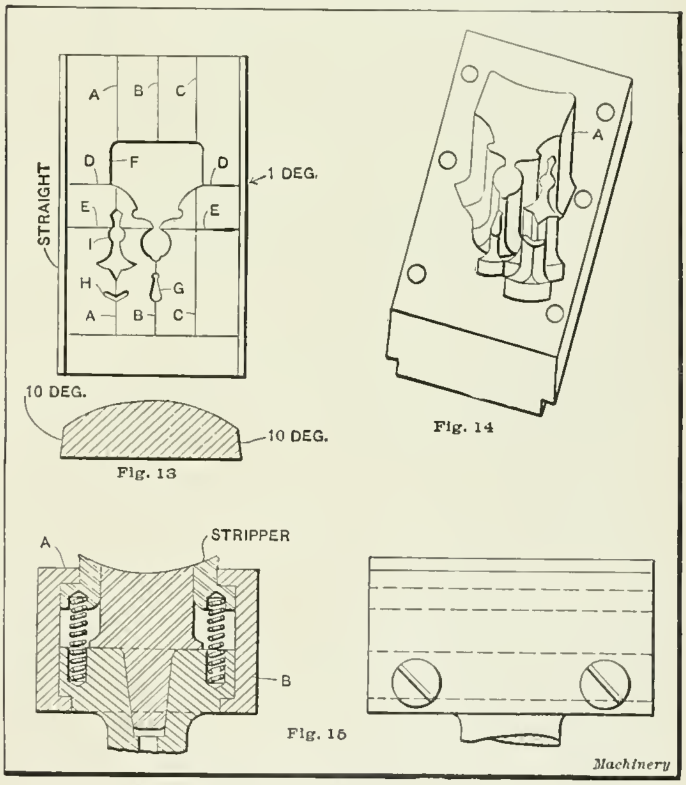

Fig. 13. Laying out a Perforating Die. Fig. 14. Perepective View of Perforating Punch. Fig. 15. Punch Holder and Stripper, showing Punch, Fig. 14, in Section

In drilling and working out the surplus stock in the die Fig. 13, the same general methods that are used for working out an irregularly shaped blanking die are used. First, remove as much of the surplus stock as possible by drilling. When drilling out the surplus stock in the hole *F*, the smaller of the two circular openings between the scallops is first drilled out and taper-reamed from the back to the finish size.

After this, the hole is plugged with a small taper pin that is filed to fit it, and the large hole is drilled and taper-bored in a lathe. The round corners at the opposite end of the hole are then drilled out. These corners are left circular in order to add to the strength of the die and to prevent cracking of the die in hardening. The remainder of the hole is drilled and worked out in the usual way. In working out the small holes *G* and *H*, the opposite ends are first drilled and taper-reamed to the finish size, after which other holes are drilled and reamed and the surplus stock is removed with a small broach or jewelry saw preparatory to filing out the die. Hole *I* is drilled out and the surplus stock removed in a similar manner.

Filing Out the Die Shape

A die used for perforating the sides of cylindrical work is rather awkward to hold, either in the vise or in die-clamps while being filed out, owing to the fact that the face of the die is circular in shape and the sides are dovetailed. For this reason, a die-holding fixture, shown in Fig. 16, is used to hold the die in the vise, die-clamp, or filing machine while it is being filed out. The device shown is adjustable to accommodate various widths of dies.

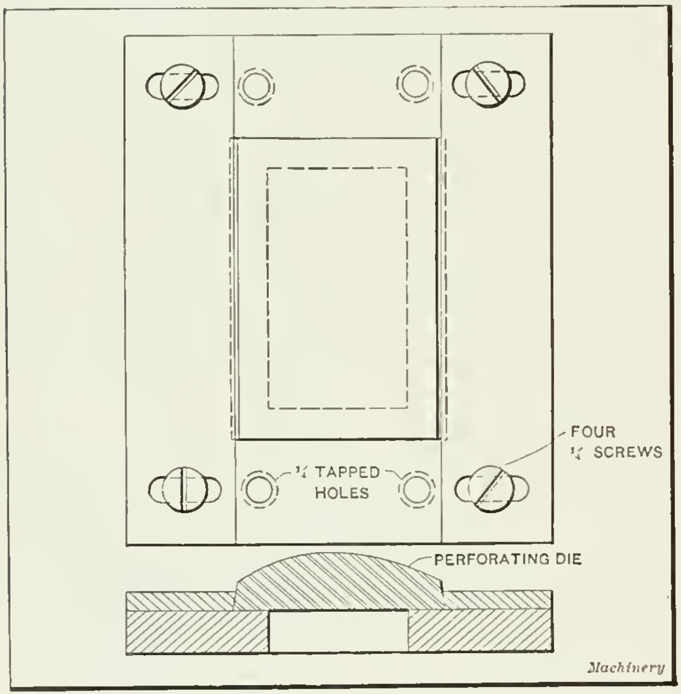

Fig. 16. Device for Holding Perforating Dies while Filing

The most essential points to be remembered when filing out a perforating die are: Use a coarse file for the rough filing and finish with a smooth one. Take care to have the clearance filed straight in order to prevent the congestion of scrap punchings in the die; perforating dies as a rule are not very strong and are often cracked and broken because of neglect on this point. The clearance should not be filed over 1½ degree, in order to make the die as strong as possible; in cases where the holes in the dies are close together even less clearance is necessary, and a very narrow wall that separates two holes is filed almost straight on each side, with just enough of a taper to clear. Care must be taken when filing to prevent the back or the sides of the file from running into that part of the die that has already been finished.

Making the Punch for a Perforating Die

The punch used with the die shown in Fig. 8 is comparatively simple in its construction. It consists of the usual form of punch-holder into which the two perforating punches are driven. The star-shaped punch, after it is fitted to the die and hardened, is driven into the punch-holder in such a position that when it is entered into the die the sides of the punch-holder will be in a straight line and parallel with the die-bed. The tools are then set up in a hand or foot press so that the die and star punch are in proper alignment with each other. The foot treadle of the press is then disconnected from the gate so that the gate which holds the punch-holder in place can be withdrawn from the press without disturbing the punch-holder or the ways upon which the gate slides. The other punch, in its unfinished state, is then driven into the punch-holder and the face is coated with a 1/16-inch thickness of soft solder. The gate of the press is then slipped back into place and the impression of the outline of the die is transferred to the solder on the face of the punch. The punch-holder is then removed from the press and the punch driven out and milled to conform to the soft solder outline of the die, after which the punch-holder is put back into the press, care being taken to see that the star-shaped punch is in proper alignment with the die. The milled punch is then put back in place and gradually sheared and fitted to the die. Each time after the punch has been lightly sheared into the die, the fins and surplus stock are removed and the punch is again entered and sheared a trifle deeper, until it enters the die at least ¼ inch.

The hand or foot press is very convenient to use when fitting perforating punches to their dies, because the construction of the press makes it possible to handle the gate conveniently and to keep the punches in proper alignment with the die.

In making perforating punches such as shown in Fig. 14, the punch-holder is first machined to the desired shape and size, after which the taper hole for the shank of punch *A* is reamed. The shank of the punch is then turned and fitted to the punch-holder and driven into place. The face of the punch is made to conform to the outside diameter of the shell and is then clamped to the face of the die and the outline scribed on it, after which it is milled to shape and sheared and fitted to the die. Before scribing the outline of the die on the face of the punch, care must be taken to see that the punch is set in the proper relation with the die, so that when the finished tools are set up in the press, there will be no necessity for elongating or widening the slots in the die-bed used for clamping the die to the bed of the press, due to the punch not being laid out central with the die.

After the first punch *A* has been fitted to the die, the holes for the other three punches are laid out so that the cutting part of the punches will be as nearly central with the shanks as possible. Holes are then drilled and reamed for the shanks, and when this is done punch *A* is hardened. The reason that this punch is hardened before the other punches are fitted to the die is that if the punches were all sheared and fitted together and then punch *A* should spring in hardening, it would cause great difficulties in again bringing the punches into proper alignment with the die. After punch *A* has been hardened and driven back into the punch-holder, the shanks of the other three punches are turned up and fitted to the respective holes into which they are afterwards driven. The shanks of these punches may be made either straight or tapered, but should be a good driving fit and should have shoulders bearing against the punch-holder.

Before the punches are driven into place, the die and punch *A* are set up in the foot press and properly aligned with each other. The gate of the press is then withdrawn, the three punches are driven into place, and the faces coated with soft solder. The gate of the press is then slipped back into place and the outline of the die transferred to the punches, after which they are driven out and milled separately in the milling machine. Sometimes the punches cannot be driven out from the back of the punch-holder, because if the holes for these punches were drilled through they would run into and weaken the shank of the holder. In such cases holes are drilled from the side to meet the shank holes, in order to allow a taper drift to be used for starting the punch so that it can be removed.

After the punches have been milled, they are driven back into the punch-holder and are sheared and fitted into the die, as previously described. The punches, of course, are lined up perfectly with the die so as to enter into their respective holes as one single punch. After the punches are hardened they are sharpened by holding the punch-holder in a special grinding fixture and drawing the punches back and forth across the face of a wheel of about the same diameter as the shell to be perforated. It will be seen in Fig. 14 that the base of the punches is strengthened by milling the punches so that there is a liberal fillet between the shoulder of the punch and the milled-out shape. This also tends to prevent distortion in hardening.

The Stripper

The stripper serves three purposes: it strips the metal from the punch; it supports the small punches by preventing them from springing; and it tends to keep the perforated shell in shape by preventing it from bending or becoming "kinked up." The commonly used stripper construction is shown in Fig. 15. The face of the stripper conforms to the outside diameter of the shell. It is drilled and worked out so that it is a sliding fit on the punches. The shoulder part of the stripper bears against the bottom lugs of the side pieces *A* and *B*, which are fastened to the punch-holder and prevent the stripper from being forced off the punch. Six spiral springs exert the required pressure on the stripper. When setting up the tools in the press, the stripper is forced back about ⅛ inch and two pieces of, say, No. 31 drill rod are placed between the stripper and the bottom lugs of the side pieces, which keeps the stripper out of the way while the punch and die are aligned with each other.

In conclusion, it may be mentioned that perforating dies of the type described are sharpened on universal grinding machines. Owing to frequent sharpening it is sometimes necessary to raise them slightly by putting shims of sheet steel under the dies. These shims are drilled and filed out to conform to the holes in the dies, in order that the scrap punchings may drop through.

* * *

REPAIRING AN OLD LATHE IN NEW ZEALAND

By JOHN PEDDIE

An article recently appeared in the pages of MACHINERY on the repair of machine tools.[†] In many shops, unfortunately, tools such as treated of in this article would not be considered in need of repairs. This, however, could scarcely be claimed for the lathe which the writer recently overhauled. It is not necessary to go into the reasons for repairing such a tool instead of breaking it up for scrap and buying a new one. This lathe had a 15-foot bed and swung 18 inches. It had a gap which, when used, allowed a swing of about 3 feet. The gap piece was fitted in such a peculiar manner—bedded down on roughly clipped projections, and held in line with a couple of similarly fitted pins—that one might suppose it had been specially built to bring the gap lathe to discredit.

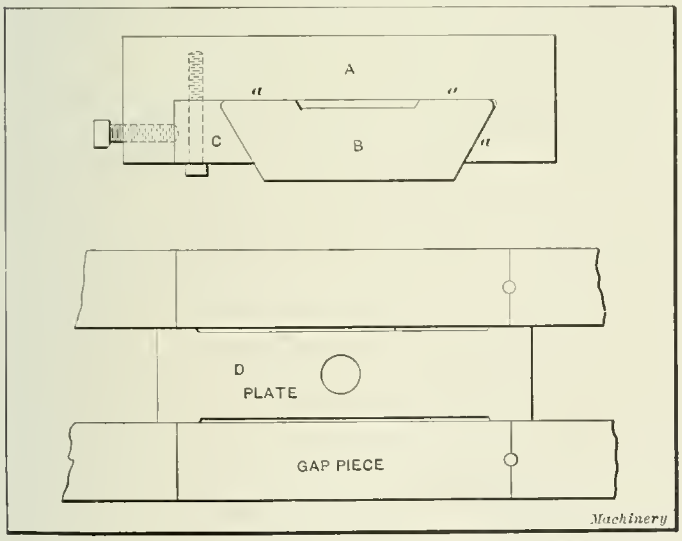

Fig. 1. Diagrammatical Outline of Slide and Gap Piece

It was resolved to have the bed planed. Before doing so the gap piece was bedded down solidly on the four corners, and a cast-iron plate was made to fit between the shears, as shown at *D* in Fig. 1. It is about 1 inch thick and fits tightly for about ¾ inch on each side of the joints, these being scraped to make a good bearing, and tight enough to require it to be tapped into place with a wooden mallet. The hole in the center admits a spanner for bolting down the gap piece.

After planing, the bed was leveled up as well as possible with an accurate level. Having no straightedge of the required size to test it with, it was assumed that the planing was accurate enough for our purpose.

The saddle on being tried on the bed proved to be worn bell-mouthed. Fig. 2 shows a diagrammatical plan of the saddle. The writer concluded that it would run longer without developing this defect if it had the bearing cleared away in the center. Accordingly the center bearing part was cut away with hammer and chisel to a depth of 1/16 inch, as shown by the dotted lines, leaving a bearing of about 6 inches at each end. This bearing surface was then filed and scraped to fit the bed. The bed was also scraped from end to end, in this case merely removing the roughness left by the planer tool.

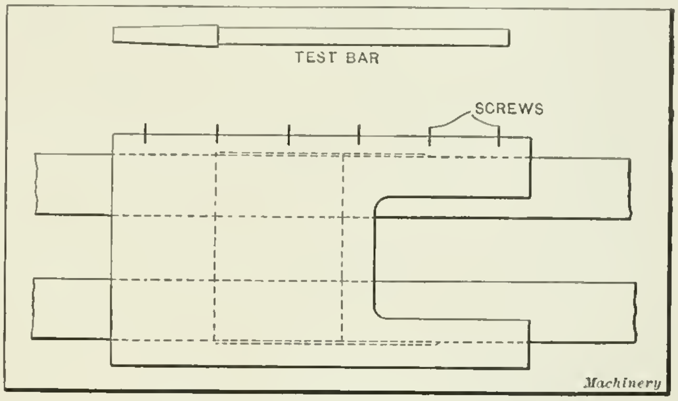

Fig. 2. Test Bar used for Lining up and Diagrammatical Plan of Saddle

The saddle, as indicated, has a number of screws for setting up the gib. A careful man may be able to keep these correctly adjusted, but the arrangement cannot be compared with the taper gib for convenience and certainty, even though the latter does wear more at one end than the other. Any defect in adjustment of this type allows a rocking motion of the saddle which is shown if one takes a light cut alternately with the right- and left-hand feed without altering the adjustment of the tool.

The refitting of the slide-rest was next undertaken. This was a compound rest bolted to the saddle and removable when the latter was required for boring. A 12-inch surface plate was available for this part of the work. The upper part of Fig. 1 shows a section of one slide. The order of operations was as follows: Faces *a* of part *B*, and the bearing face of gib *C* were first scraped to the surface plate. Part *A* was then scraped to fit *B* on the true faces. Gib *C* was then screwed into place and gradually set up while the corresponding face of *B* was scraped to fit until the slide would move with equal tension from end to end and show good contact. On these old slides, the sharp front edge which when new serves so well to keep the slides clear of grit, is worn away, leaving a slight wedge-shaped opening which offers every facility for the admission of dirt. A brass scraper was fitted at the front of the

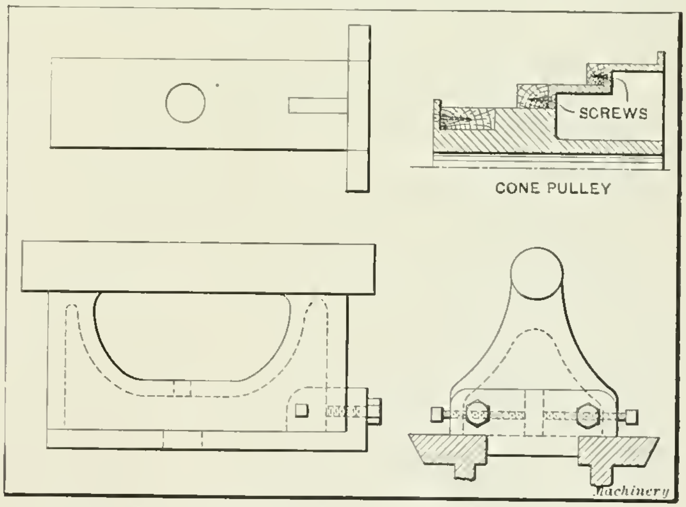

Fig. 3. Tailstock Adjustment and Cone Pulley after Improvement

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[*] Address: Technical College, Christchurch, New Zealand.

[†] See MACHINERY, July, 1911, "Repairing Lathes and Milling Machines."

saddle to keep the ways clean; this worked well until it got frayed through running over the joint at the gap.

The centers of this lathe were about 2 inches long, and with a taper so abrupt that it was almost impossible to get them to hold in their sockets for turning up the points. The sockets were, therefore, bored out to a Morse taper, a taper plug gage and test bar, as shown in Fig. 2, having first been made. The number of lightest possible cuts required to get these holes true is quite remarkable to one not used to this work.

Machinists who are accustomed to lathes which are without the set-over tailstock are familiar with the trouble of setting the lathe to turn parallel between centers and at the same time to bore parallel. This lathe had no set-over, but the base-plate shown in Fig. 3, which accomplished that end, was designed and fitted. The plate fits between the shears for its whole length, and is secured to the end of the tailstock by ¾-inch set-screws. In fitting this, the test bar was used in the tailstock center socket, and tests made by an indicator in the toolpost, in order to make the spindle parallel with the bed.

The alignment of the headstock spindle was next undertaken. The test bar showed that this was worn down at the front bearing. As the bushes were of gunmetal, in halves, set in rectangular pockets, these were adjusted by soldering a piece of sheet brass on the under side of the front bearing, and then the under side of both bearings was filed till the test bar showed that the adjustment was correct. At the same time any necessary scraping was done on the bushes to secure a good bearing. The front bearing was left slightly high to allow for future wear.

The cone pulley of this lathe had four steps, the smallest being so small as to be of scarcely any use. It was decided to make it into a three-step pulley, to enable the use of a wider belt. This was done by fitting segments of wood onto the cone as shown in Fig. 3, securing them by screws. The segments and steps were well painted with white lead paint before tightening the screws. The pulleys were then taken to another lathe and turned up. The increase in pulling power obtained was very noticeable and more than compensated for the smaller range of speeds. The difference in the class of work obtainable from this lathe before and after the repairs was, of course, very great. Little more than the barest essentials for obtaining true work was attempted, and many minor details might have been corrected had opportunity offered. In most cases it would hardly pay, however, to fix up an old tool in the manner indicated.

* * *

INTERESTING DEVELOPMENT IN HIGH-EFFICIENCY GENERATORS

In speaking before the American Society of Swedish Engineers, Brooklyn, N. Y., on "Generating Apparatus used for Wireless Telegraphy and Telephony," Mr. E. F. Alexanderson, of the General Electric Co., Schenectady, N. Y., described an interesting type of machine which he has developed for obtaining very high frequencies. In the generator described, a steel disk resembling the rotor of a steam turbine and having six hundred slots, is used. This steel disk rotates with its edge between the pole faces of the stator, at a speed of 20,000 revolutions per minute. Brass plugs are riveted into the space between the steel teeth in order to reduce the air resistance. The diameter of the steel disk is 12 inches. The generator is driven from an electric motor by gearing similar to that used for reducing the speed in De Laval steam turbines, except that in this case the gearing is used for increasing the speed. With this machine it is possible to obtain 100,000 alternations per second and with the aid of a special winding and 800 polar projections on the disk, 200,000 alternations per second have been obtained. High-frequency generators of this type will probably prove especially valuable in wireless telephony, the success of which depends largely upon the possibility of producing currents of high frequency. The development is also of great value in the wireless telegraphy field as it makes possible the sending of messages over greater distances, and also provides a means for non-interference with other wireless apparatus, as it is possible to tune the various instruments so as to receive only certain messages, in a way not possible with the lower frequencies produced by the spark system.

SOME TOOLS USED IN THE MANUFACTURE OF SMALL STEEL BALLS*

By A. G. BLACK†

Very small steel balls—say of from 1/32 to 1/16 inch in diameter—are handled in a somewhat different manner when being manufactured than are the larger sizes. The reason for this is simply that more delicate machinery is required on account of the small sizes dealt with. The best idea of how small a 1/16-inch ball really is may be gathered from the fact that there are 28,840 balls of this size to a pound, or about 1800 balls to an ounce. Comparing this with 1/2-inch balls, we find that there are only fifty-five in a pound, or less than four in an ounce.

In the following will be described the methods that were used in a factory with which the writer was connected several years ago, for making balls of small sizes.

The forgings were made from annealed crucible steel wire, the diameter of which was about 0.002 inch smaller than the diameter of the finished ball. The stock was upset enough in the forging operation to make the blank about 0.010 inch larger than the finished ball. The forgings were made in a Simonds forging machine, of the same general type as described by Mr. Grant in the February number of MACHINERY, in the article entitled "The Manufacture of Steel Balls." The machine was remodeled, however, to use the platen style of die as shown in Fig. 1, this being accomplished by cutting off the extending projection on the large driving gear and mounting one-half of the circular die on the hub of the gear, the other half being mounted on the shaft that projected through the center of the hub and revolved in the opposite direction. A gas jet was located near the point on the dies where the stock entered. In this way the stock was heated to the required heat for rolling.

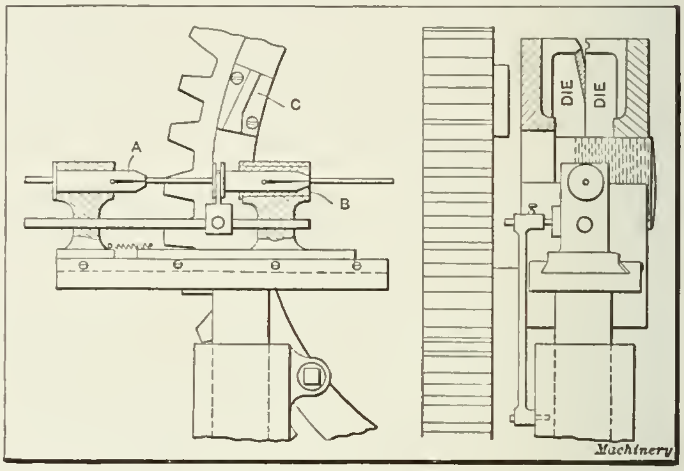

Fig. 1. Diagrammatical Outline of the Main Features of the Ball Blank Rolling Machine

The wire was furnished in a coil and fed off from a reel, an automatic feeding device being provided having one stationary, spring chuck *A*, Fig. 1, and one sliding spring chuck *B*, similar to those used on automatic screw machines. A cam *C* was provided on the side of the main driving gear to open and close the sliding chuck. When the stock fed into the dies, the cam opened the chuck and also carried it back against the action of a spring for another feed, and locked it ready for the next cycle. The stationary spring chuck held the stock from moving while the rolling operation took place. The machine could cut off and roll 75,000 blanks per day.

After the forgings were made, the blanks were passed between two large hardened revolving plates in order to remove any fins or inequalities in the blank. They were then hardened before grinding, which latter operation was done in a machine similar to the dry grinder described by Mr. Grant, except that the machine was smaller. The writer also added an improvement which consisted of a spring suspension of the upper ring which rotated the balls as indicated in Fig 2. Four coil springs *A* were mounted between the upper ring and a plate above it as shown, the upper ring being driven from this plate by four stud bolts. In this way it was possible to place any amount of pressure required upon the balls. With this arrangement the emery wheel and the rings would last much longer, because of the reduction of wear, as the upper ring was allowed to spring away from the wheel when a new set of blanks, which were not absolutely round, were first put into the grinder.

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* See "The Manufacture of Steel Balls," MACHINERY, February, March, and April, 1912.

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Another improvement consisted in making an adjustable emery wheel fastening for preventing the emery wheel from running out of balance, due partly to the inequalities of the wheel itself and partly to the wear of the spindle bearings.

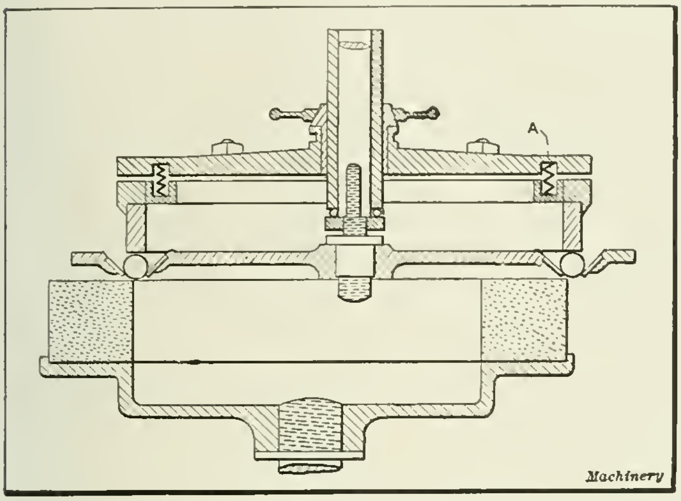

Fig. 2. Spring Balanced Dry Grinding Machine

An arrangement was introduced consisting of four wide jaws in the wheel plate, as shown in Fig. 3, which gripped the edge of the wheel in a manner similar to that of a lathe chuck, but which had surface enough to cover a fair portion of the wheel diameter. In this way, the wheel could be adjusted and balanced every time a new wheel was mounted.

The balls were dry ground to within 0.002 inch of the finished size, after which they were lapped with emery and oil, using a set of cast-iron rings. These were fitted to sensitive bench drill presses arranged in banks of six, attended by one operator. After the oil finishing grinding, the balls were polished and inspected. This last operation was done by an automatic device which the writer designed and built, the outlines of which are shown in Fig. 4.

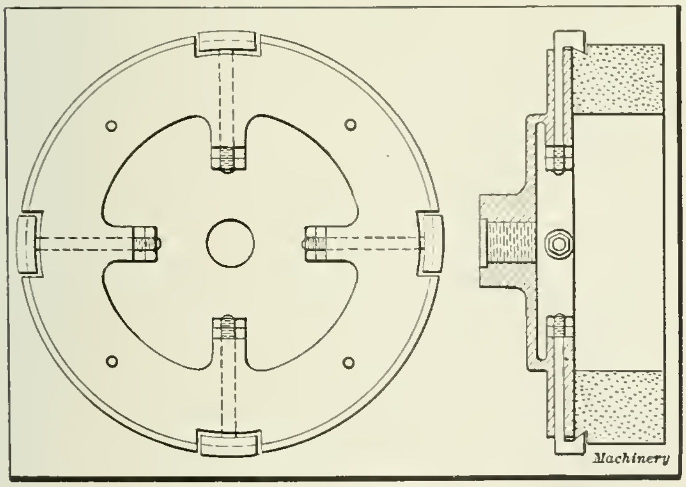

Fig. 3. Faceplate and Chuck-jaws for Holding Grinding Wheel

The principle of this machine was to feed the balls from a hopper under a fixed magnifying glass about 2¾ inches in diameter, focused to suit the operator. The balls would then remain under the glass for six seconds. The operator held a steel magnet in each hand, and with her elbows or arms resting on the table at each side of the glass lens, was ready to pick out any balls which appeared defective to her. If they were all perfect, she would merely wait until the balls turned half a revolution, exposing the other half for six seconds more. Then, in order to expose the periphery which had not yet been directly under the inspector's view, the balls were turned one-quarter of a revolution so as to bring the part but imperfectly seen in the two previous operations squarely under the glass; then another half turn was made and in that way all the parts of the balls were exposed and could be carefully inspected. After this, the feeding plate would draw out from under the glass and the balls would fall into a drawer, after which the plate would be returned to the hopper, bringing out another lot of balls ready to be inspected. This last operation required also six seconds, which gave the operator an opportunity to temporarily rest her eyes.

The various movements were timed by a cam. When changing from one size of ball to another it was only necessary to slip off one cam and put in another adapted for the desired size, and also to change the feed plate. The device permitted of inspecting balls ranging in size from 1/16 to 1/2 inch diameter. The method was very efficient and six girls were able, in this way, to handle the work which required twenty inspectors to do in the old way. The method was also more positive, and the chances of defects slipping by the inspector were not as great, as each ball was fully exposed to view from all sides.

Some of the cam motions mentioned, as, for instance, that for feeding the balls from under the hopper, were constant for all sizes of balls, but the cam operating the sliding plate that rolled the balls over was different for different sizes, as the plate had to travel further for the larger balls than for the smaller. The lens of the magnifying glass was large enough so that one could see 64 one-quarter-inch balls conveniently, and as there were often but one or two of these balls to be picked out at each movement, the operator had plenty of time, and with both hands free could pick them out very rapidly. A lever was also provided to throw out a clutch mounted on the driving pulley hub, so that the operator could stop the machine immediately, if necessary.

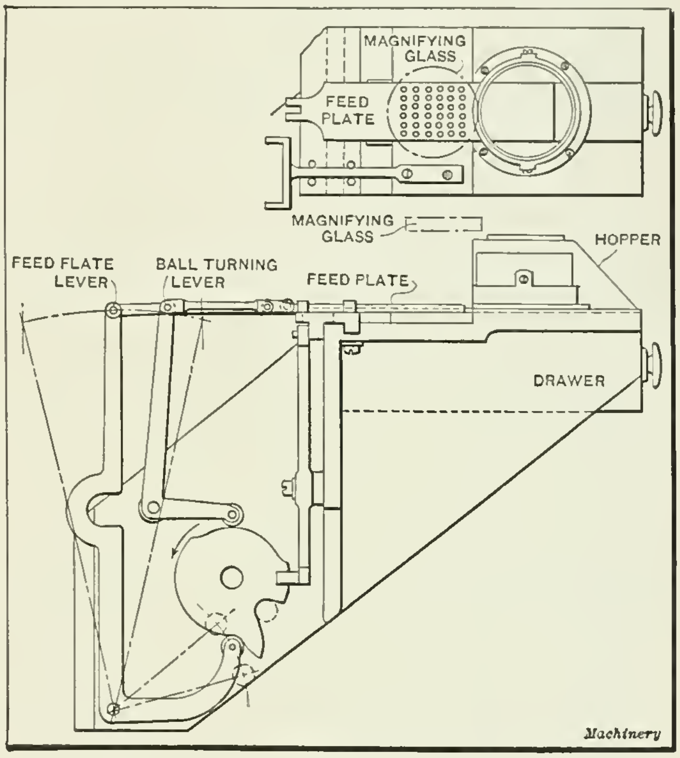

Fig. 4. Main Features of Ball Inspecting Machine

One difficulty that had to be overcome consisted in the balls clogging and refusing to roll out from a small opening. This difficulty was overcome by bridging over the outlet by a partial baffle; then the balls would easily feed out in the shallow depth under the bridge where they were always free to roll out and drop down an incline. This prevented clogging and no agitator was found necessary. The device was never patented because the president of the concern with which the writer was employed believed that if a patent was applied for the principle would become known to all ball manufacturers, and they would work out the same idea in a somewhat different manner. The gaging was done by a machine similar to that illustrated by Mr. Grant.

ON WRITING TECHNICAL ARTICLES

SUGGESTIONS ON THE PREPARATION OF CONTRIBUTIONS FOR MACHINERY

Comparatively few of the manuscripts submitted to the editor of a technical journal are from writers who are familiar with the actual requirements. This general lack of information on the part of contributors regarding the selection of a subject, its treatment and the many little things about it that go to make up a desirable article from an editorial standpoint, often results in a waste of time and effort, diminishes the chance of the contribution's being accepted and makes necessary a considerable amount of editorial revision with a consequent delay in publication. The object of this article is to give some general information which the contributor may advantageously use as a guide in the preparation of manuscripts for technical magazines.

Choice of Subjects

The writer should choose for the subject of his contribution, some form of engineering or research work with which he has had experience. The more experienced he is in the class of work described, however, the more careful should he be not to assume too much knowledge of the subject on the part of his readers. He should not neglect to explain simple points, particularly if his trade is a special one and its methods not generally known to the mass of mechanics. A thorough reading of one or two issues of the journal to which the article is to be submitted, will generally show the perspective limitations of its readers.

It is well to bear in mind that the kind of material most acceptable to a technical journal is that which has not yet found its way into the text-books, nor has become common knowledge in the profession and schools, but which has all the earmarks of getting there at a later date. Wherever engineering work is being done by a new and better method, or with new and better tools, machines or appliances—in short, wherever progress is evidenced—there is material which every intelligently conducted technical journal is glad to publish. Long articles do not receive more consideration or are not more likely to be accepted than short ones. Each must be judged on its own merit.

On Choosing Titles

The title of the article should be short but expressive of its contents. If the nature of the subject is such that it is difficult to do it justice in a title of a few words, it is advisable to use a key-word title and supplement this with a sub-title, thus:

MOTORS FOR AEROPLANES

Their Selection, Operation and Maintenance

The introductory paragraph should also be brief. It should state what the article is to treat of, the object of the device or method to be described, and should point out any original or striking features likely to prove of interest. An article having a single purpose will generally prove much stronger than one in which the reader's attention is divided. For example, this article is stronger on account of being confined to engineering magazine contributions than it would have been had an attempt been made to treat the subject with respect to all classes of magazines and books. The points laid out in the introductory statement should be kept thoroughly in mind throughout the writing of the article.

Treatment of the Subject

Next in order comes the general treatment of the subject, which should form the body of the article. Make the sentences short and clear, and the statements exact and free from ambiguities. Do not, however, attempt to be brief at the expense of correctness and accuracy of expression, but cut out every adverb, adjective and qualifying clause which can be spared. Avoid "flowery" language. It is all right in popular magazines, but hardly suitable to magazines devoted strictly to practical mechanics.

An article need not lack literary style because of the elimination of extraneous expressions and words, the meaning of which one has to hunt for in the dictionary. Express each thought, so far as possible, in a sentence by itself, having the subject as near as practicable to the beginning of the sentence. Do not be afraid of using the same words over and over again, if repetition is conducive to clearness. It is more important that a technical article be absolutely clear than that it be perfect from a literary standpoint. When uncertain as to your grammar or phrasing, rewrite the sentence rather than waste time tinkering with it.

If a device for performing certain work is to be described, always describe the work to be done first before taking up the details of the device. Do not bring in matter extraneous to the subject treated in the article. Tell all there is to be told about the subject treated, and then if there is something to be told about some other subject, write another article.

Concerning Style in MACHINERY

In general do not use symbols such as ' for feet, " for inches, and # for number; it is better to write the words, because ' signifies minutes as well as feet, " seconds as well as inches, etc.

Use figures for all numbers from 100 up. Spell out all numbers less than 100, except when used as a dimension, sum of money, percentage, or where followed by a fraction, by an abbreviated dimension, or by one or more numbers above 100 in the same sentence. Spell out all numbers when used at the beginning of a sentence.

Use "by" instead of × in giving dimensions.

All decimal numbers having no units should have a cipher placed before the decimal point, thus, 0.26 feet, and not .26 feet.

Separate whole numbers of more than four figures into threes, by a comma, thus, 10,000. Do not use a comma in numbers of four figures. Do not separate decimals into threes.

Write time of day in figures, with a colon between, thus, 7:30 o'clock. Capitalize A. M. and P. M.

Use numbers indicating per cent. and spell rather than symbolize "per cent," thus, 16 per cent. and not sixteen %.

In tables, when necessary to abbreviate, use the singular form thus, 15 in., and not 15 ins., but, as a general rule, use no abbreviations except those especially mentioned below. Do not abbreviate the name of a month when followed by the day of the month, but write out in full, thus, November 30, omitting the th, st, etc. Abbreviate the states when used after cities, thus, Brooklyn, N. Y. Omit No. or # before the number on a street, thus, 36 Fulton St. Abbreviate "Company" to "Co." "Company" is always singular, but "Works" are plural. Abbreviate "Manufacturing" when part of firm name, as Brown & Sharpe Mfg. Co. Also write Fig. 1. and not Figure 1.

Capitalize the sections of the country, thus, North, Northwest, etc. Do not capitalize the seasons, such as summer, winter, etc. Personal titles should not be capitalized: write John Jones, electrical engineer. Chemical symbols such as H_2O, etc., should always be capitalized. The "F" in "Fig." should be a capital.

Use "&" in titles of firms and corporations, and in names of railways. but not elsewhere, thus, Yale & Towne Mfg. Co.

Spelling, Punctuation and Mathematical Formulas

Correct spelling is a matter that any contributor with a dictionary at hand can settle for himself. As to punctuation, the general rules are so well known that there is no need to dwell upon them here, aside from cautioning the writer to use the points sparingly, especially the commas, and to enclose in quotation marks sentences and paragraphs taken bodily from other articles or books. Do not use quotation marks around reference letters. Underline as few words as possible; rather construct the sentence to give the required emphasis.

When it is necessary to include printed forms or blanks for illustrative purposes, and they are of such size and elaboration as to entail considerable expense to set up in type and rule, it is much better if they are sharply defined and well printed, to treat them as illustrations for direct reproduction. In this case, the original dimensions should be stated in the text or in the title of the engraving.

Do not bring in more mathematical treatment in an article than absolutely necessary for a clear understanding of the subject. Some writers seem to think that formulas make an article look "learned" and therefore more acceptable. Where mathematical or algebraic expressions such as formulas, equations, etc., are necessary, they should be clearly and carefully written in with a pen. A carelessly written formula confuses the compositor and leads to typographical errors. Check all mathematical calculations so as to be sure that they are correct. Many writers seem to depend upon the editors for checking, with the result that the editor, finding an error in the calculations, concludes that the article is unreliable and returns it. An error of judgment and opinion is excusable, but an error in simple arithmetic is unpardonable. When isolated letters referring to mathematical expressions or to an illustration are used in the body of the text, they should be underscored.

Summing up in Conclusion

Following the body of the article, there should be a general statement showing how the preceding treatment of the subject has demonstrated what the writer set out to show, as stated in the introductory paragraph. Finally, there should be given a condensed summing up, so worded that a brief glance will enable a casual reader to grasp the substance of the article and decide, without reading it throughout, whether he desires to examine it in detail.

General Notes on the Preparation of Articles

After writing an article, it is a good plan to lay it aside for a few days and then reread it. There will then often be found statements that can be better phrased and words that can be replaced by others which will more clearly express the ideas to be conveyed.

Number the sheets consecutively in the upper right-hand corner. In case it be necessary to insert any considerable amount of additional matter in a part of the manuscript already written, this matter may be written on a separate sheet which should be given the same page number as the sheet it supplements, together with an index letter, thus, "7A", "7B", etc. These sheets should be marked to indicate exactly where they are to be inserted, thus, "Insert at A, page 7", and the position of "A" should be indicated on page 7.

The writer's name and address should be placed at the bottom of the last page of the manuscript. If the writer does not wish his name to appear as author, he should write opposite his name "Not for publication," and give the nom-de-plume to be used instead.

The general appearance of a manuscript creates a first impression that often carries appreciable weight in the acceptance or rejection of an article. For this reason it is advantageous to have the manuscript typewritten when this can be done without undue inconvenience. Typewritten matter can also be read with a continuity of attention that is difficult to give hand-written manuscripts, however excellent the writing may be, and as this continuity of attention is absolutely necessary for properly estimating the value of an article, it should be the writer's aim to facilitate it as much as possible. Another advantage of having the article typewritten is the ease with which a duplicate (carbon) copy can be made. A duplicate copy should always be retained, in view of the possible loss of the copy sent to the editor.

It should be understood, however, that hand-written articles will always receive proper attention, and no contributor should feel that he must incur the expense of having his article typewritten in order that it may be accepted. The final test of all articles is their technical merit.

The original manuscript should preferably be written by hand with pen or pencil rather than composed on the typewriter or dictated to a stenographer. An opportunity is thus afforded the writer of looking over the first draft, as a whole, and making such corrections and changes as will avoid the necessity for a second typewritten version. Dependence upon a stenographer tends toward repetition and lack of clearness, because, when dictating, a man does not have the opportunity to see what he has said, to note how the statements hang together, nor to cull and collect as he proceeds—all of which is necessary in order that his thoughts be expressed in the best possible manner. While the method of composing directly upon a typewriter is not so objectionable as dictating to a stenographer, it does not afford the same facility for correction as pen or pencil.

The paper upon which the final copy of the article is written should be white and of tough texture to withstand rough usage. It should also have sufficient weight to prevent it from crumpling, as tissue or thin paper is likely to do. When a manuscript is received by the managing editor, he may turn it over to one or more readers who are sufficiently acquainted with the subject to express an intelligent opinion regarding the advisability of publishing it. Upon their decision depends to a large extent the fate of the manuscript so far as it relates to the journal considering it. If, therefore, the writer is not certain of having his article accepted, it is specially advantageous to use paper of tough texture because if it be rejected and returned, the writer will naturally submit it to other journals, and if poor paper is used, the article may then have to be rewritten.

Sheets 8 by 11 inches should preferably be used, leaving a margin about an inch wide at the left-hand side between the edge of the paper and the writing. Write only on one side of the paper and allow a full quarter inch between the lines of the manuscript, whether written by hand or machine. No matter how well the article is written, each magazine has a certain style of its own which the editors follow, and minor changes are therefore necessary. After all the sheets of the article have been written, arrange them in numerical order and clip the sheets together. Do not pin, bind or sew them, as this is troublesome to those who handle the sheets.

As a rule, do not write articles to suit illustrations. Frame up the article first, and then make the drawings and take the photographs which are necessary for making a clear presentation of the subject. When the sketches and photographs are ready, it is a good plan to rewrite the article, basing it upon the original framed-up article and adding such information as may be suggested by the illustrations.

Copy for Illustrations

Use illustrations liberally. Nice drawings add to the value of the article. In making drawings use a separate sheet for each one and write your name in the lower right-hand corner. A clear lead pencil drawing, with sharp, well-defined lines, is all that is necessary for ordinary reproduction. Good blueprints, original drawings or tracings are also generally satisfactory for reproducing by the so-called wax-engraving process. Finely executed drawings are not essential; but only when time, skill and drafting materials are lacking to make a finished drawing, should rough pencil sketches be submitted.

When drawings are intended for direct reproduction—that is, to be photographed directly for use in the columns of a journal—they should be made in black ink on bristol-board, heavy smooth paper, or tracing cloth. First decide upon the space the figure will occupy on the printed page and make the drawing about twice this size. There will then be ample space to make the details clear and the imperfections in the drawing will be much less noticeable in the reduction, so that the printed effect will be more pleasing to the eye. Make the drawing first with a hard lead pencil, and then go over it with ink, making the numerals and reference letters about twice the size and thickness they are to be in the reduction. Use only black ink, because red and most other colors will not reproduce. In order to see how the drawing will appear when printed, look at the sketch through a reducing glass or a pair of ordinary opera-glasses with the large lenses held to the eyes. Corrections or changes may be indicated on the drawings by using a blue pencil, as markings in blue will not show up in the reproduction.

It is important to bear in mind that any illustrations intended for direct reproduction, such as original drawings or tracings, must not be folded. Original drawings can be sent protected by paper flaps pasted over them, and should be enclosed between stiff card-boards. Tracings should be rolled and sent in mailing tubes. Blueprints which cannot be used for direct reproduction, and pencil drawings, may be folded.

Don't make three or four drawings if all the information can be given just as clearly in one or two. Generally a plan and elevation show everything required. Use the "third angle of projection," and show all the parts of a device in their proper relative locations. Be sure that hidden parts are indicated by dotted lines if necessary to show the construction clearly. Use shade lines according to the rules of mechanical drawing. A shaded drawing is more easily comprehended than one that is not shaded. Do not use shading, however, to indicate curved surfaces.

In selecting photographs, or making photographic prints for illustrations, give preference to those which are sharp and clear with the proper contrasts of light and shade. The best reproductions are made from glossy silver prints of a slightly reddish tone and not too dark. Glossy velox prints reproduce very well by the halftone process, and being printed by gaslight are often furnished instead of sun prints when the weather is cloudy and time cannot be spared to wait for sun prints. Do not put reference letters directly on photographs. If the various parts of the object illustrated on the photographs need reference letters, lay a piece of tracing paper on the photograph and trace the outline of the picture. Then put the reference letters on the tracing paper in the exact place where they ought to appear on the photograph. Use capital reference letters in preference to small letters. Care should be taken not to write figure numbers, titles, etc., with a hard pencil or with ink on the back of an unmounted photograph; otherwise, the pencil marks will be embossed on the face of the print and the ink will soak through when the photograph is mounted, injuring the copy for reproduction. Either write lightly with a soft pencil on the back of the print or have the photograph mounted and write on the back of the mount. As in the case of drawings, the writer's name should be written in the lower right-hand corner of each photograph.

Make a single package of the manuscript and illustrations, keeping the sheets of the former flat if possible. Either mail or express the material to the editor, and under separate cover, send a letter advising him of the fact and stating concisely the purpose and scope of the article. Ordinarily, it is safer and better to send bulky material by express, especially if there are mounted photographs in the package, because in case of loss or misdirection the material can be more readily traced.

Payment for Articles

Contributions published in the leading technical journals are generally paid for, usually on some space rate basis. The prices paid for contributions differ with the journals and character of the contributions. In general the rates vary from $5 to $8 per 1000 words. In fixing the rate paid for a contribution the editor takes into consideration the probable value of the article to his readers; the labor incident to its preparation; and the expenses that have been incurred in obtaining photographs. Obviously, an article containing many mathematical formulas and calculations requires more time and care in its preparation than one purely descriptive of a machine or process. On the other hand, the description of a machine may include a photograph, or photographs, to illustrate, which have meant some expense to the contributor. The space filled by text, tables and illustrations of articles published in MACHINERY is all figured at the same rate.

Exclusive Contributions

Contributions submitted for publication in MACHINERY with the expectation of payment are accepted only for exclusive publication. A contributor who sends the same articles to other journals will have his offerings rejected if the fact becomes known to the editor; if an article is published and it becomes known that it was sent to other journals, payment will be withheld or its return demanded. Unless other arrangements are made, the purchase of an article for MACHINERY includes all rights of publication.

Character of Desirable Articles

Among the matter acceptable for publication in MACHINERY are tables of data suitable for the Data Sheets, especially when accompanied by articles; articles on new developments in machine shop practice, machine shop methods and machine design, especially when illustrated with photographs and drawings; articles with photographs or drawings on lathe, planer, milling machine and screw machine work, punch and die work, safety devices, lapping, scraping and fitting, laying out work, drafting-room methods, etc. Unusual methods of machining large castings and making repairs on machinery are generally interesting, and should be illustrated with photographs whenever possible.

Why Manuscripts are Rejected

In the course of a year the editors read several hundred manuscripts, and many are rejected for various reasons, among which are: the articles are badly prepared or poorly illustrated; the conclusions are erroneous or at variance with generally accepted good practice; the subjects are not of general interest to the readers of MACHINERY; or many similar articles have been published in recent numbers.

In case the article is not accepted, it will be returned to the writer. He should not, however, be discouraged, because the rejection of a manuscript does not necessarily mean that the article is not worthy of publication. It may be that the subject would not interest the readers of that particular journal, or on the other hand, that it has already been fully covered in previous articles; then again, that particular journal may have an abundance of material on hand that would make it unwise for the editor to accept more.

Articles on machine design which merely review common methods of analysis found in textbooks are not generally acceptable. Periodicals should publish records of advance of the science which they represent, and for that reason be somewhat in advance of the records in textbooks.

Correcting Proof Sheets

After an article is accepted and put into type, the writer may be asked to read the proofs, mark on them any correction or changes he deems necessary and return the proofs O. K'd. to the editor, as soon as possible. In reading proofs, it must be remembered that they are to be gone over mainly for the purpose of seeing that the author's idea is accurately and correctly expressed. Such corrections as wrong spelling, punctuation, etc., can be left to the proofreader. In making these corrections on the proofs, proofreaders' marks may be used because they save some time, but those unaccustomed to their use should simply cross out the erroneous matter and write the correct expressions on the margins of the proof sheets, using lines as leaders to show where the new matter is to be inserted.

Be sure that you have said all that you want to say when the article is first sent. It is annoying to the editor and not creditable to you if you add whole paragraphs or even sentences when the article is submitted to you in type. If, however, through oversight on the part of the author in writing the manuscript, or of the printer in setting it in type, an important phrase or sentence has been left out, the writer should endeavor to supply the omission in the proof by adding enough new words to form one or more complete lines; otherwise, the additional matter may make it necessary for the compositor to "overrun" each remaining line in the paragraph involved, and cause considerable labor and expense. If this addition is not easy to make, it is generally possible to find room for the new matter so that it forms one or more complete lines, by taking out words from the neighboring lines without loss to the sense of the article.

The rules and suggestions given in the preceding paragraphs are intended to touch only the high spots in technical writing. The personality and style of the writer thus are not thwarted by iron-bound rules, but simply directed in the proper channels.

While the suggestions here given have been prepared with a special view to the form in which contributions to technical journals should be written, they may be used, in general, equally well as a guide by those who are called upon to prepare papers for presentation before engineering societies and by those who have in mind the compilation of technical matter for publication in book form.

* * *

SURFACE OR FLAMELESS COMBUSTION

The discovery of means for burning explosive gases, that is, gases mixed with air just sufficient for perfect combustion, described in the May number, was, it appears, erroneously attributed to Prof. William A. Bone of Leeds University, Leeds, England. Prof. Charles E. Lucke of Columbia University, New York, described the same process, in effect, in a paper presented before the American Society of Mechanical Engineers in 1901. Prof. Bone's work, which showed the possibility of attaining temperatures from 2900 to 3600 degrees F. on the surface of porous firebrick with great economy of gas, appealed more to the popular mind as having direct application to cooking and heating. Hence the great interest in the idea.

WATCH CASE MANUFACTURE—2

Before a watch case is fitted up, that is, on a hinged case, before the cap, back and bezel are joined, it is necessary to fit and solder the pendant into the case center. The majority of pendants on watch cases are made from rolled-plate in two pieces, but some are made in one piece by a number of successive press operations. The pendant is used for holding the bow and the stem setting mechanism.

The crown *b* shown in Fig. 8, which is used for operating the setting mechanism, is also made from rolled plate. The press operations on this part have previously been described in the December, 1909, number of MACHINERY, so that a short summary of the most important operations will be sufficient. The first operation is to make a blank and draw it up into a cup, both operations being accomplished at the same time in a double-action press. This cup is then cut to the desired length in a small sawing machine, after which it is passed through a corrugating die. A core of the required shape, which has been made in an automatic screw machine and corrugated in a die in the punch press, is then inserted and the two parts—cup and core—are placed in a swaging die. The upper part of the die is so formed as to shape one end of the crown, while the lower die forms the other end.

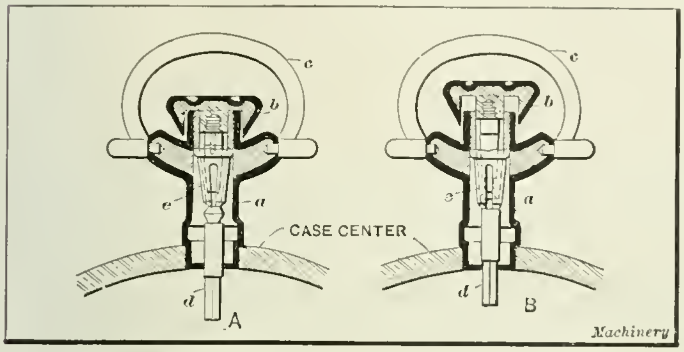

Fig. 8. Pendant Set in the "Up" and "Down" Positions

After the crown is completely formed, it is taken to an automatic screw machine where it is counterbored, drilled and tapped to fit the pendant and pendant set. This machine is equipped with a magazine attachment which was illustrated in an article entitled "Magazine Attachments—1," in the February, 1912, number of MACHINERY. This, with the exception of polishing, completes the operations on the crown.

The bow *c*, Fig. 8, or ring, as it is sometimes called, is made from either solid gold or gold-plated stock, drawn out into wire. Bows made from solid gold are used on solid gold watch cases, and also on some filled cases. The operations followed in making the solid bow are simple and need no description. It might be well, however, to state that it is first blanked from the flat sheet about 1/16 inch thick to approximately the desired shape, then the center is pierced out, and finally, it is completely formed in an embossing die held in a hydraulic press. The flash is then trimmed in a trimming die and the inside ends of the bow milled on a milling machine to fit into the holes in the pendant.

The operations for making the bow from drawn wires are a little more difficult. The material from which the bow is made is first blanked out and drawn up into a cup, and then by successive drawing operations, it is extended to such a length that it can be completely drawn in a draw bench. The drawn wire is then cut up into pieces of the desired length and drawn up in dies. After this operation, the bow is bent around to the desired shape in a simple bending fixture. As bows are generally plain and have no small crevices to polish out, the polishing is very easy.

Construction and Operation of the Pendant Set

On watch cases provided with a pendant set, it is necessary to pull out the crown before the hands can be rotated independently of the motion transmitted to them by the gear train. Some means, however, has to be provided so that the crown cannot be easily pulled out, or the utility of this simple device would be destroyed. This is accomplished by screwing a stem *d*, Fig. 8, provided with a cone shoulder into the crown, and also screwing a split "chuck" *e* into the pendant *a*. Now before the crown, which is shown "down" at *A* can be pulled out, the split chuck *e* has to be expanded as at *B*, by the cone shoulder on stem *d*, the necessary pull being sufficient to prevent the setting mechanism from being operated accidentally.

The stem *d* presses on another squared stem which is used in operating the setting mechanism (see "Setting Mechanisms" in the May number of MACHINERY), and when stem *d* is pulled out by the crown as shown at *B* it allows the setting mechanism to operate the hands.

Polishing Watch Cases

A watch case, as a rule, is given a very high polish and is free from scratches and imperfections. The methods employed in polishing a watch case are interesting, and as they differ slightly from other polishing work, it might be well to give a short description of the materials used and the order of the operations. After the case is jointed and assembled, it is rough polished on a rag wheel with dry tripoli, also called "rottenstone," on it. For additional rough polishing, a hair brush is used and lard oil and tripoli are applied as an abrasive. The second polishing of the inside of the cases is accomplished with an elk skin polishing buff supplied with rouge and alcohol. The outside of the case is polished with a rag wheel and rouge. The center of the case is brushed with a hair brush and hard rouge.

The third polishing is done after the case has been pinned and fitted. The inside of the back and cap are polished with elk skin, soft rouge and alcohol, the outside of the case being polished with a rag wheel and hard rouge. All plain parts and shields are polished with rouge and elk skin, after which an additional polishing is accomplished with soft rouge; then the cases are washed in ammonia water and soap and dried. The drying is done in a heated drying box. After being dried the cases are cleaned with chamois and then sent to the inspector who examines them to see that everything is perfect. The case also passes through numerous other inspections during the course of its manufacture.

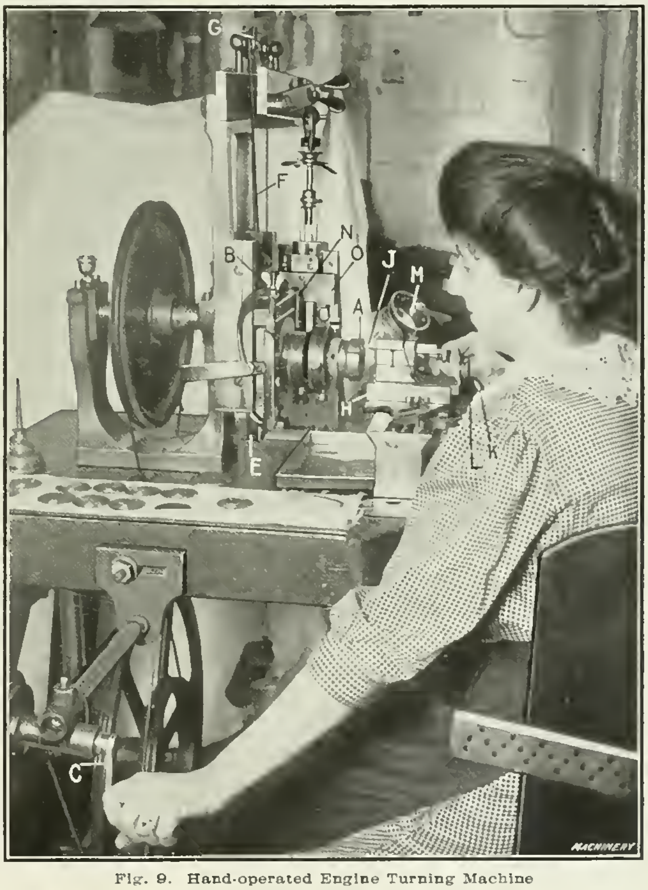

Fig. 9. Hand-operated Engine Turning Machine

Engine Turning

Engine turning, another name for engraving by machinery, consists in cutting various designs or patterns on the backs of a watch case or bezel. Thousands of patterns are cut, and the designs vary considerably. Some types of patterns, of course, require slightly different methods for their production, and in many cases patterns can only be cut on certain types of machines, or hand engraved. There are at least six distinct types of engine turning machines employed on this work. Three of them, the most interesting ones, will be described in the following.

Hand-operated Engine Turning Machine

The engine turning of the straight-line variety cut in the backs of watch cases is accomplished in the hand-operated machine shown in Fig. 9. The back or bezel, whichever it may be, is held in a chuck *A*, which, if desired, can be rotated by hand or can be indexed by thumb-screw *B*. The screw on which thumb-screw *B* works, has a worm formed on its lower end meshing with a worm-wheel on the head. This device is brought into play when it is desired to cut lines crossing each other at right angles or any other angle.

For producing straight-line work on this machine, the vertical slide carrying chuck *A* is simply moved up and down by the operator, by means of the hand-crank *C*. The motion from this crank is transmitted by grooved pulleys, belting and chains to the vertical slide *E*. This slide is kept in the "up" position by a weight attached to a string *F*, which runs over the grooved pulleys *G*.

The table *H*, carrying the tool-slide *I* in which the tool *J* is held, has a circular adjustment, so that the center line passing through the point of the tool is always at right angles to the face of the back being operated upon. This adjustment is controlled by the knurled thumb-screw *K*, which is rotated by the operator a slight amount after each cut. The tool-slide *I* is advanced to bring the tool in contact with the work by hand, the operator gripping the spring "handle" *L* by the first finger and thumb. The depth to which the tool advances into the work is governed entirely by the pressure given to this slide; and it requires considerable experience before an engine turner can produce lines of a uniform depth. It is simply a matter of "fine touch," as no stop is provided for the forward movement of the slide. The slide is returned by a spring which is compressed when the slide is advanced. The work is viewed while under progress through the magnifying glass *M*.

Various patterns are secured by irregular faced strips *N* held vertically in the slide *O*. This slide can be moved to bring any desired pattern into operation by means of a handwheel, not shown. The patterns impart an oscillating movement to the head (which is also equipped with a horizontal slide) at the same time that it is moved up and down by the hand-crank *C*. The spacing of the lines is effected by a pawl and ratchet, not shown, which move the slide carrying tool *J* along, giving any desired width of spacing.

Electrically-operated Engine Turning Machine

The engine turning machine illustrated in Fig. 10 is electrically operated and is used for producing the "barley corn" engine turning, as it is called. The back that is being engine turned is held in a split chuck *A* which is tightened on the work by a knurled nut. The entire mechanism is driven from a shaft under the machine, which, in turn, derives power from the countershaft through belting.

The spindle *B*, which carries the work and is rotated by spur gears from the lower shaft, is mounted in an oscillating head *C* called a "cradle." This head receives its oscillating motion from a cam held on the lower shaft, which is provided with a series of projections and depressions that impart the oscillations to the head. The "electric pattern" *D*, as it is called, is driven by spur gears from spindle *B*. The tool-slide *E* that carries the holder in which a cutter is retained is also operated from spindle *B* through spur gears, a universal joint and bevel gearing.

The electric pattern *D* is made by engravers who cut out the portion to be "barley-corned" and fill the depression with a non-conductor of the electric current. A steel needle *F*, under spring tension, runs or is pressed against this pattern and is fed in from the outer circumference towards the center at the same rate of travel that the tool makes across the face of the work, the latter also being traversed in the same direction.

The tool-slide *E* which is operated in the manner previously described, carries a taper guide which through a roll, lever and crank, forces up the rod *G* carrying needle *F*, at the same time as the tool is fed from the outside circumference to the center of the work. This system of levers and cranks constitutes a pantograph arrangement which can be changed to reduce the pattern for any size of watch case. The roll is kept in contact with the pantograph form, so that the motion transmitted to the cutting tool will conform to the shape of the back, by means of a string *H* to which a weight is attached.

In operation, as the needle *F* passes over the non-conductor on the pattern *D*, the electric circuit passing through the armature *I* is broken so that plate *J* flies back, and in so doing operates the tool-slide *K* through lever and crank connections, thus forcing the tool into the work. When the needle *F* passes over the brass portion of the pattern the circuit is closed and the reverse action is imparted to the tool-slide *K*, that is, the tool is withdrawn from the work. This action is repeated until the engine turning is completed, when the machine is automatically stopped.

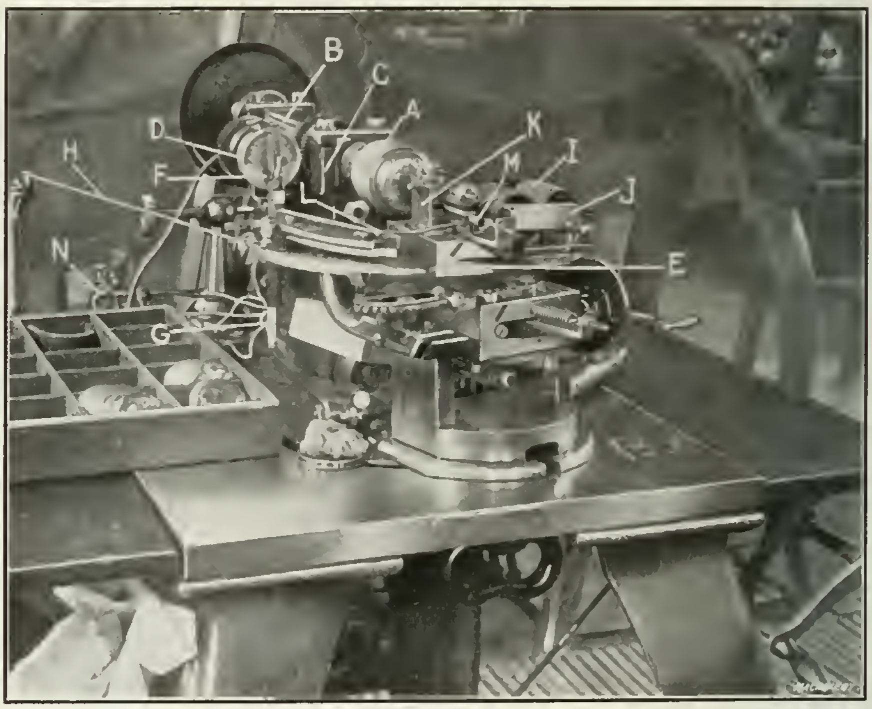

Fig. 10. Electrically-operated Engine Turning Machine

The tool-slide *K* is withdrawn to remove the work by a handle *L* which, when pulled back, brings back the slide and releases it from the tension of the spring *M*. This spring has sufficient strength to keep the tool in contact with the work, when the electric circuit is broken. The barley-corn effect is governed, of course, entirely by the cam on the shaft under the machine, but the pattern can be made either coarse or fine as desired, by altering the change gears that transmit motion from the spindle *B* to the main tool-slide *E*.

Swiss Brocade Machine

The interesting machine shown in Fig. 11 is for "brocade" or "Swiss machine" work, as it is called, which is simply a special class of engine turning resembling in appearance the regular work on currency bills, which is produced by a geometric lathe. This brocade machine was designed and built in Switzerland and is a marvel of mechanical ingenuity. As an engine turning machine its possibilities are practically unlimited, and it is doing away with a large amount of the work previously accomplished by skilled engravers. The work, when being operated on, is held in a split chuck *A* by a knurled nut. The power for operating the entire mechanism is transmitted from a countershaft by round belting running over grooved pulleys *C*, *D* and *E*, up to the main driving shaft at the rear, not shown. This shaft drives the front shaft *F*, which through change gears *G* operates the spindle carrying the work. This spindle can be centered, that is, located in the desired relation to the other mechanism when starting a pattern, by means of the screw and worm-wheel *H*; this turns around the sleeve or spindle carrying the work.

This machine is supplied with two pattern plates *I* and *J*. Plate *I* is made of hard rubber and is called the outline pattern plate, while plate *J* is made of cast brass and is called the filling-in pattern plate. Plate *I* is rotated by a spur gear held on a shaft at right angles to the rear driving shaft, and is driven from the latter by bevel gears. Plate *J* is also driven from the shaft which is at right angles to the rear driving shaft, through bevel gears and change gears *K*.

The faces of plates *I* and *J* are provided with the desired patterns and transmit up-and-down oscillating movements to the tool carrier *M*. The movement is transmitted by steel points held in vertical brackets *N* (only one can be seen), which are fastened to a dovetail-shaped bar operated by a pantograph arrangement. From this bar, motion is transmitted through a universal joint and a shaft running parallel with and under the tool-slide *M*. As tool-slide *M* is fulcrumed at a point directly under the point of the cutting tool, it is consequently given an up-and-down oscillating movement by means of this shaft and levers connected to it. By changing the position of the ends of the universal joint, the tool *O* can be put into the work to any desired depth.

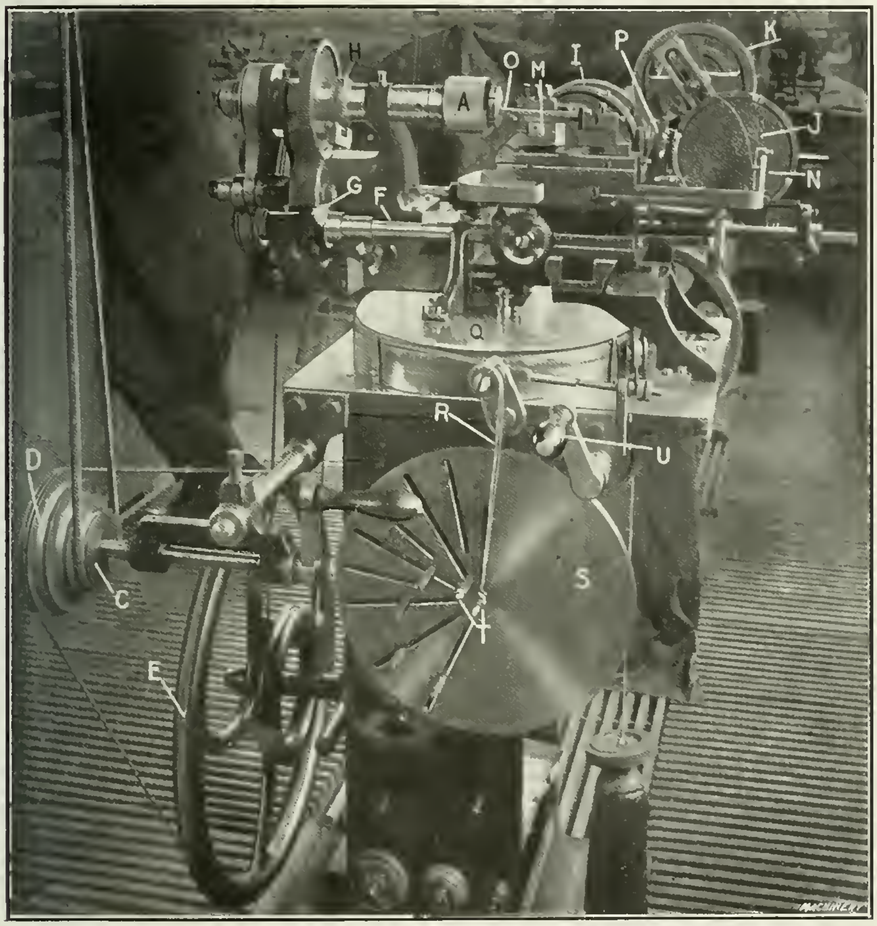

Fig. 11. Swiss "Brocade" Machine, which produces Special Designs of Engine Turning

The ratio of the gears driving the filling-in pattern, to those operating pattern *I*, can be changed so as to alter the pattern of the work. Barley-corn filling-in cams *P* are also provided which have a series of indentations and projections distributed around their peripheries. These cams have slightly different patterns, and any one of them can be brought into operation as desired. The cams are held on a shaft which is driven from the holder carrying plate *I*, by bevel gears, the rear face of the plate-holder being formed into a bevel gear. Through a steel pointer, not shown, these cams *P* also give a slight oscillating movement to the tool-holder *M* carrying the cutting tool *O*, which produces a neat barley-corn pattern in the bottom of the depressions, where neither of the other two patterns act.

The work-holder head is mounted on a circular table *Q*, which is rotated to swing the head to conform to the shape of the back by a wire rope *R*. This rope is wound partly around the table and is fastened to it by a dog, and is also fastened to dogs *T* held on the faceplate *S*. This faceplate is provided with a series of radial slots in which dogs *T* are located, the latter being adjustable to any position. It is also provided with a spur gear at the rear, and is driven through change gears from the main driving shaft. As the faceplate rotates, it unwinds the wire rope from table *Q*, and consequently pulls the latter around, which action swings the head carrying the work. The table is graduated and a pointer is provided so that it can always be started from the same point, after it has been swung around by the hand-crank *U* to insert a new piece of work in the chuck. The unwinding of this wire *R* imparts a movement to the head which approximates closely an involute curve.

The principle employed in driving the front shaft *F* for rotating the work is both interesting and novel. From the preceding description, it will be seen that the work-holder must swivel through an arc, and also be rotated at a constant speed irrespective of its position. This is accomplished by double-face miter gears called "A gears." These gears roll on each other and the center of contact is always directly in a vertical line passing through the cutting point of the tool *O*. If this were not the case the pattern would not be accurately reproduced.

A pantograph arrangement of levers compensates for the size of the case being brocaded, and the position of the dogs *T* is altered to provide for the changes in the shape of the back. The slide on which the pantograph arrangement of levers, tool-slide *M* and pattern plates *I* and *J* are held is traversed by a worm and worm-wheel from the rear driving shaft. The cutting tool starts at the outside circumference of the case and works in towards the center. The machine is automatically stopped when the work is completed by a bracket held on the slide carrying the pantograph arrangement, which comes in contact with an adjustable stop screw in a lever held under a latch. This bracket pushes the lever from beneath the latch and shifts the belt on the countershaft, thus stopping the machine.

Special Designs and Colored Gold

Many watch cases are furnished with elaborate designs such as plated work of colored gold, and gilded. The gold-plated patterns are cut out in punch presses and soldered onto the back of the watch. The patterns are made in all sorts of color, which is accomplished by alloying coloring matter with the gold when melting. Most of the designs cut on the Swiss brocade machine are gilded in an electric bath, colored gold being used as the annode. The part of the back not to be gilded is coated with shellac, which is removed in hot water after the work has been gilded.

* * *

Some time ago there was exhibited before the French Academy of Science a small dynamo, the total weight of which is claimed to have been only one-fifth ounce. This machine measured about 0.6 inch in height and length. The diameter of the armature was about one-quarter inch, and the magnet was wound with silk-spun wire 0.002 inch in diameter. The total length of the field wire was about five feet. The collectors and brushes were constructed exactly as in large dynamos. When run as a motor, the machine consumes about two amperes at two and a half volts and runs at a very high speed, making a humming noise like a large insect.

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MACHINERY is published in four editions. The practical work of the shop is thoroughly covered in the Shop Edition, $1.00 a year, which comprises approximately 700 reading pages. The Engineering Edition—$2.00 a year, coated paper, $2.50—contains all the matter in the Shop Edition, about 300 pages a year of additional matter and forty-eight 6 x 9 Data Sheets filled with condensed data on machine design, engineering practice and shop work. The Foreign Edition, $3.00 a year, comprises the same matter as the Engineering. The Railway Edition, $2.00 a year, is a special edition, including a variety of matter for railway shop work—same size as Engineering and same number of Data Sheets.

MECHANICALLY-GUIDED WELDING AND CUTTING MACHINES

The mechanically-actuated oxy-acetylene torch for cutting shapes from iron and steel plates, described in the July number, is one of the most interesting developments in metal working apparatus brought out in the past decade. The oxy-acetylene torch fed with an excess of oxygen becomes a cutting tool of extraordinary efficiency, making a narrow clean "saw" cut of any desired pattern at a speed in thick plates that cannot be equalled by any existing machine tool. Mounted on a pantograph frame, the torch is made to follow a pattern traced on a drawing, and the rate of traverse is fixed by an electrically driven feed wheel. Being capable of cutting steel three inches thick, the apparatus should obviously be of great value in die making.

The use of a gas flame as a cutting tool evidently is capable of still greater development when the torch is guided and traversed mechanically. The flame is used at its highest efficiency, and the shapes produced require a minimum of finish to meet the requirements of many lines of metal-working. The process can be regarded as another of the auxiliary processes of which grinding, drawing, extrusion and swaging are examples, that extend the economical possibilities of metal working, and thus directly promote the usefulness of the so-called "standard" machine tools in those fields for which they are best adapted.

* * *

TOOLMAKING AND EFFICIENCY

In these days of interchangeable manufacturing, when the tool designer and toolmaker are chief factors in determining the kind and quality of accessory equipment provided for manufacturing, and, therefore, to a large extent in determining the efficiency of the production departments, their attitude toward efficiency assumes great importance. The production of fine tools, jigs and fixtures is to some degree an artistic job, requiring men who love the work and exercise their ingenuity because they love it rather than for the wages paid for the work. To men of this disposition some of the principles of higher efficiency in shop management as applied by enthusiastic organizers are very distasteful. This mental attitude of the expert toolmaker, as expressed in the following paragraph, taken from a recent letter, is important:

"I have been through the mill—made master plates, and all classes of tools for the finest and most accurate instruments.

* * * * * * * * * * *

Too much is said by most writers regarding speeds, cuts, angles of tools, etc., for their articles to be of value to a toolmaker. A toolmaker is not working on a premium basis, nor is the nature of the work such that a table of speeds could be compiled that would be worth a row of pins, and a table of angles, etc., simply confuses a young toolmaker and especially one who is endeavoring to get the rudiments of toolmaking by study."

While it is undoubtedly true that the data so useful to the machine shop in promoting efficiency have little direct application to the toolroom, we believe that toolmakers generally should have a clear idea of shop conditions and the importance of speeds, feeds, cuts, cutting angles, etc. A toolmaker who has been a machinist and has developed the artistic quality and skill of the toolmaker is likely to be more practical and efficient from the production standpoint than one who has been a toolmaker all his life. Toolmakers should guard themselves from becoming absorbed in their specialty to the exclusion of the practicalities of the shop. Too much concentration on one thing makes for narrowness, and the narrow man is not a desirable development in any walk of life.

* * *

SAFETY APPLIANCES AND THE WORKMAN

Some years ago, when the agitation for safety devices in work-shops began to be carried on in a systematic manner, it was directed mainly towards the manufacturer, exhorting him to install devices to safeguard his workmen, and this agitation has in the last few years produced the desired effect with many large concerns. But as these devices became more numerous it was found that in many instances the problem was not solved, for a second difficulty arose—that of inducing the workmen to make proper use of the safeguards installed. Men who have been accustomed for years to working around dangerous machinery not provided with adequate protective devices, are liable to develop a spirit of bravado and ridicule new devices intended to safeguard them. Instances are recorded where workmen have deliberately removed the safeguards, claiming that they were unhandy and hindered them in their work. In some cases, no doubt, safeguards may have been improperly designed and caused inconvenience to the workmen, but it is probable that in the majority of cases the objections of the workmen have been due to prejudice towards innovations.

In order to counteract this opposition of the workmen towards safety devices, it is necessary that the management should educate them in the proper use of such appliances. A notice such as the following does not reflect credit upon its originator: "Use the accident guards; if any workman does not intend to use these wherever possible, he will please report to the office for his pay." Instead of securing the cooperation of the workman in preventing accidents, such a notice will merely arouse his antagonism. One firm that has been remarkably successful in reducing the number of accidents in its shops has made use of an entirely different method. When new safeguards were placed on the machinery, their men were thoroughly instructed how to work without being inconvenienced by the appliance. They were given an opportunity to complain if they found that the safeguards interfered with their work; and, if practicable, the design was altered to suit the conditions. In this way, the cooperation of the worker was secured, and security against accidents was increased. There is, perhaps, no condition where cooperation between the management and the workmen is more necessary, nor where it results in a better understanding between employer and employes, than when they meet on common ground, in an endeavor to prevent accidents in the shops.

ELIMINATE THE HUMAN FACTOR

On July 4 forty people were killed outright and many injured by a rear-end collision on the Lackawanna Railroad at Gibson near Corning, N. Y., where an express running at full speed crashed through the rear cars of a passenger train. This train was protected by a flagman and by automatic block signals, but these were not seen by the engineer of the express, probably because of a fog which prevailed at the time. The present "safety" system is reasonably safe, so long as the employes are alert and watchful, but it is not proof against carelessness or negligence. The block signal may be set for danger, but so long as the engineer stands between it and the throttle, there will be wrecks and loss of life. To prevent them, the elimination of the human factor is necessary.

There are various inventions for automatically stopping a locomotive in case of danger, and if none of them are perfect they can probably be made as nearly so as the semaphore, by experiment and use. An expression of public opinion may overcome the indifference of railroad managers to this improvement.

* * *

A NEGLECTED FUNCTION OF ENGINEERING SOCIETIES

In another part of this number a brief review of the history and activities of the British Engineering Standards committee is given, from which it appears that the British engineering societies recognize as one of their most important functions, the compilation of data for the standardization of specifications for engineering work, machine details, etc. Very little of this kind of work has been done by the engineering societies in the United States. The American Society of Mechanical Engineers has done very useful service in bringing about the standardization of machine screws; but important as this work has been, it is insignificant when compared with the great need and the unlimited opportunity for the standardization of hundreds of details in the mechanical engineering fields.

The British engineering societies have set a fine example, and by the successful accomplishment of their work have proved that it is possible to formulate certain standards upon which all manufacturers can agree. Our engineering societies are neglecting a great opportunity by not devoting themselves to work of this character. No other body is so well fitted to render this important service as a national engineering society and it should be considered a duty by all of them. The important work of the national engineering bodies can never be done at the conventions, because these are, and probably always will be, largely social functions; but a vast amount of matter of permanent value would be available to the engineering profession if the papers presented at these meetings were crystallized into permanent records by being used as an aid in preparing standards for mechanical practice. In addition, the engineering societies would then become a kind of clearing house for mechanical information, where data relating to standards of all kinds could be readily obtained, and where the reason for the adoption of these standards could be ascertained.

At the present time, there seems to be no one subject to which the engineering societies could devote themselves with greater profit than to the establishment of engineering standards. There is in the mechanical engineering field, at least, a hopeless confusion as to the established practice with relation to many details of machine design and shop practice. No other body is better fitted than the national engineering societies to clear away this confusion.

* * *

At one of the busy machine shops in the heart of the city of Boston where the machinists prefer to take but one-half hour for their luncheon and thus make their day one-half hour shorter, the management allows the men to go to luncheon at 11:45 returning to work at 12:15; thus the men are enabled to get into the luncheon rooms and restaurants just before the rush hour commences, which insures them prompt service and good lunches.

INDUSTRIAL ADMINISTRATION AND SCIENTIFIC MANAGEMENT—2

CAUSES OF INDUSTRIAL INEFFICIENCY

By FORREST E. CARDULLO[*]

So far this article has considered only the broad aspects of industrial administration. In order to get a better idea of the objects of scientific management, the methods which it is likely to adopt, and the obstacles which it must overcome, I propose to classify and describe some of the causes of inefficiency in our industrial life. In studying the causes of inefficiency we will discover the remedies which a proper system of administration should apply, and develop some of the principles underlying scientific management. I do not claim that all the faults which I will describe are prevalent in every industrial plant not under scientific management. I will admit that most of them can be eliminated without the complete adoption of scientific management. I do know, however, that they are astonishingly prevalent in our industrial life, and that neither conventional nor systematic management has succeeded in uprooting them.

The causes of inefficiency may be divided into three classes: The first are those causes which are chargeable primarily to the employer, the second those which are chargeable primarily to the workmen, and the third those which are chargeable primarily to our political and industrial system.

Those causes of inefficiency which are chargeable primarily to the employer may, in turn, be divided into two classes. Those of the first class arise from a lack of knowledge. They can be remedied by showing the management the possibilities of better methods. Those of the second class arise out of moral defects on the part of the employer, and will require more than a change in the system of management or full information of the conditions of the plant in order to eliminate them.

Mental Laziness

The first and most prolific source of inefficiency is mental laziness. Most of us dislike to think. While a good many of us will devote a spare hour now and then to the consideration of some interesting subject, no man will, if he can avoid it, devote two hours a day, not to mention eight hours a day, to the task of devising and comparing methods of work. That kind of thing is entirely too strenuous to suit the average officer of administration. In the average plant, each officer places upon the shoulders of his underlings the burden of detail for which he himself ought to be responsible. When work is to be done, the manager "puts it up" to the superintendent. The superintendent, in turn, puts it up to the foreman, the foreman to the gang boss, and the gang boss to the workman. Upon the workman devolves the task of devising the methods and of planning the details of the work. Now as I will show later, the workman is no fonder of thinking than the management, and performs his task in that way which involves a minimum of mental effort. He is not to be blamed for so doing, because he has merely followed the example of the management. It is the duty of the management and not of the men to study the work, to discover the most efficient methods, and instruct the men in those methods. When, because of lack of instruction, the men fail to perform their work in the most efficient manner, it is the fault of the management and not of the workmen. Conventional management is fundamentally wrong, in that it compels the workmen to originate the methods, and leaves to the management only the task of criticism.

When the management of an industry is reproached for laziness in not properly directing the workmen, the officers of administration will usually reply to this effect: "These workmen which we hire are supposed to be competent men. They are experts in machine molding, tool dressing, lathe work, or whatever it is that we hire them to do. They have devoted their lives to these lines of work, and know a great deal more about it than we do. When a man receives a job, he can devote his entire attention to that one job. His task is easy, because he has to think of but one thing at a time. If we devised the methods of work, we would have a thousand jobs to figure on each day. They could not receive the same amount of attention that they get now, nor would that attention be as satisfactory, since we are not experts, and the men are. When you ask us to direct the workmen in the details of their work, you are demanding of us an overwhelming and impossible task."

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In answer to this argument, it is only necessary to say: First, while the workmen are usually much more capable than the management, this is due to the lamentable ignorance of the management, and not to the extraordinary knowledge of the workmen. It is practicable for the management to acquire and apply knowledge which it is impossible for the workman to have. Second, many shops that are eminently successful do direct all of the acts of their workmen. Third, when the workmen devise the methods of doing work, they are handicapped by being obliged to use such tools and machines as the management provides, while, when the management devises the methods, they can and will secure the proper tools and machines for doing the work.

Prejudice against So-called Non-productive Labor

A second source of inefficiency is a dislike on the part of most managers to employ a considerable executive staff to direct the efforts of their workmen. The management balks at such a staff, and claims that "non productive" labor is a necessary evil if you have to employ it, and an unnecessary evil if you can do without it. In the old days draftsmen were regarded as an unnecessary evil, and the designing was done by rule of thumb and the head patternmaker. Experience has shown that Johnny Pencilpusher is not an evil, nor is he unnecessary, and that it pays to employ him. Accordingly he is now classed as "productive" and not as "non-productive" labor. The men who direct the work of the shop are just as necessary as the men who make the designs, yet it is difficult to persuade the average manager that a large executive staff is desirable even when you can show him that a gain will result from its employment. The attitude toward such a staff is well shown by the name "non-productive," so often applied to this class of labor. The labor of the planning department is just as truly productive as the labor of the drafting department, the machine department, or the erecting department. A new attitude in regard to the employment of indirect labor is a pre-requisite to greater efficiency in many of our shops.

Timidity of Capital

A third fault of management is timidity. Capital seems to be ruled by fear quite as often as by judgment. Men dislike to risk their money in something which they feel is not absolutely sure to bring adequate returns. They especially dislike to risk money in any investment which is of such a character that they cannot recover the principal in case they decide to give up the enterprise, even though adequate returns are almost certain. Managers often hesitate to spend money for new tools or equipment until other firms have tried the tools or equipment and found them to be successful.

Probably one of the best examples of this is the difficulty which Mr. George Corliss had in selling his engines at a reasonable price, when they were first brought out. It will be remembered that in some cases he had to take for his pay the value of the coal which his engine could save in a given period of time, and was under bonds to take out his engine and reinstall the old one in case the purchaser decided that the new engine was unsatisfactory. Just as Mr. Corliss' customers were fearful of spending money for an improved type of engine, and insisted on making a contract which was, in reality, unfavorable to themselves, so the present-day employer is fearful of assuming the expense incident to proper management, even though it can be shown that great gains ought to be realized from proper administration.

Lack of Foresight

This brings us to a fourth fault of management, which is lack of foresight. The management, in performing the work of today, fails to make allowance for the needs of next week, or the growth of next year. Plants grow in haphazard fashion. Equipment is added without making plans for the future. No attempt is made to insure that there will always be a corps of trained workmen and a staff of able foremen. The lack of definite and far-reaching plans for future work is not felt at the time that such plans should be made, but is felt later.

Mental Inertia and Lack of Adaptability

A fifth fault of management is one which may best be described as "mental inertia." Managers tend to follow methods which have been satisfactory in the past, but which changing conditions have made unsatisfactory for present requirements. Whenever a new invention of any importance is introduced into a shop the conditions of work are greatly altered. The introduction of high-speed steel is a case in point. When the time required for machining work is cut down to a third of that formerly required, the amount of crane service for a given number of machines is trebled. The foundry and forge shops must be made very much larger in order to furnish the stock required by the machine shop. The amount of storage room required for stock and for finished product is greatly increased. The relative importance of different items of cost is radically altered, and the nature of the problems of administration are greatly changed. Notwithstanding these changes, we will find that in most cases the management will attempt to get along with the least possible change in equipment, and in methods of work and administration. Many men resist change simply because it is change, in spite of the fact that the change may be desirable.

One of the best examples that comes to mind of the mental inertia that prevents the adoption of new ideas is the general disregard of Mr. Taylor's discovery that the use of a heavy stream of water at the cutting point of a roughing tool, increases the permissible speed of cutting by forty per cent. If the machines of a shop are engaged on roughing work for one-third of the time, by the use of such a stream of water their output will be increased by thirteen per cent. In a shop in which 100 men are employed on machine work, this will mean a reduction in the cost of machining of about $20,000 per year. To install a system for distributing soda water to all the machines in such a shop, and for returning and purifying the water, will certainly not cost more than $20,000, yet, so far as the writer is aware, there is only one shop in which such a system has been installed, even though it would unquestionably pay one hundred per cent on the investment. This is an example of bad management arising from mental inertia, which occurs in almost every shop. When the subject is brought up in any plant, the management fortifies itself in its obstinate attitude, by advancing as arguments statements which are untrue, for instance, that the system costs more than it is worth, that the soda water destroys the machines, or that it is always giving trouble. Were the management to give the matter proper study however, it would find that practical experience has demonstrated that the benefits realized are so great that their shops cannot afford to operate in any other way.

Lack of Study of the Industry

A sixth and probably one of the greatest of all causes of inefficiency is the fact that the management very seldom makes a careful study of the industry. In the few cases where a careful study is made, it is usually done for the purpose of improving the materials used or the quality of the output, or increasing the amount of work turned out by the use of a given method.

It is of equal or even greater importance that the methods themselves should receive the same careful study. Probably the best example of a scientific study of methods of manufacture is the work of Mr. Taylor on the art of cutting metals, to which reference has already been made. It is probable that a similar study of methods would result in equally important developments in other lines of industry. Such studies are not made for three reasons. In the first place, managers do not realize the need of such studies nor the advances which are possible. In the second place, very few men are capable of making such studies. In the third place, inertia opposes the changes which would result from such studies, and timidity hesitates to expend the money necessary to carry them out. Very few managers would have the courage to commence an investigation whose final cost would be $800,000 and which would take twenty-six years for its completion, and while the management of some very large industries might be willing to take a chance on an investigation of this kind, even the most sanguine would deride the possibility of such an investigation producing such valuable and far-reaching results as have followed from Mr. Taylor's experiments. When all is said and done, it will be found that most managers want someone else to do the experimenting, feeling that by so doing they can participate in the profits of such work without sharing its expenses.

Systems of Rewarding Labor

A seventh source of inefficiency in many industrial plants is the system of wage payment adopted. It would be hard to devise wage systems better calculated to limit efficiency than the two which are in most common use; namely, the day wage plan, and the piece-work plan with frequent cuts. Under the day work plan, the man receives no reward for his efficiency, he is instead punished for inefficiency. This is a method which is fundamentally wrong, and only to be employed when no other method is possible. When a man receives day wages, he is paid for the time which he spends at his work. The first question which arises in connection with this system of wage payment is: What wages ought a man to get? The answer is he ought to get all he can. He is selling a commodity, labor. He asks for it the highest price he can get, and is justified in so doing. His labor is measured by time and the value of the labor performed in a given time has nothing to do with the payment which he receives. The only thing which limits him is the fact that if he does not do a satisfactory amount of work, he will be discharged. What constitutes a satisfactory amount of work, neither he nor anybody else knows. The whole thing works out very much as it would if a man when buying a quart of milk, were to insist simply that there be some milk in the quart measure, and the matter of how much milk there was to be in the measure, should be left with the milk-man, with the understanding that the milk-man would lose his customer in case the amount of milk was not satisfactory to the purchaser.

When you discuss with the average workman the question of proper wages and the proper amount of work to be done in a day, he will tell you that his motto is "a fair day's work for a fair day's pay." Different men, however, have very different ideas as to the amount of work which constitutes a fair day's work. Some employers think that it is all the workmen can possibly accomplish. Some workmen think it is the least that they can accomplish and still not get fired. Most workmen think it is work they can do when working steadily at the gait that habit and temperament have fixed in their cases. Most employers think it is the amount of work which their most honest and industrious employe normally does. When there is such a great diversity of opinion as to what constitutes a fair day's work, it will naturally be seen that there will be great diversities in the efficiencies of different men and different shops.

When a piece-work plan is adopted, the management usually knows very little about the possibilities of the work. If the management fixes what the men think to be a reasonable piece-rate, the men will soon so increase their output that they will be making exorbitant wages. The management will then cut the piece-rate, and after the men have experienced a series of cuts as a result of successive increases in efficiency, they will discover that the management does not propose to pay them more than a certain amount of money, and will work just hard enough to secure a trifle less than the maximum amount they can secure without experiencing a cut.

If, on the other hand, a proper piece-rate is established in the first place (*i. e.*, one by which the men can earn fifty per cent to one hundred per cent more than a regular day's wages when they have reached their best efficiency), the men will believe that it is impossible to earn reasonable wages under the proposed piece-rate, and will decline to accept it.

"Holier than Thou" Spirit of Some Employers

An eighth cause of inefficiency is one which is happily becoming less frequent. It is a disposition on the part of some employers to regard their workmen as being of a lower order of humanity than themselves. I have talked with such men on more than one occasion. Among their associates they were highly regarded for their kindness of heart, but I have heard them speak of their workmen as "beasts" and "ignorant brutes." No man who regards his employes in that light can be persuaded to adopt scientific management nor can he bring the efficiency of his plant to a high standard, because such feelings will unconsciously affect his attitude in dealing with his employes, arouse their antagonism, and destroy that feeling of cooperation which is the essential basis of high efficiency.

On the other hand, even though the employes of such a man are ready and anxious to cooperate with him, his attitude will prevent him from doing many things which would utilize such potential cooperation to advantage.

Avarice of the Management

The last source of inefficiency of which I will speak is avarice on the part of the management. Avarice reduces wages, cuts piece-rates, purchases inferior materials and equipment, employs unskilled labor, skimps on supplies and makes unjust exactions of its employes. Avarice refuses to expend money for the collection of information, for increasing the facilities of work, and for improving the efficiency of administration. Avarice hampers the administrative staff at every point. Avarice is the sin of the board of directors and the stockholders, and not of the superintendent and his staff. Scientific management often requires a large staff of clerks and costly experiments when it is being introduced into a new line of work, and this effectually prevents its adoption by the avaricious employer.

Not only will avarice prevent the adoption of scientific management in a great many cases, but it is also very likely to give scientific management a black eye by adopting some of its methods, without adopting its spirit. An avaricious employer finds himself coming out second best in competition with one who utilizes scientific management. He attempts to appropriate the experience of his competitor in the same spirit in which he imitates his trademarks, copies his designs, and steals his methods of work. Now while it is possible to imitate a trademark or steal a method, it is not possible to imitate or to steal the scientific habit of mind or the spirit of fair play, which lie at the basis of scientific management. The reward and instruction are just as essential to scientific management as the discovery of a method of work, but the avaricious employer cannot be made to see this. When his neighbor has discovered a method of work better than that which his workmen employ, he will attempt to force his workmen to accomplish the same results without teaching them the new method and without offering them the reward to which they should be entitled, and his attempts will therefore always end in failure. While there is no question but that scientific management will continually discover new and improved methods, processes and materials, and while these improvements will gradually find their way into shops which do not employ scientific management, the extraordinary performances possible under scientific management will never be achieved in the shops of the avaricious employer because knowledge alone will not lead workmen to increase their efficiency.

I have not by any means exhausted the list of causes for inefficiency which arise from faults of the management. It would be as easy to name a hundred as to name nine, but the task is not agreeable. I have endeavored merely to point out the fact that such faults exist, that they can be remedied, and that before scientific management can be applied to an industry, they must be remedied.

Causes of Industrial Inefficiency due to the Workmen

While most of the causes which lead to inefficiency are chargeable to bad management, I would not have it inferred that the workmen are free from blame in the matter. I know of many shops in which the blame rests almost wholly on the workmen. In one that I have particularly in mind, the management is keenly alive to the possibilities of improvement. They could today increase their output fifty per cent, and would gladly increase their wages in the same proportion, if the workmen would cooperate with them. Time and again they have attempted to make changes leading to higher efficiency, but in every case the opposition of the workmen was so strenuous that they were convinced that it was the part of wisdom to accept the inevitable and to permit the inefficiency which they deplored. Were they to insist on a change of methods, it is quite likely that labor troubles would force their plant into bankruptcy on account of their limited capital.

The Natural Pace of Workmen

The first source of inefficiency chargeable to the workmen is their disinclination to work at any other than their natural pace. If a man is allowed to work as he pleases he will soon settle down into a certain pace which suits his temperament and nervous organization, and will keep to that pace without very much variation from day to day. I may call this his natural pace. It is perfectly possible for such a man to work very much faster without tiring himself, and if he is properly trained and given adequate inducement, he will adopt the faster pace, and make it his habit to work at that faster rate. I may call this faster pace his proper pace. In order to illustrate the relation of the natural to the proper pace, I would like to compare them to the natural gait which a horse takes when his driver allows him to go at his own free will, and the proper gait which an experienced driver will set for the horse, in order that he may accomplish the best results. A careful and experienced driver will get a great deal more work out of a horse if he urges him to travel at the proper gait. Notwithstanding this, the horse will be no more tired at the end of the day when driven at the proper gait, than he would be had he traveled at his natural gait. The faster gait does not mean undue wear and tear, and the horse will maintain good health and vigor just as long when working for a careful driver who makes him work, as he will if he works for an indifferent driver who allows him to do as he pleases.

A man differs from a horse in two ways. In the first place he cannot be driven, and in the second place, a reward offered him for extra labor must seem to him to be reasonable. It is not difficult to get a man to change his pace if you offer him an adequate reward. If, however, he finds that the reward is not always forthcoming, *i. e.*, if he finds a piece-rate being cut or a premium reduced, or if he feels that the reward is inadequate, he will not respond. He cannot be driven by threats of discharge or by fines, and he cannot be coaxed by broken promises or gold bricks.

Lack of Ambition

A second source of inefficiency is lack of ambition. While most men will be stimulated by a proper reward, there are some classes of labor which cannot be reached in this way. Some workmen do not accomplish as much or as good work when well paid as they do when poorly paid. In certain sections of the South contractors find that when negro laborers are paid seventy-five cents a day they will work a full week, when paid $1 a day they will lay off one day in the week, and when paid $1.50 a day they will lay off half the time. The reason is that these men are not ambitious. Four dollars and a half a week supplies their needs, and when they have earned that amount they do not care to work any more. It is needless to remark, however, that the average artisan is not of that character. He is ambitious, and invariably responds to a suitable reward, unless he believes that in so doing he is acting against the best interests of himself or his fellow workmen.

Mental Laziness of Workmen

A third source of inefficiency lies in the fact that the workman does not like to think any more than the superintendent, the foreman, the manager, or the board of directors. He prefers to work without thinking when it is possible. Few men are physically lazy, but nearly all men are mentally lazy. The only way that a man can work without thinking is to do the job the way in which he or someone else has done it before. When he has to do a new job, he must do some thinking, but usually it will be found that the workman will adopt the method which requires on his part the least mental effort for its origination. Very seldom is the method adopted the best one. In the course of his work, ideas will come to the workman. Sometimes these ideas are good. If the ideas make it easier for him to perform the work, that is, if the new method is in accord with his temperament and habits, the idea is put into practice. If the idea makes it harder for him to work, that is, if it requires him to do something disagreeable or not in accord with his habit, the idea will be rejected. An investigation of methods of work will usually show that men who are physically restless will often adopt difficult and tiresome methods of work on account of their temperament. Men who are physically lazy will adopt easy-going and slipshod methods of doing work. In every case the workman seeks to conform the method to his temperament, in order that the mental and nervous effort which he must make in accomplishing the work shall be a minimum.

Fallacy of the Arguments against a Good Day's Work

A fourth, and possibly the most prolific source of inefficiency is the belief held by many workmen, and unfortunately, taught by many union officials, that in doing efficient work men are displacing other workmen and lowering wages. There can be no greater economic fallacy than this. One illustration alone will serve to make clear the falsity of the argument that a man who works efficiently reduces wages and the opportunities for labor. Let us suppose that on account of the increased efficiency of the workmen, the cost of making cement is materially reduced, and the output greatly increased. Of course, if the demand for cement were fixed at so many barrels per year, some cement makers would be thrown out of employment, but with the increased output and diminished cost there will come an increased demand for cement, and there will be a greater amount of concrete construction. Instead of reducing the number of men employed, it is quite possible that a larger number of men will be employed in manufacturing cement, and it is certain that a very much larger number of men will be employed in concrete work. If these concrete workers, in turn, become more efficient, cheapening the cost of concrete construction, the use of concrete will be stimulated, more cement makers will be employed, new factories, warehouses and bridges will arise, and finally every branch of industry will be stimulated by the improvement. The workman who increases his output is a benefactor, not alone to his employer, but to every man in the community. His increased efficiency will result in higher wages, and more general prosperity.

The facts in the case are so simple and so easily understood that it is strange to me that every workman does not understand and appreciate them. If all workmen were twice as efficient, the annual value of the products of labor would be twice as great as at present. The products of labor are distributed among the community (somewhat inequitably it is true), and the share which each member of the community can get will be proportional to the total amount to be distributed. Any increase in efficiency means that there will be more goods to be divided, that every one will get a larger share, and that the community will be benefited. It is impossible in an article of this character to go into the subject of economics, but the more the subject is studied, the more clearly the advantages of increased efficiency will be seen. As a matter of fact we can only reach that millenium when poverty, disease and unhappiness will disappear, by the straight and narrow path of increased industrial efficiency, and anything which impedes that efficiency is in reality as great a crime against humanity as the poisoning of a well, or the adulteration of drugs.

Enmity to Employers

A fifth source of inefficiency chargeable to workmen is a feeling of enmity against their employers. A great many workmen are unable to see the community of interest between the workman and the employer. Some workmen act as if they believed that the two were at war, and that anything done to injure the employer was a benefit to labor.

Now there will always be discussion and bickering between capital and labor as to how the wealth created by their joint effort should be divided. There can, however, be no discussion over the point that each must have a share, and that the amount of wealth which they can divide between them, and the size of the share to which each is entitled, will be great or small according as they are more or less efficient.

Any sensible man can see that the more efficient the workmen are, the more prosperous their employer will be, the better able he will be to extend his works and employ more labor, and the higher wages he will be able to pay. Until all feeling of enmity between capital and labor is replaced by a knowledge of mutual need and appreciation of mutual interest, and a desire for mutual success, not only efficiency, but also prosperity, must suffer.

Causes due to Political and Industrial Systems

Those sources of inefficiency which arise out of the imperfections of our political and industrial system are just as important as are those due to faults of management or of workmen. Unlike the latter, however, it is impossible for either the management or the workmen to correct the faults we are about to consider. It is not usual to discuss such matters in a technical paper and on that account this phase of industrial administration will be dealt with in the briefest possible manner, confining the discussion to a description of the causes, and not to a discussion of legal remedies. Everyone studying the industrial history of this country will be struck with the fact that we have alternate periods of feverish activity and of deadly dullness. In so-called "boom times" factories are run twenty-four hours a day, efficiency and quality of workmanship are sacrificed to output, our railroads are crowded to the limits of their capacity, untrained and inefficient men find ready employment in all trades, ill-considered plans for industrial expansion are hastily carried into effect, inferior and unsatisfactory equipment is eagerly purchased and installed because no other kind is available, and the general efficiency of our industrial system suffers a severe decline.

As a result of this inefficiency a "period of business depression" sets in, men are discharged, plants lie idle, wages fall, men are forced to move at great expense, and to seek new employment for which they are not trained, and again inefficiency is the order of the day. Now there is no reason why these alternations of activity and dullness should occur, except that our methods of conducting business are wrong. Proper laws, proper methods of banking, improved business customs, and a rational development of our natural resources and methods of communication will very nearly eliminate such conditions.

Certain industries, however, are subject to seasonal variations of opportunities for work. Agriculture and the canning industries are examples. Other industries are subject to seasonal variations in the demand for their products. The automobile industry and the manufacture of Christmas goods are examples. Where the supply of raw materials for an industry is subject to seasonal variations, nothing can be done except that such an industry may be operated in connection with another industry so that the workers and possibly a portion of the plant may be efficiently employed, practically all the time. Where the demand for the products of an industry is subject to seasonal variations, the industry may run steadily throughout the year if an accumulation of stock is permitted. The amount of capital tied up in the stock will usually, in such a case, be less than the capital otherwise tied up in the plant, since a plant which turns out a given product in three months will have to be four times as large as one which turns out the same product in a year, working the same number of hours per day. There is also the possibility of operating such an industry in connection with another industry, possibly of a like character, in such a way that both the plant and the workmen may be efficiently employed throughout the year.

We must all recognize that one of the causes of inefficiency at the present time is the struggle which is going on in the business and political world over the question of whether capital shall be used for the benefit of those who nominally own it, or whether it shall be used for the benefit of the community. Originally the position sanctioned by law was that capital belonged absolutely to the one owning it, and that he might use this capital in any way that he saw fit, except that he might not employ it in levying war on the sovereign, or in committing a criminal act. We are gradually coming to the view that capital must be used for the benefit of the community, and while we believe that the nominal ownership and the detailed administration of industrial enterprise should be left to individuals, we are coming to insist that a business shall be conducted efficiently, that in case the business is not regulated by competition the profits shall be reasonable, and that the methods of making and marketing the products shall be those which will further the well-being and efficiency of the community as a whole, rather than the profits and self-satisfaction of the owner of the business. While we are engaged in this process of changing the fundamental principles of law and of business, we must expect that inefficiency will be more or less the order of the day.

One of the economic sins of the present day which is very effective in destroying efficiency, is foolish and wasteful competition. The construction of parallel and competing lines of railway when one line is adequate to serve the traffic is a case in point. The installation of two telephone companies in the same city, of competing street car and electric railway lines, the duplication of generation and distribution plants by two electric power companies, and competition in other so-called "natural monopolies" are other examples. There are certain kinds of industrial work in which competition is undesirable and inevitably leads to inefficiency, and laws which permit or encourage such competition place a premium upon such inefficiency.

Another cause of inefficiency is frequent and sudden changes in laws, customs, fashions, and social conditions. For instance, a bounty, subsidy, or extraordinarily high tariff may cause the factories and workmen of an industry to be transferred from Europe to America. This transfer means a considerable temporary loss, and in case American conditions are not naturally favorable to the development of the industry, it causes a permanent loss. A few years later the abolition of the tariff or the bounty may cause the plant to be re-transferred to Europe and the workmen to be thrown out of employment, with a further loss. Similarly, a change in the direction or amount of traffic in a given district, the development of new resources, the sudden growth or decline of a transient industry and many similar things may affect the efficiency of a given plant, or even a whole industry. Often these changes are entirely beyond human control, or are incident to increased efficiencies in other and more important lines.

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SHERMAN LAW HELD TO APPLY TO RESTRAINT OF TRADE BY PATENTS

The Supreme Court of Massachusetts, in an opinion of the full bench handed down July 3, advanced the application of the Sherman law to embrace combinations in restraint of trade by reason of patent rights held by corporations. In a suit of the United Shoe Machinery Co. against Euclid I. Chappelle, an inventor who worked for the corporation for $12 a week, the corporation endeavored to force Chappelle to transfer certain patent rights under a contract of employment. Chappelle offered to show that the company was a monopoly and doing business in restraint of trade and contrary to the provisions of the Sherman act, but Judge Hardy refused to admit the testimony. Counsel for Chappelle took exceptions to his rulings and appealed to the Supreme Court. The decision holds that the lower court erred in not admitting such evidence. Chief Justice Rugg, who wrote the opinion, finds that the question of whether the United Shoe Machinery Co. is an illegal combination in restraint of trade and had monopolized trade and commerce between the several States must be governed ultimately by the Supreme Court of the United States. The opinion states, however, "that no word or phrase in the Sherman anti-trust act reveals an intent to exempt the owners of patents from its sweeping provisions against monopolistic combination."

"We are unable to perceive," stated the court, "any underlying reason for supposing that by implication growing out of economic or business conditions such an exemption was intended. There appears to be no inherent natural distinction between owners of patents and owners of oil which would justify the application of the statute to one and not to the other. The conclusion seems to follow that the comprehensive condemnation of the act against every person who monopolizes interstate commerce by combination with others includes holders of patents as well as others."

* * *

Most men need to ream out their mental cavities occasionally to enlarge their calibre.

CHARTS FOR HORSEPOWER TRANSMITTED BY GEARING AND BELTING*†

By CHARLES E. EVANS‡

The accompanying illustration and the Data Sheet Supplement show a number of charts which the writer has found convenient and useful. Two of the charts in the Data Sheet Supplement give the horsepower transmitted by spur gearing, one of them being used for circular-pitch gears and the other for diametral-pitch gears. When using these charts one can choose the fiber stress most suitable for the material and work in question. The charts do not give values directly proportional to the pitch line speed, but values that are relatively lower for high speeds as compared with low speeds. The light upper dotted line in the charts shows the form the upper curve would take if the horsepower were taken as directly proportional to the pitch line speed.

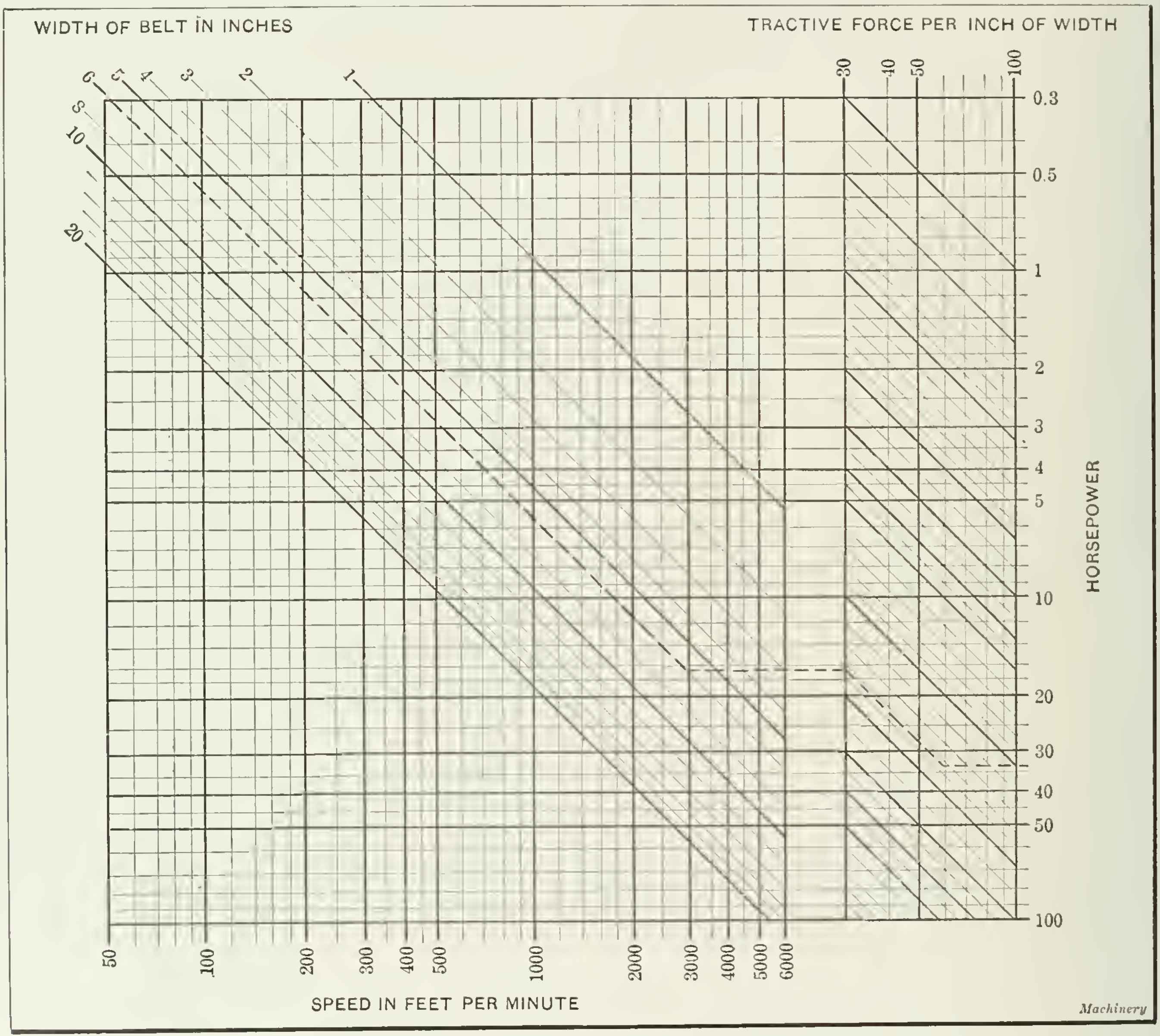

Chart for Finding the Horsepower transmitted by Belting

Gears having a large number of teeth have a stronger tooth form than gears with a small number of teeth, and provision has been made in these charts to cover this point, but if it is not desired to determine the results with such refinement as this arrangement makes possible, the values for a 12-tooth pinion can be used for gears of any number of teeth, thus reading straight across the chart at the right-hand side. The horsepower transmitted by gears of different width of face from that specified can be obtained by proportion.

The following examples are traced in dotted lines on Charts I and II in the Data Sheet Supplement:

A 12-tooth pinion of 4-inch face and 3 diametral pitch, running at a pitch line speed of 100 feet per minute, will transmit 2.3 horsepower with a fiber stress of 3000 pounds per square inch.

A 20-tooth pinion of 4-inch face and 3 diametral pitch, running at a pitch line speed of 100 feet per minute, will transmit 4.1 horsepower with a fiber stress of 4000 pounds per square inch.

A 12-tooth pinion of 1½-inch circular pitch and 4-inch face, running at a pitch line speed of 100 feet per minute, will transmit 3.3 horsepower with a fiber stress of 3000 pounds per square inch.

A 20-tooth pinion of 1½-inch circular pitch and 4-inch face, running at a pitch line speed of 100 feet per minute, will transmit 5.8 horsepower with a fiber stress of 4000 pounds per square inch.

The chart contained in the accompanying engraving gives the horsepower transmitted by belts or friction gears. When using this chart one can choose a tractive force per inch of width consistent with the problem in question. An example traced on the chart in dotted lines indicates that a 6-inch belt running at a speed of 3000 feet per minute will transmit 33 horsepower at a stress of 60 pounds per inch of width of belt.

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*With Data Sheet Supplement.

†For additional information on this and kindred subjects previously published in MACHINERY, see "A New Gear Chart," December, 1911, engineering edition; "Horsepower Transmitted by Leather Belts per Inch of Width," September, 1906; "Horsepower Transmitted by Belts," July, 1906, engineering edition. See also MACHINERY'S Data Sheet Book No. 5, "Spur Gearing," pages 21 to 23, and 26 to 29; Data Sheet Book No. 19, "Belt, Rope and Chain Drive," pages 14 to 16; Reference Book No. 15, "Spur Gearing," Chapter IV, "Strength and Durability of Spur Gears"; and Reference Book No. 52, "Advanced Shop Arithmetic for the Machinist," Chapter VI, "Horsepower of Belting."

‡Address: Fifth Ave., near Ohio St., Aurora, Ill.

Charts III and IV in the accompanying Data Sheet Supplement are auxiliary diagrams for finding the pitch line or rim speed in feet per minute. Chart III gives this when the diameter and the revolutions per minute are known. The example traced on the chart in dotted lines indicates that a gear or pulley having a diameter of 3.4 inches and running at 500 revolutions per minute has a pitch line or circumferential speed of 445 feet per minute; or if the diameter is 34 inches and the speed 50 R. P. M., the pitch line speed is 445 feet per minute; in other words, the chart can be used for other dimensions than those actually given if proper care is taken with regard to the position of the decimal point.

Chart IV gives the pitch line speed of a gear when the pitch, the number of teeth and the number of revolutions per minute are known. The example traced on the chart by dotted lines indicates that a 13-tooth pinion of 3-inch circular pitch, running at 100 R. P. M., has a pitch line speed of 325 feet per minute.

* * *

HINTS TO EXPORTERS

By ERNST VOEGELI*

From time to time American journals have published instructions relating to the proper crating of machines for export. This is a very important subject, but there are some other points almost as important which are frequently overlooked. Details, which at first sight may seem to be of little or no importance, sometimes cause considerable trouble and damage. With the present-day competition between different firms and different industrial nations, every reasonable precaution should be observed in order to avoid inconvenience to the customer.

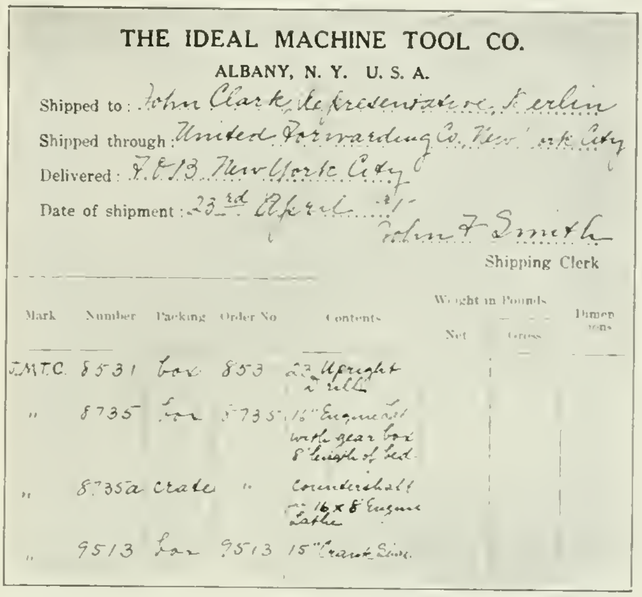
A very important point is that machines should be carefully greased before shipping. Solid crating will prevent breakage, and careful greasing will prevent rusting. The machines are often exposed for several days to the mist or fog at the harbors, and sometimes sea water may come into direct contact with them. The boxes may lie for some time in the open air, not even protected against rain. Hence, if not carefully greased, the machines will rust, and it is extremely unpleasant for the customer to receive high-priced and high-class machines in this condition. When badly rusted, the polishing and cleaning almost always injures the accuracy of the machines to some extent, and this may be detrimental to the reputation of the manufacturer of the machine. It is a fact that a good many machines arrive in Italy badly rusted.

Another important point is to have the boxes distinctly marked. Having almost daily had to do with the forwarding of American, German and English machines, the writer has observed that many American firms make mistakes in this direction. They place the address of their customer in large black letters on the box or crate. However, the customer is not always also the receiver. The customers of American manufacturers, on the other hand, are mostly agents and dealers, but the machines ordered by them are sometimes sold in advance and are to be shipped direct to the user's factory. Thus only a small part of the machines ordered are delivered to the address printed on the box, the larger part being forwarded to the ultimate buyer by the customer's forwarding agent. In that case, the addresses on the box are useless.

Difficulties are met with especially when different machines are arriving at the same time for the same machine dealer. Of these machines some are already sold and are to be forwarded direct to the buyers' addresses. The machines may originally have been shipped by different manufacturers in America, but they are all delivered to the forwarding agent at an American harbor, generally in New York City or Boston, and this forwarding agent sends all the machines at approximately the same time to the European forwarding agent. This agent, therefore, only knows that the American agent has shipped a number of machines, but he does not know who are the original shippers. The machine tool dealer gives the European forwarding agent instructions to ship some machines to one firm, others to another firm, and, perhaps, a third lot to still another destination, while a small part of them will be delivered to his own address.

How, now, is the forwarding agent to distinguish the different machines? There is no way to do it if all the crates are sent to one address. It is not possible to risk having the forwarding agent open the cases and distribute the machines according to the machine tool dealers' descriptions. Some machines might seem very much alike to one not familiar with them, and mistakes would easily be made. The writer knows from his own experience that such mistakes have occurred, simply for the reason that the box bore nothing but the address of the machine tool agent. In one case, where two machines were thus substituted for each other, the agent had to pay a penalty for delay in delivery, as well as the additional freight charges, to straighten matters out. In another case, the delay very nearly caused the customer to refuse the machine and to buy another from an agent who had it in stock for immediate delivery, but this latter machine was made by a competing firm in another country.

In order to avoid such inconveniences, it is suggested that the crates be marked in some way to avoid mistakes. This method is already followed by some of the American firms familiar with the export business, and is generally followed by German and other European firms. In place of the machine tool agent's address, it would be advisable to print on the box some distinctive marks and numbers, preferably the initials of the firm which ships the machine and the number of the order. If, however, the order comprises more than one machine, each crate should have a separate number so that every crate bears a distinctive mark. The Jones & Smith Mfg. Co., for example, may use the marks J. S. M. C. with a number. The probability that two or more boxes would bear the same identification marks is very small. These marks and numbers are to be repeated in the invoices, possibly together with the net and gross weights and the dimensions of every crate. This will allow the machine tool agent to give precise instructions to the forwarding agent for the delivery of the machines, and mistakes will be avoided. The writer would recommend a shipping list to be sent to the machine tool agent together with the invoices as soon as the machines are shipped, this shipping list being made up about as shown in the accompanying illustration. Of course this illustration only shows an example, and special conditions may require modifications; but the principle is illustrated.



THE IDEAL MACHINE TOOL CO.

ALBANY, N. Y. U. S. A.

Shipped to: John Clark, Representative, Berlin

Shipped through: United Forwarding Co., New York City

Delivered: F.O.B. New York City

Date of shipment: 23rd April

John F. Smith

Shipping Clerk

Mark	Number	Packing	Order No	Contents	Weight in Pounds Net	Weight in Pounds Gross	Dimensions
I.M.T.C.	8531	box	853	22" Upright Drill			
"	8735	box	8735	16" Engine lathe with gear box 8' length of bed			
"	8735a	crate	"	Countershaft for 16 x 8' Engine Lathe			
"	9513	box	9513	15" Crank Shaper			

List sent by Manufacturer to Agent for Identifying Shipment

Another thing worth mentioning is that very small packages containing small tools, catalogues or circulars are frequently sent by express to European countries. This is a slow and expensive way and should be avoided whenever possible. It is preferable to make, if necessary, a number of parcels and to send them by parcels post, or, in the case of catalogues and circulars, as printed matter. It will cost much less and the packages will arrive much earlier.

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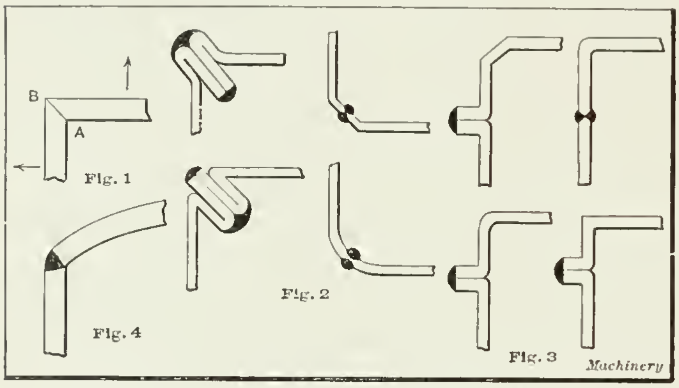
*Address: Via Morgagni, 28, Milan, Italy.

OXY-ACETYLENE WELDING OF TANKS AND RETORTS[*][†]

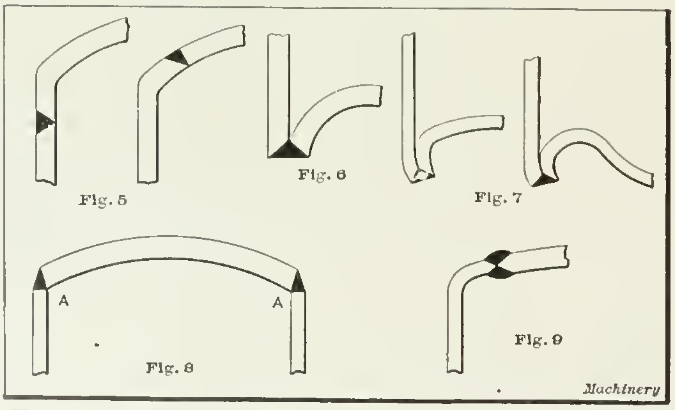
By J. F. SPRINGER[‡]

One of the most important applications of the oxy-acetylene welding process is in connection with the manufacture of tanks and cylinders from sheet metal. In this field the new process promises to supersede soldering and riveting to a very large extent. The advantage over soldering consists principally in the increased strength of the joint and the equality of the expansion and contraction of the metal in the seam and in the work. There is also much less likelihood of the occurrence of poisonous corrosions.

In constructing vessels of sheet metal which are subjected to alternations of high and low internal pressures, it is generally advisable to use special forms of joints at the corners or to avoid corner joints entirely. The stresses on the corner joints become very severe if the corners are of right-angled shape. If the corner is rounded, the effect of the internal pressure at the joint is reduced. In Fig. 1, for example, if the welded joint is made at the square corner *AB*, it will be located at the point where the stresses on it, acting as indicated by the arrows, will be most severe. By forming the joint in the various ways shown in Fig. 2, the weld will be considerably strengthened as compared with a weld that merely joins the two sides at the corner *AB* in Fig. 1. It is still better, however, to remove the joint from the corner altogether. In Fig. 3 are shown the methods used for doing this. The best method of all to relieve the welds of the excessive corner stresses is, of course, to change the horizontal section to that of a circle.



Figs. 1 to 4. Illustrations showing Various Methods of Making Welded Joints



Figs. 5 to 9. Methods of Welding Tops and Bottoms to Cylindrical Shells

Tops and Bottoms of Sheet-metal Vessels

One of the most difficult operations in the welding of tanks and retorts is the attaching of the tops and bottoms to cylindrical vessels. One of the first methods employed was that of making a joint as shown in Fig. 4. The welding was done from the outside and could be well finished. However, when the vessel was subjected to pressures from within, a combination of compressive and tensional stresses was produced at the weld, thus causing cracks. To overcome this difficulty, joints as indicated in Fig. 5, were made. Where the metal is quite thin, sufficient contact of the surface can be secured by bending the metal outward to form a kind of a flange. By using more welding material than necessary to produce a joint flush with the adjoining surfaces, a stronger weld can also be made.

In all these cases, the top or bottom is assumed to be convex on the exterior. Another method, shown in Fig. 6, is to make it concave on the outside. Such forms are especially suitable for bottoms. In Fig. 6 the rim of the bottom is bent and the edges of the bottom and of the cylinder are both beveled to provide a welding groove. Another method which does not necessarily include concaving is to bend up the rim of the bottom for a short distance, the dimensions of the piece being such that this rim snugly envelops the cylinder; the two may then be welded together.

The use of flat tops and bottoms should, of course, be avoided. The expansion and contraction of these during welding are different from those of the cylinder. The flat piece does not yield to the cylinder, and, hence, the work is likely to be distorted. The convexing and concaving of the tops and bottoms provides a suitable margin for yield. Two forms of bottoms are shown in Fig. 7, in both of which elasticity in the diameter is provided for. The bending in of the edges enables the cylinder wall to support the bottom when the latter is under pressure from within. In some cases it may be necessary to prevent diametral expansion of the cylinder when welding. A heavy removable band of metal in the form of a hoop may be used for this purpose. It is placed close up to the location of the seam. Most of the heat from the cylinder will then be absorbed and dissipated by this hoop.

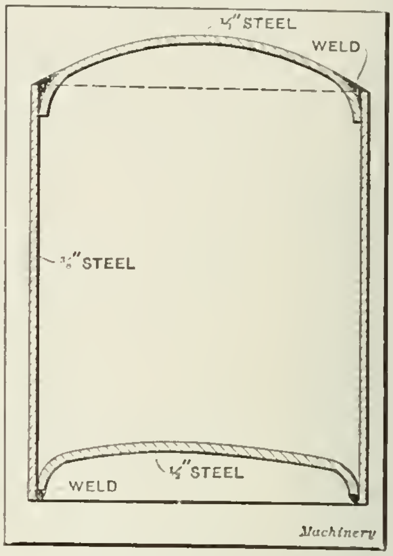


Fig. 10. Example of Tank welded by the Oxy-acetylene Process

An interesting example of the application of the foregoing principles is afforded by a large containing vessel constructed by Munk & Schmitz, Cologne-Bayenthal, Germany. This vessel is a cylindrical shell, closed at top and bottom, and is formed of sheets 0.40 inch thick in the cylindrical portion and 0.83 inch thick in the end portions. The vessel is 15 feet high and over 9 feet in diameter. All joints were made by the oxy-acetylene torch and the vessel successfully withstood, when tested, a pressure of 90 pounds per square inch.

General Considerations in Welding Tops and Bottoms to Cylindrical Vessels

If the joining of the top to the cylindrical shell were made at the precise point where geometrically the side of the wall joins the top, as shown in Fig. 8, an outward pressure exerted from within and tending to produce a spherical shaped bottom, would tend to make the angles at *A* more obtuse and would thus produce a tensional stress on the inner portion and a compressive stress on the outer portion of the weld. Hence, it should be carefully noted that this method of joining ends to cylindrical shells is objectionable, and that the methods shown in Fig. 5 should, in general, be adopted.

It is also very important in forming welds of the type described not to forget the effects of expansion and contraction. It is recommended that the weld be hammered during the cooling-off process. The hammering should be discontinued while the metal is still quite hot, and should not be continued below the point where a horse-shoe magnet attracts the iron; in fact, at this point, one has perhaps gone a little too far. Subsequent to the cooling, the region that has been exposed to the high temperature should also be well annealed. This may be done by using two oil torches for gradual re-heating, one from the inside and one from the outside. Incidentally it might be mentioned that in performing the welding operation it is also often advisable to use two welding torches, in which case a weld of the double-V character, as shown in Fig. 9, will be produced. The bottom of such a vessel should be so arranged that the weld is not located where the weight of the vessel itself comes upon it.

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[*] For further information on autogenous welding, see "Modern Welding Methods," MACHINERY, December, 1911, and the previously published articles there referred to.

[†] This article was prepared with the cooperation of the Davis-Bournonville Co., N. Y., and is a chapter from a forthcoming book: "Oxy-acetylene Torch Practice."

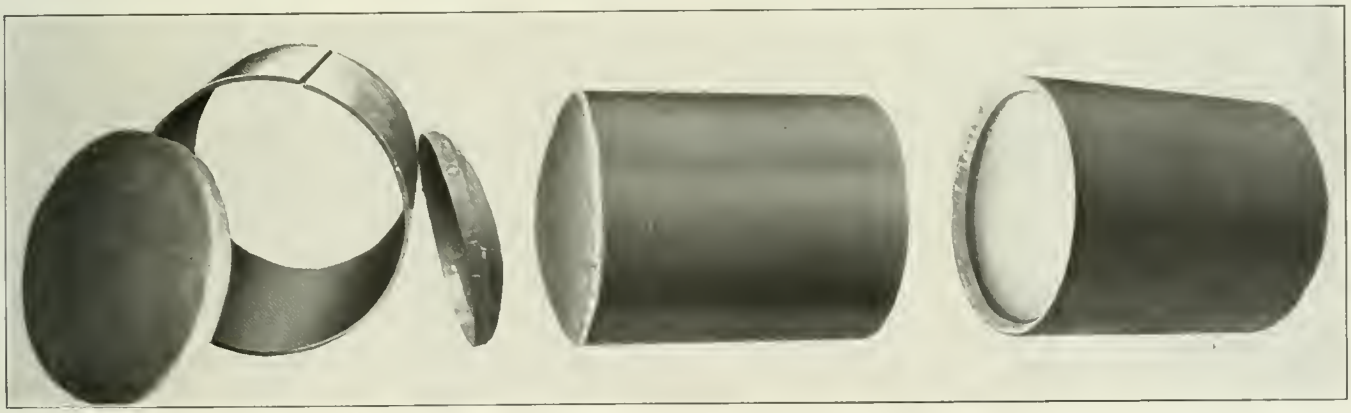
[‡] Address: 608 West 140th St., New York.

As an interesting practical example, the illustrations Figs. 11, 12 and 13 are shown, indicating the progressive steps in welding a cylindrical shell, as well as the welding of a top and bottom to it. A diagrammatical view of a section of the welded container is shown in Fig. 10, the work being done by the Vilter Mfg. Co., Milwaukee, Wis. It will be seen that the top is convex and the bottom concave, as viewed from the outside. The shell is of ⅜-inch boiler iron; the metal in the heads is ½ inch thick. The tank is 20 inches in diameter and 24 inches long. Both heads fit the inside of the shell as indicated.

After welding, this tank was tested at a pressure of 1200 pounds per square inch. For carrying out the test, a hole was drilled on one side of the shell and a nipple inserted after tapping. The tank was then connected with a hydraulic press pump. At 1100 pounds pressure the nipple started to leak, but there was no leak at the welded joints. A No. 7 Davis-Bournonville tip was employed in making the straight weld in the shell, and a No. 8 tip was used for the ends. The straight weld was made in 45 minutes at a cost of $1.62 (exclusive of labor, but including depreciation); the circular weld at the convex end required 2.67 hours and cost $6.99; the circular weld at the concave end required two hours and cost $5.24. At thirty cents per hour, the labor cost would be about $1.63, making a total cost of $15.48. These tanks are used at a maximum working pressure of three hundred pounds per square inch. A water cooled torch was employed in part of this work.

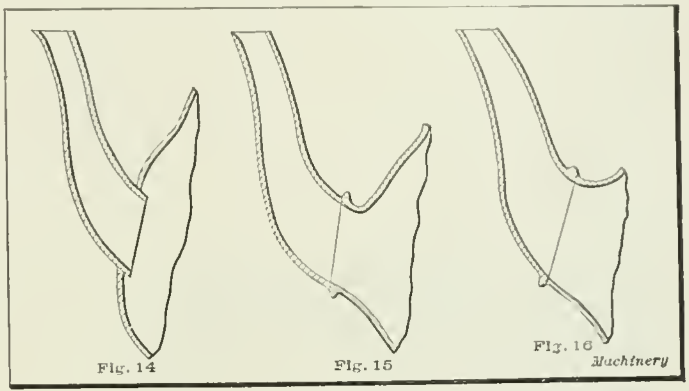
Autogenous Welding of Copper

While copper is normally tough and ductile, it enters a brittle stage when heated to about 1650 degrees F. This brittleness continues up to the melting point (at about 1930 degrees F). In order to weld copper it must be heated to this critical stage. At these high temperatures copper possesses a remarkable capacity for absorbing certain gases. If exposed to the atmosphere while at a white heat it absorbs oxygen. Another peculiar quality of copper is that when heated to a high temperature, quenching in water has a softening or annealing effect. Copper that has been highly heated and oxidized will, however, begin to fracture when one commences to hammer it, even if it has been annealed; hence, it is very important to prevent oxidation when welding, and by proper management of the outer flame of the oxy-acetylene torch the operator may succeed in preserving the new copper in the weld from oxidation. To make perfect work, however, it is necessary also to preserve the old copper, and here is where difficulties are met with. On account of the great heat conductivity of copper, a high temperature will be found for some distance on either side of the joint to be welded. Unless the operator can protect this outlying region, the results will not be satisfactory.



Figs. 11, 12 and 13. Progressive Steps in Making the Tank shown in Fig. 10

It is well known that phosphorus has a great avidity for oxygen. If, then, instead of a very pure copper we use a phosphor-copper alloy when welding, good results may be expected. A welding powder containing a percentage of phosphorus may also be used to secure a de-oxidation. Investigations along these lines are now being carried on in Germany, the exact results of which are not yet known, but it can be stated, in a general way, that good welding powders for copper can be made of such mixtures as borax, phosphor-natrium and prussiate of potash. The borax is not commercial borax, but that which has been subjected to a high temperature in a crucible and has then been pulverized. Boracic acid may be used instead of borax. The powder is prepared by mixing the boracic acid and the phosphor-natrium. Welding powders of this description form a film over the work and thus exclude the atmosphere. It is recommended when welding copper sheeting to spread the powder containing phosphorus for about 1½ inch on either side of the joint. This powder is then melted before the welding operation proper is begun. As there is some possibility of blowing away some of the powder when used in this way, it would seem desirable to apply it in the form of a paste.



Figs. 14, 15 and 16. Methods of Welding Spouts to Household Utensils

The Welding of Aluminum

The coefficient of expansion of aluminum is equal to twice that of steel and its melting point compared with that of copper and steel is rather low, being about 1215 degrees F. It is also comparatively weak in tension. Cast aluminum resists a tensional stress of about 10,000 pounds per square inch. Because of this weakness, and on account of its high rate of expansion and contraction, it is a difficult material to weld. As its heat conductivity is high, it is also difficult to localize the region of the high temperature. Oxidation of aluminum, however, can be avoided by the use of a proper flux.

While the total expansion and contraction from 100 degrees F. to the fusion point or welding temperature is about the same for cast iron and aluminum, because of the fact that the fusion point of cast iron is at a temperature about twice that of the fusion point of aluminum, the expansion and contraction, due to temperature changes, take place much more rapidly with aluminum, and the operator must use special care on this account. The low temperatures dealt with when welding aluminum make the pre-heating easier, but the operator must guard against not exceeding the fusion temperature. It is sometimes possible to make slight saw cuts here and there, and thus assist in making the effects of expansion and contraction harmless. These cuts, of course, must be repaired when the main operation is completed. Aluminum should never be welded without a flux. If welding is attempted without a flux, little globules consisting of aluminum within and a coating of alumina (oxide of aluminum) will appear. In order to eliminate these by heat, it would be necessary to raise the temperature to the melting point of the oxide of aluminum, which is about 5400 degrees F. A flux consisting of the following ingredients has been recommended: chloride of sodium, 30 parts; chloride of potassium, 45 parts; chloride of lithium, 15 parts; fluoride of potassium, 7 parts; and bisulphate of sodium, 3 parts.

When melting new metal from a rod, it is good practice to keep the rod constantly submerged in the molten bath of the metal in the welding groove, which for aluminum should be much larger than usual. If no powder is used, the oxidation is then confined to the upper surface. The main point to remember when welding aluminum is that the fusion point of this metal is very low; hence, the working flame should be kept further away from the metal than is usually the case when welding cast iron and steel. The torch should be so adjusted as to furnish an excess of acetylene. There need be but little fear of carbonizing the metal, for the reason that the temperature of the work is comparatively low.

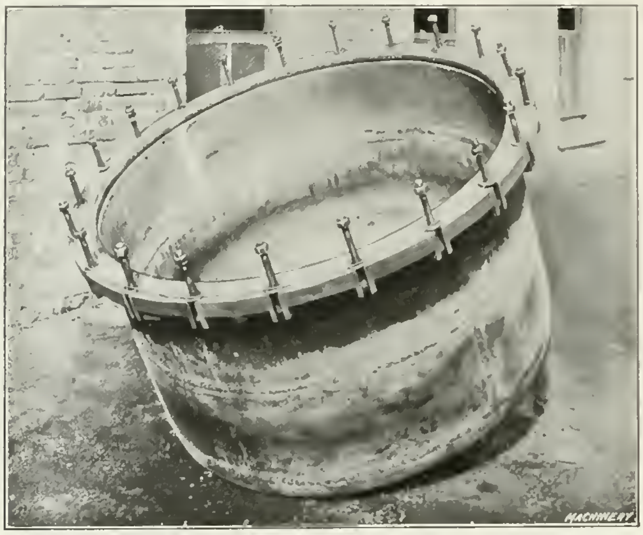


Fig. 17. Example of Welding Copper. Kettle is 5 feet 6 Inches in Diameter, 31 inches deep and used under Pressure. All Seams are welded on Both Sides

The Welding of Household Utensils

Some forms of household utensils, such as, for example, coffee and tea pots, cause considerable difficulties in their manufacture, particularly in connection with the attachment of the spout. Soldering has been used to a great extent in making these joints. However, the basic material of the solder is altogether different from the material united. The uses to which the vessels are put expose the joints to the action of acids, and galvanic currents are set up which injure the joint. Aluminum vessels are especially exposed to the action of these currents, because this metal is electro-positive to nearly all of the common metals. One means to obviate the difficulty is to bend the metal of the main vessel or body inwards at the hole for the spout. The material of both body and spout is then bent into a fold on the interior, no soldering material being used. The presence of this fold on the inside, however, is very objectionable. Even though it is closed when the vessel is new, the effect of repeated heatings is liable to open it, and the crevice becomes a trap for various small particles, which prevents effective cleaning. The oxy-acetylene welding presents the best solution of the foregoing difficulties.

When seeking to unite the spout and body by the oxy-acetylene torch, the worker is, however, confronted with several difficulties, especially if the sheet metal be aluminum. The expansion and contraction of aluminum, due to temperature changes, as already mentioned, is very rapid, so that the operator must guard against distortions of the work. The melting point of the metal is low, so that holes are apt to be made in thin metal. Heated aluminum is very readily oxidized with the result that a proper intermingling of the material is difficult. In view of these facts, it is recommended that the joint be placed away from the main body, that welding wire be dispensed with, and that a suitable flux be employed. In Fig. 14 is shown a joint which eliminates the necessity for the welding wire; the spout fits closely into the hole and is introduced far enough to protrude about ¼ inch into the interior, the projection thus furnishing the welding material. There is considerable advantage, of course, in thus eliminating the handling of the wire as far as the worker is concerned, and another advantage is that the welding material is precisely the same as the material of the work. It is difficult, however, to operate on the interior, but this difficulty may be reduced by using a tip of special form. The appearance of the exterior, however, is good.

Another form of joint is shown in Fig. 15. Here the diameter of the hole is first made smaller than the interior diameter of the lower end of the spout. The material is then bent outwards to form a ridge of the same diameter as that of the spout end. The body and spout can then be butt-welded by using welding wire. It is preferable, however, to bend the edge of the projection from the vessel outward, thus supplying the needed welding metal, or the auxiliary metal may be provided by bending the edge of the spout outwards, a joint of this kind being shown in Fig. 16. In either case, the ring of metal protruding at the joint will not be thicker than ¼ inch in a radial direction. In both cases, the interior is smooth.

* * *

COST OF MAINTENANCE OF GASOLINE MOTOR TRUCKS

An interesting paper was presented by Mr. Louis Ruprecht, before the summer meeting of the Society of Automobile Engineers, at Detroit, June 27-29, 1912, on the "Cost of Work with Gasoline Motor Trucks." It may be of interest to quote a few of the figures given, as the motor truck is now looked upon with considerable interest by many manufacturers. The depreciation may be figured at from 10 to 15 per cent per year, the tire value being deducted from the cost of the complete vehicle and the tires considered independently. The drivers' wages on a half-a-ton delivery wagon may be assumed to be about $2.75 per day, and on larger trucks from $3.00 to $4.00 per day. The garage charges, including only the washing and storing of the vehicle, are on an average from $240 to $300 per year, according to the size. The tire cost should be figured on the basis of a life of 8000 running miles, as guaranteed by the makers. The gasoline cost may be taken as about 11 cents per gallon, although at times it may be somewhat higher. Oil may be assumed to be 30 cents per gallon, and one gallon of oil will be sufficient for 50 to 125 running miles according to the size of the vehicle. The insurance will come from $100 to $250 per year according to the size. Repairs and replacements should be figured up to 3 cents per mile in the case of heavy trucks. This figure is based on extensive records.

Based on these figures a table has been compiled which gives, in the first place, the fixed charges per day for different sizes of vehicles, and in the second the additional running cost per mile. For example, the cost of operating a six-ton truck, all charges included, 45 miles per day, will be $\$6 + (0.1540 \times 45) = \$12.93$. The figures presented by the author also show conclusively that wherever a large tonnage is to be handled it is of the highest importance to use a few large units instead of many small ones.

Size of Vehicle	Fixed Charges	Increment Per Mile
1000-pound	$5.07	$0.0686
3-ton	5.33	0.0860
5-ton	5.60	0.1253
6-ton	6.00	0.1540
7-ton	6.15	0.1718
12½-ton train	7.40	0.2070

* * *

The data on the effect of vanadium in high-speed steel, given in the July number, was erroneously attributed to a publication issued by the American Vanadium Co., Pittsburg, Pa. The data should have been credited to the Vanadium-Alloys Steel Co., Latrobe, Pa.

THE STURTEVANT AERONAUTICAL MOTOR*

By CHESTER L. LUCAS†

Although the past few years have witnessed remarkable achievements in mechanical flight, it is evident, from the constantly recurring accidents, that, at best, aerial navigation is still extremely hazardous. Many of these accidents have been due to motor troubles of some form, and it is generally admitted that the majority of the present-day motors are inadequate, either through faulty design, poor workmanship or both. In the mad race for a light-weight motor, safety seems to have been almost entirely disregarded by introducing freaky designs and employing unsuitable light-weight materials; moreover, some of the workmanship displayed has been unmechanical, to say the least. The really reliable motors are few in number.

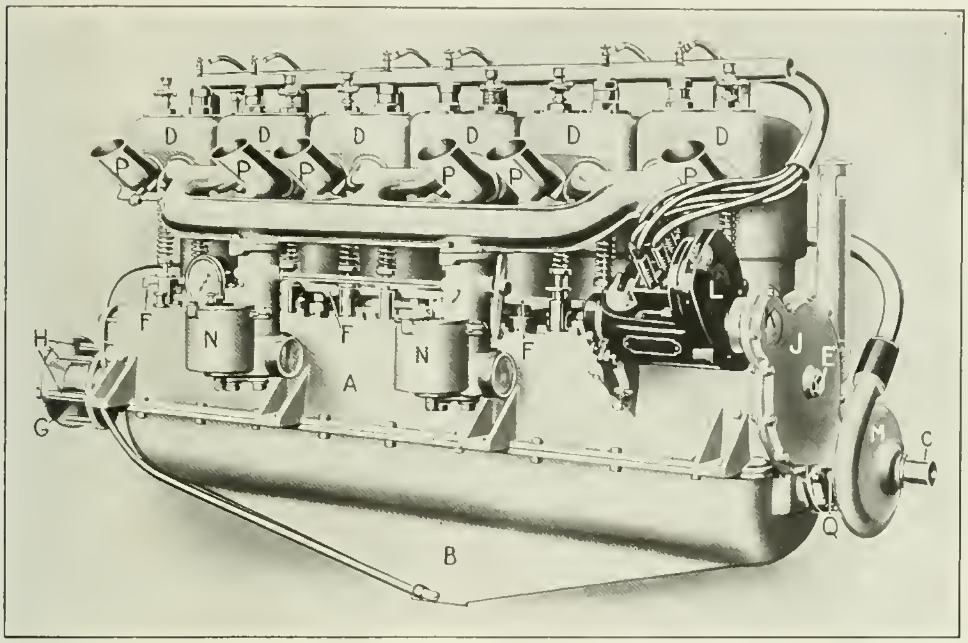


Fig. 1. The Sturtevant Aeronautical Motor, Six-cylinder

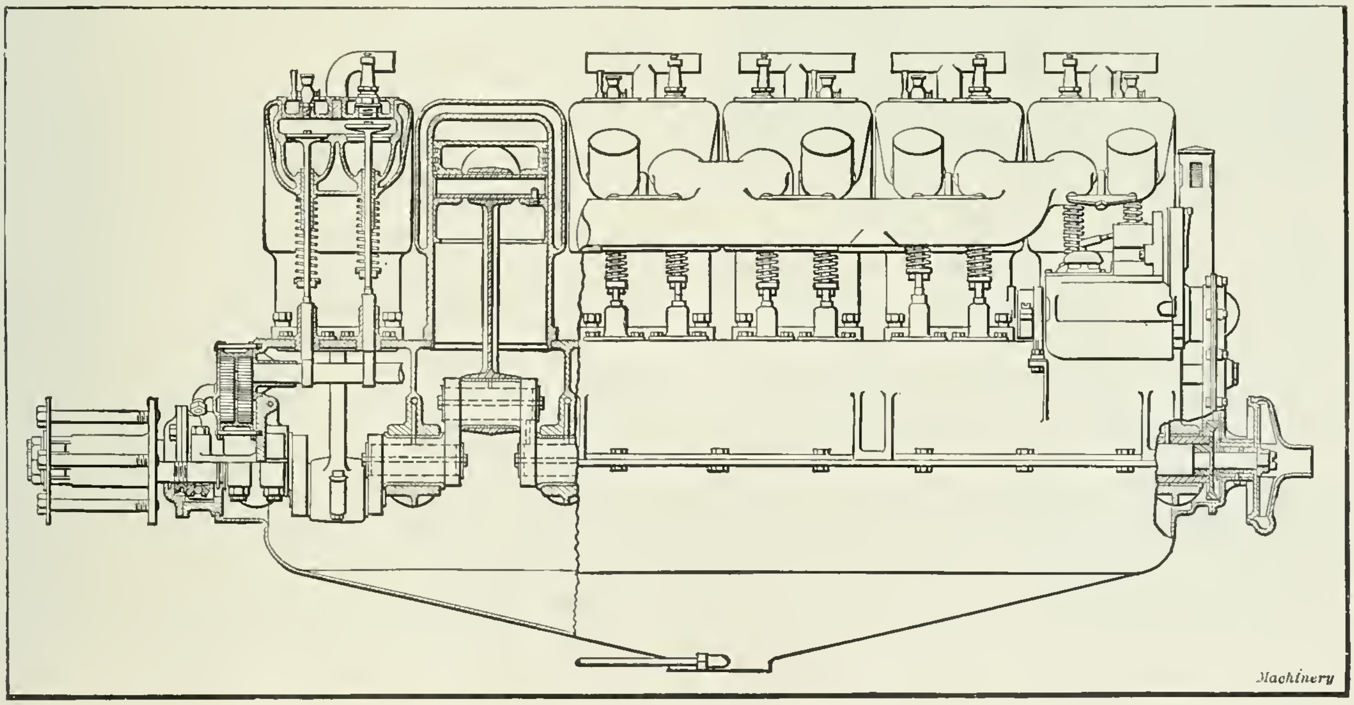


Fig. 2. Construction of Sturtevant Motor, Six-cylinder

The ideal aeronautical motor should possess certain fundamental qualifications; these qualifications may be briefly summed up in the order of their importance: First it should be capable of continuous satisfactory performance at various angles over long periods; second, it should produce the maximum amount of power for a given weight, at the same time being economical in consumption of gasoline and lubricating oil; and third, it should be refined in appearance and operation, being hooded and muffled so as to be as small a source of distraction to the aviator as possible. This latter consideration is not, perhaps, as important at the present time as it will be in the future of aviation when the use of aeroplanes in war will necessitate that the motors employed be as nearly noiseless as possible, and when aeroplanes become more common it does not seem fanciful to state that there will be active legislation to silence aeronautical motors.

Distinctive Types of Aeronautical Motors

Generally speaking, aeronautical motors may be divided into two distinct classes: namely, those of the rotary type, in which the cylinders are arranged radially and constitute a revolving member about a stationary hollow shaft fitted with an inlet valve, and those of the stationary type in which the cylinders do not revolve. Under this latter head may be included those motors in which the cylinders are arranged vertically and in tandem; those in which the cylinders are placed in the form of a V, commonly known as the V-type; and those in which there are but two cylinders which are sometimes placed directly opposite each other as in the opposed type. Some motors operate on the four-cycle principle, while others are of the two-cycle type. Each of these different forms of motors has qualifications more or less important in its favor, but most of them have objectionable features to offset these qualifications.

The Rotary Type of Aeronautical Motor

Without doubt the rotary type of engine, of which the Gnome make is representative, is at present the most powerful type of motor in proportion to its weight. Its advantages, aside from being of light weight, are that up to certain powers it may be satisfactorily air-cooled; the torque is exceptionally uniform, due to the fact that while in operation, the group of cylinders acts as a flywheel, so of course no added weight is given to the motor. An additional advantage is present in this type of motor in that all the cylinders are in one plane, thus minimizing the effect of unbalanced forces.

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* For additional articles on this and kindred subjects, see MACHINERY, September, 1911, engineering edition, "Seventy-two Horsepower Adams-Farwell Aviation Motor; January, 1911, engineering edition, "Aeroplanes and Airship Engines" and articles there referred to.

† Associate Editor of MACHINERY.

On the other hand, however, the head resistance offered by a motor of this type is considerable; there is a large waste of lubricating oil due to the centrifugal force which tends to throw the oil away from the cylinders; the gyroscopic effect of the rotary motor is detrimental to the best working of the aeroplane, and moreover it requires about seven per cent of the total power developed by the motor to drive the revolving cylinders around the shaft. Of necessity, the compression of this type of motor is rather low, and an additional disadvantage manifests itself in the fact that there is as yet no satisfactory way of muffling the rotary type of motor.

Stationary Type of Motor

The advantages and disadvantages of the stationary type of motor may be summed up by considering the same points as set forth in connection with the rotary type. Of necessity, it is heavier in proportion to the power developed; it is not successfully air-cooled, nor is the torque as uniform. The reciprocating movements cause wear and loss of power and except for engines employing six or more cylinders, the balance is not nearly as good in this type of motor.

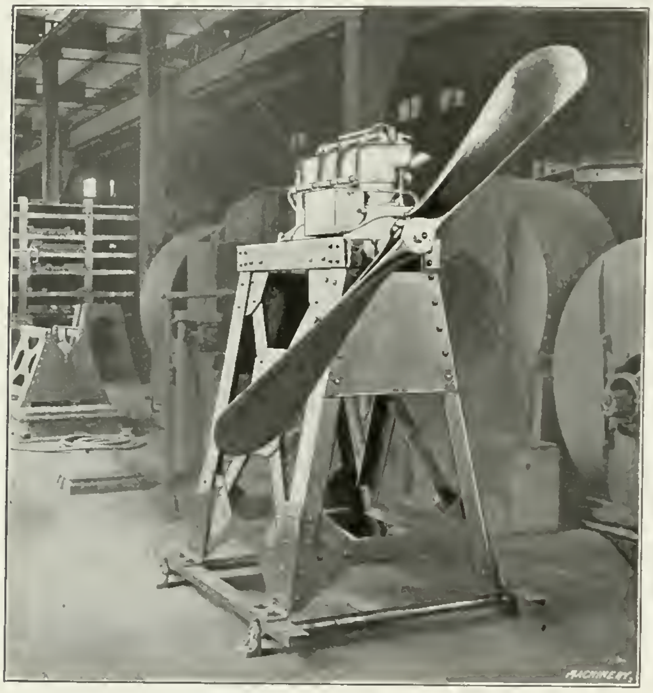

Fig. 3. Four-cylinder Motor mounted on Testing Stand

On the other hand, the head resistance of the stationary type of motor is much less than in the case of the rotary motor; it is very economical in its use of lubricating oil, and it has little gyroscopic effect upon the aeroplane. Less power is consumed in driving a revolving member about the shaft; when water-cooled, the compression may be kept high and it may be satisfactorily muffled, if desired.

While a much simpler motor may be designed by employing the two-cycle principle, its operation is not nearly as satisfactory as the four-cycle, and there are many sources from which trouble may arise. The V-type of motor is usually employed when the cylinders are above six in number, mostly on account of the compactness of this cylinder arrangement. The increased head resistance offered by this type of motor is, however, considerable. The opposed type of motor is seldom used except on two-cylinder engines.

Performances of Various Makes of Aeronautical Motors

The accompanying table has been compiled to show general characteristics and performances of several makes of aeronautical motors. The data used has been furnished by the respective makers of these motors and it is believed that this table should be of assistance to those interested in aeroplane power plants.

The Sturtevant Aeronautical Motor

The Sturtevant aeronautical motor was recently brought out by the B. F. Sturtevant Co., Hyde Park, Mass. Fig. 1 shows the general appearance of the six-cylinder motor, rated at 60 H. P., and Fig. 2 shows the same motor partly in section. The motor is also built as a four-cylinder type, rated at 40 H. P. This motor is shown in Figs. 3 and 4, and in Fig. 13, where it is set up ready for a propeller test. In designing this motor, the primary consideration was to build an absolutely reliable engine which could be depended upon when making long flights. While the weight has been reduced at every point possible, it has not been done at the expense of strength or reliability. The motor is of the stationary type, having either four or six cylinders. The company has endeavored to make this motor conform as nearly as practicable to the automobile type of motor, for the reason that this type of motor has been found the most practical for general use as evidenced by its employment in automobiles and, though a secondary consideration, it seems to be one which is generally appreciated by the average mechanic.

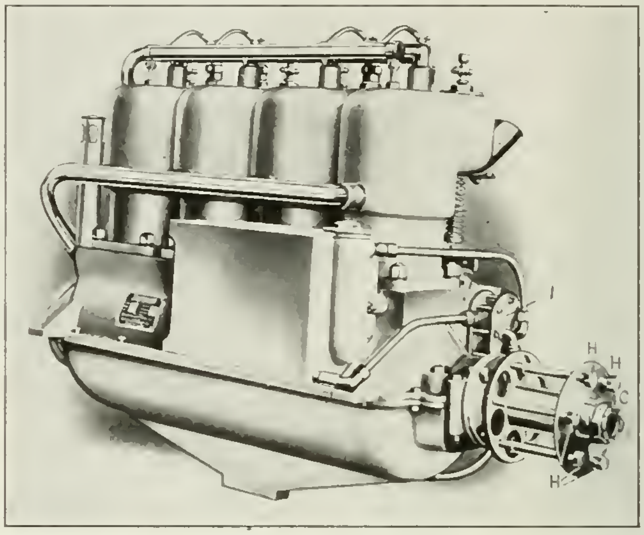

Fig. 4. Rear View of Four-cylinder Motor showing Method of Attaching Propeller

Crankshaft

The crankshaft which may be seen at C in Fig. 9 and in detail in Fig. 5, is machined from a bar of 3½ per cent nickel steel, containing 0.40 per cent carbon. After being machined, the crankshaft receives two heat treatments and has an ultimate tensile strength of 125,000 pounds per square inch of section. The bearings of the crankshaft are each 2⅜ inches long and are 1¾ inch diameter, the pins also being of the same dimensions. In order to lighten the crankshaft as much as possible, the pins and bearings are drilled and bored, the drilling operation being shown in Fig. 10, and the boring operation being illustrated in Fig. 11. The drilling of the pins and journals is accomplished by strapping the crankshaft to a suitable base located upon the Prentice Bros. drilling machine as shown. The boring to size is done in a

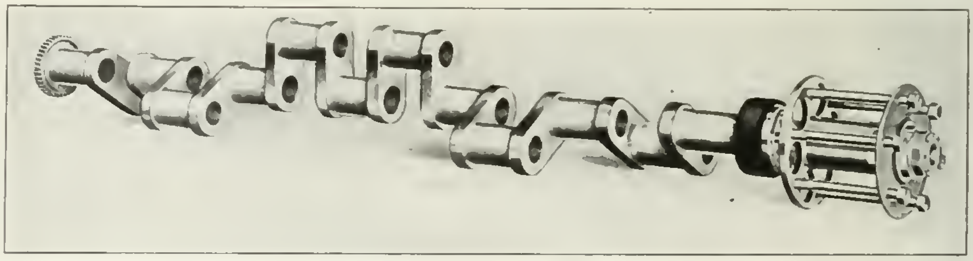
Fig. 5. Six-throw Crankshaft

lathe by means of special boring-bars of the proper sizes. It is interesting to note that in finish-boring the crankshaft, the diameters of the holes in the successive journal bearings decrease regularly commencing with the first cylinder, which is bored to a diameter of 1⅜-inch and thence down to the sixth cylinder which is bored to a diameter of 1 inch. The reason for this is that at the driving end of the crankshaft, it is not necessary that there be as much strength as at the position of the sixth bearing where the power delivered by all six of the connecting rods is being transmitted. The pins are bored uniformly in order to preserve the balance of the crankshaft. These hollow pins and journal bearings are connected by drilled cross holes, and by closing the ends of the holes in the journals and pins by suitable caps *R*, shown in Fig. 9. The crankshaft is thus provided with a lubricating duct through which oil may be pumped. Fig. 12 shows the operation of grinding the pins and journals on a Norton grinding machine. The propeller end of the crankshaft is fitted with a ball thrust bearing shown at *T*, Fig. 9, which may be arranged to take the thrust in either direction as desired. The method of attaching the propeller is worthy of noting. The end of the crankshaft which receives the propeller is slightly tapered; a flange *G*, Fig. 1, is provided having six holes to correspond with the attaching bolts *H*, and the opening in the flange is castellated to slide over the end of the shaft which has, in turn, been castellated to receive this flange. Thus, by means of the flange the propeller is supported from both sides and the tendency of shearing the attaching bolts is distributed over both ends of the hub.

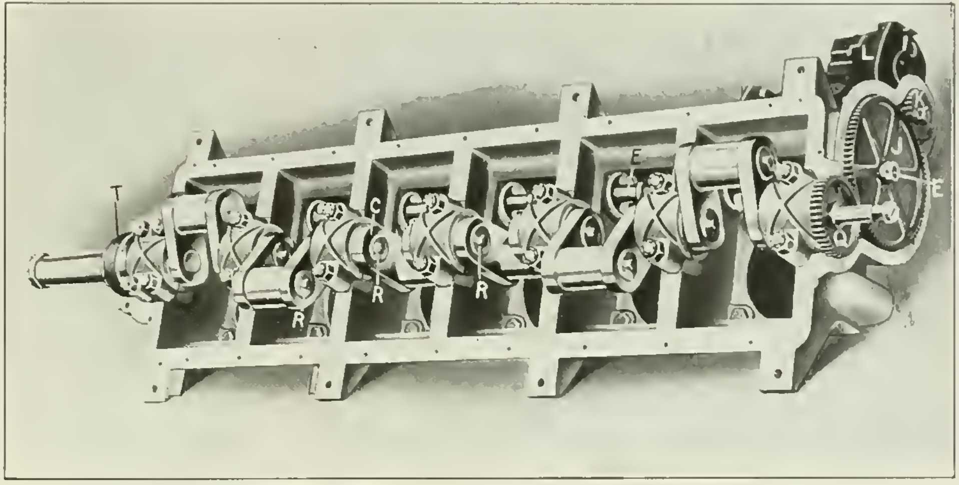

Fig. 9. Crankshaft and Base, showing Method of Mounting

Connecting-rods

The connecting-rods are made from drop-forgings of 3½ per cent nickel-steel and are of I-section. The bearings are die-cast bushings of Parsons white brass. When it is stated that some connecting-rods are made of non-ferrous metals it will be readily understood how inadequate they must be for use as aeronautical motor connecting-rods, and it is little wonder that they will not do the work required. Sturtevant connecting-rods are balanced with respect to the center of gravity, being placed on balances with opposite ends together; that is, the large end of one connecting-rod, together with the small end of another connecting-rod, is placed in the pans on one side of the balances, while the opposite ends are placed in the pans on the other side of the balances. Before being machined and balanced, the connecting-rods are heat-treated in accordance with the S. A. E. specifications. The connecting-rod caps are adjusted in position by the use of shims of laminated metal. Pieces of this metal are shown in Fig. 14 and, as will be seen, the metal is about 3/32-inch thick, and is composed of many thicknesses of thin sheet brass, each 0.002 inch thick and sweated together with soft solder. Successive layers of the metal may be easily pulled off as required in adjusting the boxes.

Pistons

The pistons, one of which is shown in Fig. 6, are cast from semi-steel having a tensile strength of 40,000 pounds, The exterior of the piston is ground and balanced to within two drams of standard weight. This balancing is done by removing metal from a boss which is left projecting within the interior of the piston, enough metal being removed to bring the pistons to standard weight. The piston rings are cast iron, of the ordinary type and are three in number. The piston pins are of 3½ per cent nickel steel and are bored hollow to reduce weight.

Cylinders

The cylinders, as shown in Fig. 7, are of the L-type, having the exhaust and intake valves located on the same side. An important reason for selecting this type of cylinder lies in the fact that with the straight cylinder which has been used to a large extent on aeronautical motors, there is always danger from broken valve parts being caught in the cylinder and causing damage to the motor. Of necessity, on cylinders of this type, the water jackets are cast integral. Experiments have been conducted in electro-depositing copper jackets, but so far, at least, the integral jacket seems to be the most satisfactory. The metal from which the cylinders are cast is the same semi-steel mixture from which the pistons are cast, and, of course, the jackets are made as thin as it is possible to cast the metal. After being machined, the cylinders are

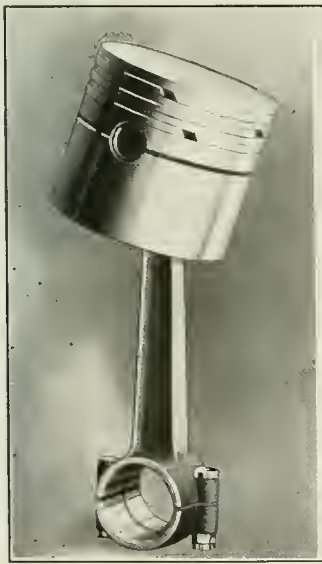

Fig. 6. Piston and Connecting-rod

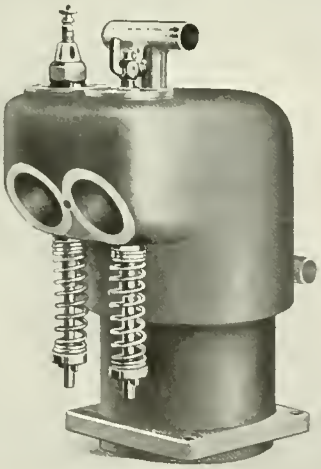

Fig. 7. Cylinder

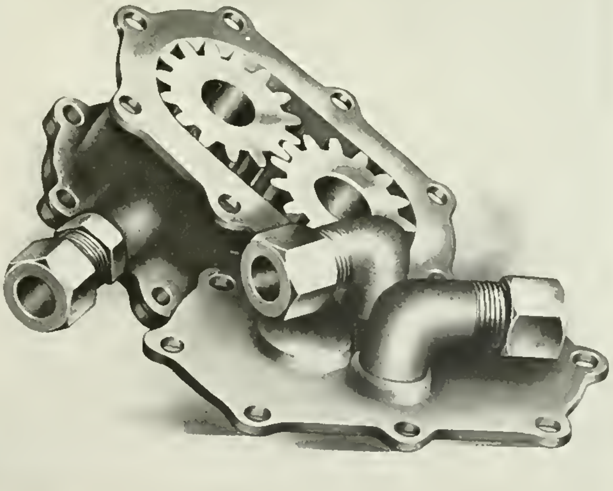

Fig. 8. Lubricating System Pump

hydraulically tested to 600 pounds per square inch. They are then heat-treated and accurately ground. The ratio between the stroke and the bore of these cylinders is 1 to 1, the stroke and bore each being 4½ inches. Upon this point of cylinder design there seems to be a difference of opinion, some designers being in favor of long stroke motors, while others consider the short stroke to be the better.

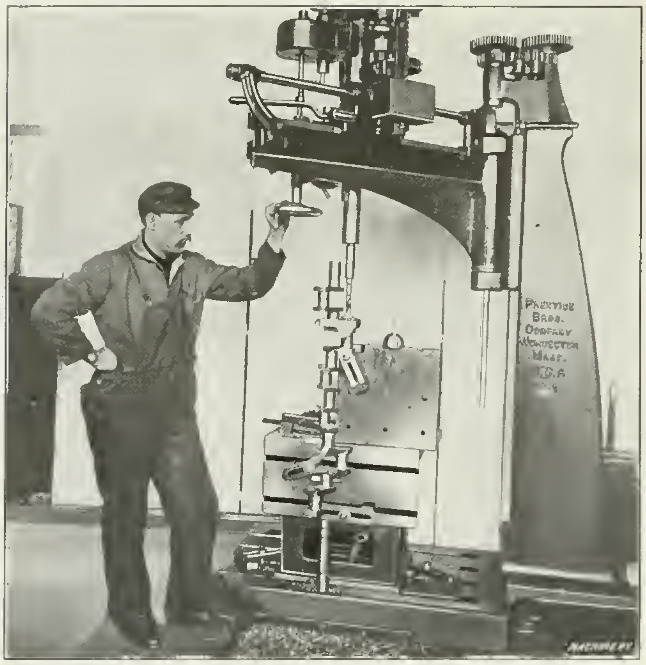

Fig. 10. Drilling out the Pins of the Hollow Crankshaft

Camshaft, Valve Mechanism and Other Parts

The camshaft, a portion of which may be seen at *E*, Fig. 9, is turned and ground from nickel steel, being ground with the Norton cam-grinding attachment. Previous to being finish-ground the camshaft is pack-hardened. Upon the forward end a gear *J* is mounted which transmits motion from the gear *Q* on the crankshaft to give rotation to the camshaft. This gear *J* also acts as an intermediate gear in the driving train which operates the magneto *L*, Fig. 1. These parts are also shown in Fig. 9. The camshaft is supported throughout its length in phosphor-bronze bearings. The inlet and exhaust valves for each cylinder, made of 30 per cent nickel steel, are located in the pockets cast integral with the cylinders. The exhaust pipes are shown at *P* in Fig. 1. The water pump, *M*, Fig. 1, is attached directly to the end of the crankshaft, the inlet *C* being coupled to it.

COMPARATIVE DATA ON LEADING AERONAUTICAL MOTORS

Name	Rated H.P.	Speed*	Dev. H.P.	Weight	Wt. per H. P.	Type	No. Cylin.	Cycle	How Cooled	Gasoline†	Lub. Oil†	Prop. Diam.	Prop. Pitch	Prop. Thrust	List Price
Sturtevant	40	1200	46	200	4.34	Vert.	4	4	Water	4.87	0.303	7' 6"	4' 6"	375	1500
Sturtevant	60	1200	69	300	4.34	Vert	6	4	Water	7.31	0.455	8' 0"	5' 0"	450	2000
Hall-Scott	40	1250	35	160	4.57	Vert.	4	4	Water	3.50	1.000	7' 0"	5' 0"	300	1500
Hall-Scott	60	1250	70	265	3.78	V	8	4	Water	7.00	1.500	7' 6"	5' 0"	400	2250
Hall-Scott	80	1250	70	290	4.14	V	8	4	Water	7.00	1.500	7' 6"	6' 0"	500	2750
Gnome	50	1200	42	167	4.00	Rot.	7	4	Air	4.00	0.375	7' 6"	7' 0"	420	3000
Gnome	70	1200	63	212	3.35	Rot.	7	4	Air	6.00	1.000	8' 0"	8' 0"	500	4000
Renault	50	1800§	59.4	420	7.07	V	8	4	Air	......	......	......	......	......	3200
Renault	70	1800§	79.8	453	5.66	V	8	4	Air	......	......	......	......	......	3700
Gyro	50	1200	48	165	3.30	Rot.	7	4	Air	4.25	1.500	7' 9"	5' 2¼"	420	2000
Roberts	50	1200	51	170	3.33	Vert.	4	2	Water	6.00	0.133	7' 6"	5' 3"	320	1500
Roberts	75	1200	70	270	3.43	Vert.	6	2	Water	9.00	0.200	8' 6"	5' 6"	480	2200
Curtiss	40	1100	45	175	3.90	Vert.	4	4	Water	4.20	0.750	7' 0"	6' 0"	310	1200
Curtiss	75	1000	78	285	3.65	V	8	4	Water	7.2	1.2	7' 6"	8' 0"	500	2200
Kirkham	50	1300	54.5	235	4.31	Vert	6	4	Water	5.00	0.33	7' 2"	5' 0"	410	1400
Kirkham	35	1300	38.3	180	4.83	Vert.	4	4	Water	3.68	0.21	6' 10"	4' 6"	300	975
Kirkham	70	1680	76.3	285	3.40	Vert.	6	4	Water	7.71	0.42	8' 0"	8' 0"	500	1650
Adams-Farwell	72	1000	80	285	3.56	Rot.	5	4	Air	......	0.5	9' 6"	6' 6"	460	2500
Adams-Farwell	125	‡	......	......	2.25	Rot.	6	4	Air	......	0.75	9' 6"	6' 6"	......	3000
Trebert	100	1000	90	350	3.70	V	8	4	Water	8.75	0.25	8' 0"	8' 0"	450	1500
Trebert	50	900	50	250	5.00	Rot.	6	4	Water	5.25	0.15	7' 6"	7' 6"	250	2000
Maximotor	50	1050	50	210	4.20	Vert.	4	4	Water	......	0.50	7' 6"	4' 6"	360	1200
Maximotor	75	1350	75	320	4.25	Vert.	6	4	Water	......	0.68	......	......	400	1600
Maximotor	70	1350	70	270	3.86	Vert.	4	4	Water	......	......	......	......	......	1500
Maximotor	105	1350	105	390	3.83	Vert.	6	4	Water	......	......	......	......	......	2000

* Recommended by manufacturer. † Consumption in gallons per hour at developed H.P. ‡ Cylinders revolve 800 R.P.M. in one direction and crankshaft 1000 R.P.M. in opposite direction. Both are direct-connected to two propellers. § Propeller revolves at one-half engine speed or 900 R P.M.

Means are provided for starting the motor in mid-air; this is an advantage in that it will enable an aviator to shut off his motor while "volplaning," and yet be able to start it again at will without landing. Referring to Fig. 1, at *F* may be seen a valve-lifting rod whose function it is to lift the exhaust valves, should the motor stop while in flight. By thus lifting the exhaust valves, the action of the air on the propeller will cause the motor to start automatically. The base of the motor, indicated at *A*, is a strong aluminum casting reinforced throughout and the cylinders are held to this base by means of four bolts, each of which passes through flanges on the cylinder bases. The construction of this base is illustrated in Fig. 9, and as will be seen, the bearings for the crankshaft are bolted to the under side. These bearings are die-cast bushings of Parsons white brass. The oil pan or sump *B* shown in Fig. 1, is of slightly different design than that ordinarily used. As the deepest point is at the center, the oil will gravitate toward the center of the sump, even though the motor be operating in an inclined position.

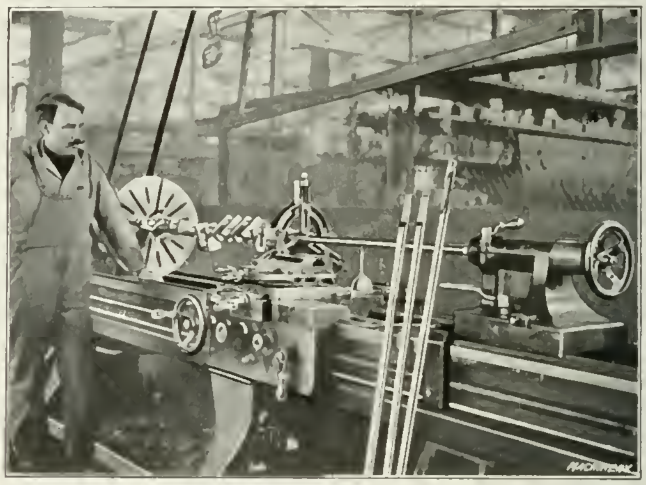

Fig. 11. Boring the Journal Bearings

Lubricating System

The lubrication system employed in the Sturtevant aeronautical motor is of more than ordinary interest. The fundamental idea in designing this system was to provide a method of lubrication that would be absolutely dependable. By means of a pressure pump shown in Fig. 8, driven directly from the end of the camshaft, the oil is forced through cored holes in the base and into the hollow crankshaft already described. It is thus distributed to the bearings in which the crankshaft runs, and also to the connecting-rod bearings. From these points the oil flies in a fine spray to all parts of the mechanism enclosed within the crank case, finally gravitating to the sump. Mounted in tandem with the first pump is a second pump. This pump is of slightly greater capacity and its function is to remove the oil from the sump, force it through the oil filter and into the tank ready to be used again. As this second pump is of slightly greater capacity than the pressure pump, the sump is always kept drained, and, moreover, as the filter is in advance of this pump, the oil is *forced* through the filter. In the event of the filter becoming clogged, the pump would exert sufficient force to burst the filter and prevent the lubrication system from failing. These pumps are shown detached from the motor in Fig. 8.

The lubricating oil storage tank holds sufficient oil for three hour's use and by virtue of the form of sump employed, there is no danger of overlubrication of the end cylinders when the motor is being operated continuously at an angle, since the sump is kept drained of its oil by means of the pump. The 40 H. P. motor requires 0.3 gallon of lubricating oil per hour's run.

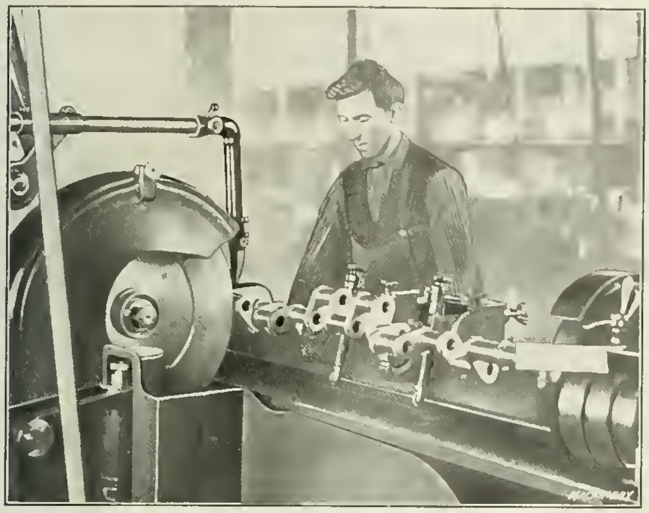

Fig. 12. Grinding the Crankshaft

Muffling

The subject of muffling aeronautical motors seems to have been an after-consideration with most manufacturers. The Sturtevant muffler is a part of the power plant and can be shipped with the motor, or if ordered at any future time can be easily applied. It is very probable that in the near future no aeronautical motor which cannot be efficiently muffled will have commercial standing. As a forerunner of this view, the design of the Wright engine has recently been changed in order that it may be muffled. The Sturtevant muffler can be instantly detached from the motor when not required, and as its total weight is but eighteen pounds, it does not seriously handicap the aviation equipment. The loss of power due to the muffler is about five per cent.

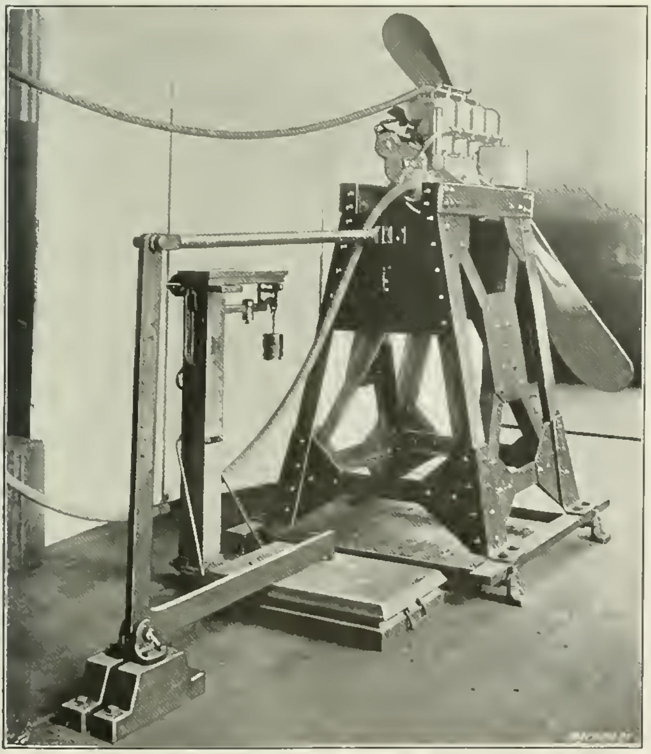

Fig. 13. Sturtevant Engine set up for a Propeller Test

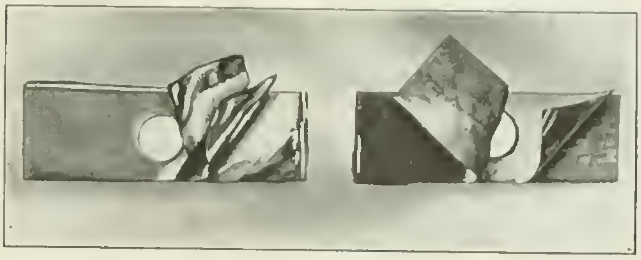

Fig. 14. Laminated Metal

Carbureter

The carbureters employed on this motor are of the Zenith make. An advantage claimed for the Zenith carbureter over other makes lies in the fact that after once being set no adjustment is required. Provision is also present for furnishing the carbureter with hot air from the exhaust, so that there will be no danger from freezing of the mixture in high altitudes. The carbureters may be seen at *X* in Fig. 1.

Tests

In addition to flying tests which have been conducted with the Sturtevant motors, interesting shop tests are being made from time to time. One of these tests was conducted over a period of 100 hours, the motor being operated for twelve consecutive days, 8 hours per day for 11 days, and 12 hours on the last day. The motor used was four cylinder, 40 H. P., equipped with a 7½ foot diameter 4½-foot Sturtevant propeller. It developed brake horsepower as indicated upon the power curve chart shown in Fig. 15. During this test an average thrust of 360 pounds was recorded, the speed on the propeller being 1200 revolutions per minute. The only attention which the motor received was the cleaning of the spark plugs and the supplying of oil and gasoline to the tanks at the end of each day's run.

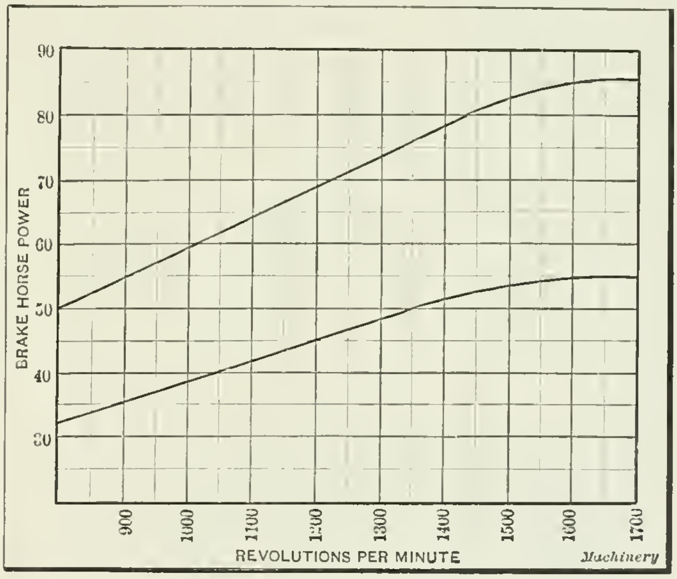

Fig. 15. Power Curves of Six-cylinder (Upper) and Four-cylinder (Lower) Motors

Referring to the power chart, Fig. 15, the comparison of A. L. A. M. ratings with the actual performances of these motors is very interesting and shows exceptionally high efficiency. The A. L. A. M. rating assumes a piston speed of 1000 feet per minute, with which speed the 4½-inch motor necessitates 1332 R. P. M. At this speed the four-cylinder motor is rated at 32 H. P., while its actual performance at 1332 R. P. M. is 50 H. P. The A. L. A. M. rating of a six-cylinder motor is 48 H. P., while the motor actually develops 76 H. P., at 1332 R. P. M. In both cases the peak of these power curves is reached at 1700 R. P. M., at which speed they develop 55 and 86 H. P. respectively.

BALL AND ROLLER THRUST BEARINGS*

By ROBERT H. GRANT†

In the early development of so-called "anti-friction" thrust bearings, there was no data with which the engineer could begin to work, and the great difference between the point bearing of a ball and the surface bearing of a collar or washer was not generally appreciated. In a great many cases, therefore, the early bearings were poorly designed and were made of materials which were not adapted for the purpose. Hence, they were often condemned by the user, and a general opinion was created that they were almost worthless; in fact, if the bicycle, which became so popular simply on account of the introduction of ball bearings, had not been a great factor in counteracting the hostile feeling, the adoption of ball and roller bearings in many fields would undoubtedly have been much slower. The automobile, the development of which followed immediately upon the bicycle, added to the favor with which ball bearings were received.

When ball bearings were first introduced, grinding machines were used to a very small extent, except as tool-room appliances. Hence, the bearing surfaces of the first ball bearings were simply polished, and the balls touched only on the "high spots," producing a bearing which did not work smoothly and which soon wore out of true. This also accounts for the unfavorable results obtained with early ball bearings.

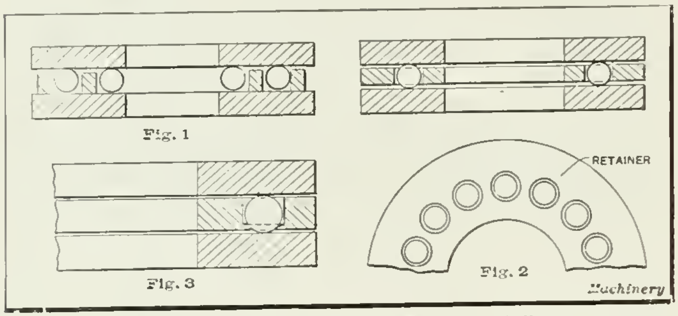
Fig. 1

Fig. 3

Fig. 2

Figs. 1 to 3. Evolution of the Ball Thrust Collar

Early Development of Ball Thrust Collars

The first and simplest ball bearing made was that known as the "thrust collar." In 1888, Simonds Rolling Machine Co. made a worm-driven machine and experienced considerable trouble with the end thrust of the worm. This company manufactured balls at that time and decided to try a ball thrust bearing for the worm. The thrust collar, as it was first made, consisted of two washers, with two rows of balls and two rings, as shown in Fig. 1. In assembling this bearing, the washer was first placed upon the shaft against the bearing collar or shoulder and then the small ring was placed on the washer, after which a row of balls was placed between the shaft and the ring. The second ring and row of balls were then placed upon the washer, after which the second washer was put on the top. The washers and balls had to be held together by one man while another man put the shaft in place. However, the bearings often came to grief by the balls falling out, and it was therefore suggested that a soft steel washer of the same diameter as the hardened bearing washers be drilled with holes slightly larger than the balls. This washer would then act as a retainer and keep the balls in place. Experiments were made and it was found that this method worked satisfactorily. This type of bearing is shown in Fig. 2.

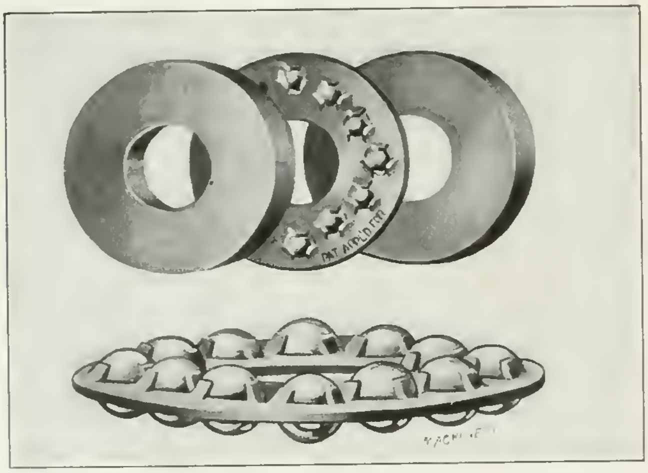

Fig. 4. Pressed Steel Ball Retainer of the Type made by the Pressed Steel Mfg. Co., Philadelphia, Pa.

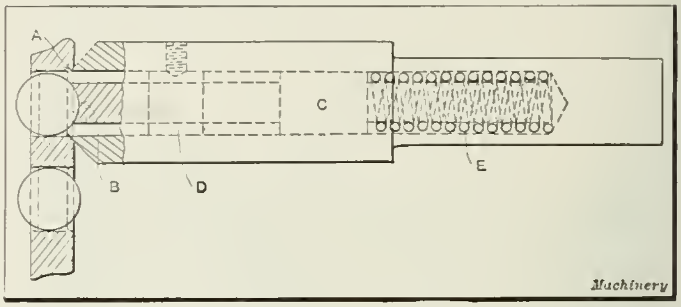

Fig. 5. Spinning Tool used in the Manufacture of Ball Cages

After this style of cage had been used for some time, a further improvement was made in that the holes in the cage were not drilled quite through, but as shown in Fig. 3, so that the balls could not fall through the retainer. This aided the assemblers in handling the balls in the cage without losing them. A groove would soon wear in the washers, however, and in order to cover as much of the surface of the washer as possible with the balls, the balls were later staggered in the cage so as to distribute the load and wear over a greater part of the washer surface.

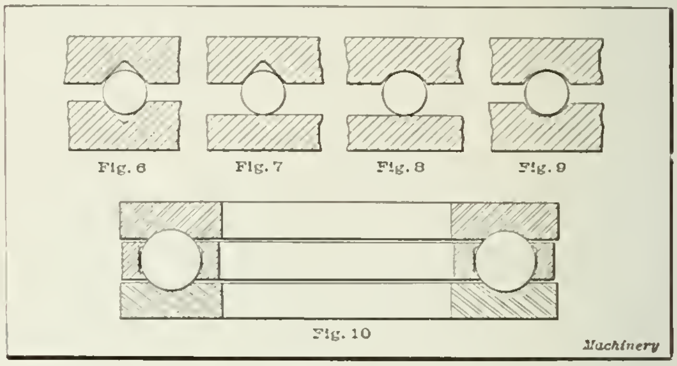
Fig. 6 Fig. 7 Fig. 8 Fig. 9

Fig. 10

Figs. 6 to 10. Different Types of Grooves for Balls

The Standard Roller Bearing Co. of Philadelphia made its first retainers by drilling holes in the periphery of the washer, and after the balls had been inserted in each hole, the edges of the holes were peened over at the outside. The drill, of course, was somewhat larger in diameter than the thickness of the washer, so that the balls could project on the sides of the retainer. The balls were thus arranged in a radial line from the center of the washer, but were not staggered, so that each row of balls took the same circular path. The generally adopted cage is now pressed out of sheet steel and the openings made of such a size that the balls can be sprung into them by a slight pressure. Such a cage is shown in Fig. 4. In special bearings the cage is made of brass and the holes are drilled the size of the balls. They are not drilled quite through, however, and after the balls have been inserted the holes are spun over with a tool of the type indicated in Fig. 5. The spinning edge *A* of this tool is hardened. The end of the plunger at *B* is concave so as to center the tool with the ball. At *C* is a shoulder on the plunger which is a sliding fit in the hole, thus keeping it straight; *D* is a collar held in place by a headless set-screw, which retains the plunger; *E* is a spring which presses the plunger forward and allows it to recede while in operation.

Thrust collar washers can be made either from bar stock in an automatic screw machine with a multiple cutting-off tool, or from punchings. The latter method is the preferable one, as the sheet steel is rolled lengthwise and the grain or fiber is so arranged that the point bearing of the ball does not come in contact with the ends of the fibers, as it does when the washers are cut in the automatic screw machine. The punched washers, therefore, have from 35 to 40 per cent better wearing qualities than the other type. The thrust collar is not used for heavy loads except in special cases, and the washers are, therefore, seldom made of tool steel, but of case-hardened machine steel. As the washers are perfectly plain, a number of them can be put at a time on a magnetic chuck and can easily be ground parallel so that all the balls will have a bearing and take their share of the load. Table I gives the loads and speeds recommended by the ball bearing manufacturers.

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* For information on ball and roller bearings, see the following articles previously published in MACHINERY: "Some Notes on Ball Bearings," May 1909, engineering edition, and also other articles there referred to. See also MACHINERY'S Reference Book No. 56, "Ball Bearings."

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Grooved Ball Thrust Bearings

The grooved ball thrust bearing can be made with grooves of different shapes, but the round groove is the only one to be recommended. In Fig. 6 is shown a thrust bearing with V-grooves. It is difficult to get the grooves in the two washers directly opposite each other so that there will be a perfect four-point bearing. Of course a sample bearing in the tool-room can be easily made to meet all requirements, but when the bearings are made in quantities, difficulties are met with. This, however, is not the greatest objection to this bearing. The main objection is that when the load is applied, the ball is squeezed into the V and prevented from turning freely. While the bearing is hardened, it is not glass hard, and it will allow the ball to seat itself so as to wear the bearing out of true in a short time.

TABLE I. GENERAL DIMENSIONS AND APPROXIMATE LOAD PER BEARING FOR REGULAR BALL THRUST BEARINGS

Diameter of Bearing, Inches		Diam. of Balls, Inches	Load in Pounds at					
Inside	Outside		1500 R.P.M.	1000 R.P.M.	500 R.P.M.	300 R.P.M.	150 R.P.M.	10 R.P.M.
$1\frac{1}{4}$	$2\frac{11}{32}$	$\frac{1}{4}$	350	500	600	750	800	2750
$1\frac{7}{16}$	$2\frac{15}{32}$	$\frac{1}{4}$	500	600	750	1000	1100	3750
$1\frac{5}{8}$	$2\frac{31}{32}$	$\frac{5}{16}$	600	750	850	1100	1350	4000
$1\frac{3}{4}$	$3\frac{3}{32}$	$\frac{5}{16}$	750	850	1000	1350	1750	5000
2	$3\frac{11}{32}$	$\frac{5}{16}$	850	1000	1250	1600	2000	5500
$2\frac{1}{8}$	$3\frac{19}{32}$	$\frac{5}{16}$	1000	1250	1500	1850	2500	7000
$2\frac{1}{4}$	$3\frac{23}{32}$	$\frac{5}{16}$	1100	1350	1750	2100	2750	7500
$2\frac{1}{2}$	$3\frac{31}{32}$	$\frac{5}{16}$	1250	1600	2000	2500	3000	9500
$2\frac{5}{8}$	$4\frac{11}{32}$	$\frac{3}{8}$	1500	1750	2250	2750	3500	10000
$2\frac{3}{4}$	$4\frac{15}{32}$	$\frac{3}{8}$	1750	2000	2750	3000	4200	12500
$3\frac{1}{4}$	$4\frac{31}{32}$	$\frac{3}{8}$	2100	2350	3200	3750	5000	15000
$3\frac{1}{2}$	$5\frac{7}{32}$	$\frac{3}{8}$	2500	2850	4000	4750	6000	17500

In the three-point bearing, Fig. 7, where there is one V and one flat surface, the objections to the V groove are the same as already mentioned, and the flat surface does not allow a greater load to be carried than that which can be carried by a plain thrust collar. Hence, this bearing is not superior to a regular thrust collar ball bearing, but is more difficult to make; nor is a bearing having one plain and one grooved washer as shown in Fig. 8 superior to a thrust collar. In Fig. 9 is shown the regular grooved ball thrust bearing in its simplest form. The radius of the groove is made from five to ten per cent greater than that of the ball used in the bearing. This allows some latitude for the washers so that they can line up properly. It can be readily seen that when the load increases on the ball, the surface bearing between the ball and the washer will become slightly greater on account of the fact that the radius of the groove is slightly larger than that of the ball. Theoretically, there is only a point contact when there is no load, but as the load gradually increases this point contact will become a surface contact over a gradually increasing length of the ball circumference.

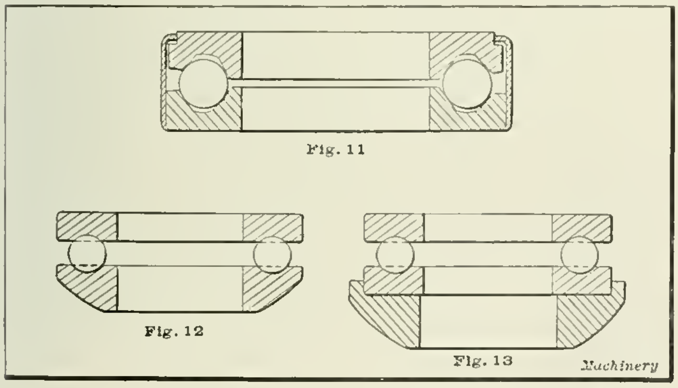
Fig. 11

Fig. 12

Fig. 13

Fig 11. Ball Grooves with Different Angles on the Sides. Figs. 12 and 13. Thrust Bearings with Leveling Washers

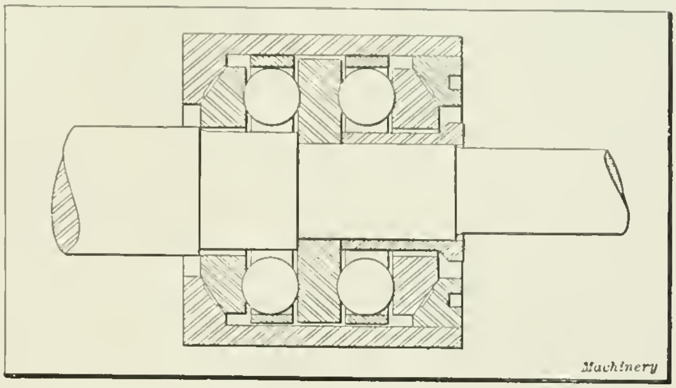

Fig. 14. A Ball Bearing taking Thrust in Both Directions

This makes it possible for the bearing to stand up under heavy loads. But it is difficult to make both grooves bear equally upon the balls unless the bearings are made in a very careful way.

Grooved thrust bearings require the use of a separator the same as the thrust collar. In Fig 10 is shown the simplest form of retainer for this purpose. When the grooves in the washers are made very deep, the retainers must be made rather thin.

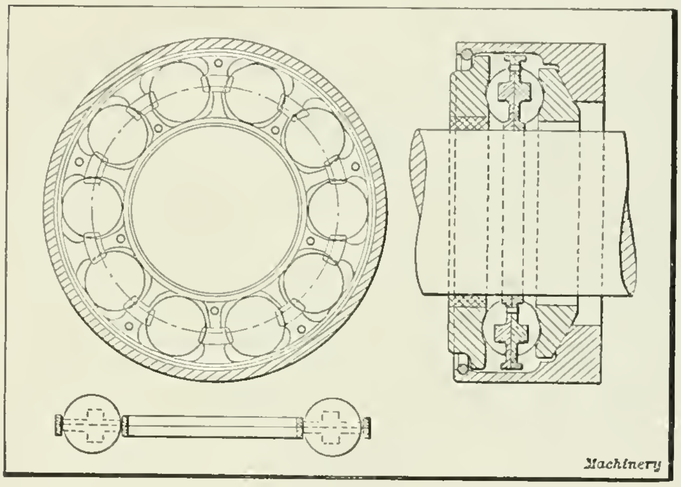

Fig. 15. Skeleton Cage for Ball Bearings

In order to overcome the slippage caused in the V-grooves on account of the inside bearing of the ball running slower than the outside, the Auburn Ball Bearing Co. makes a bearing in which the angle of the V is greater on one side than on the other, as shown in Fig. 11. This prevents slippage of the ball, but it does not overcome the squeezing effects of heavy loads. Nevertheless, this bearing has given satisfaction in light and mediumly heavy service.

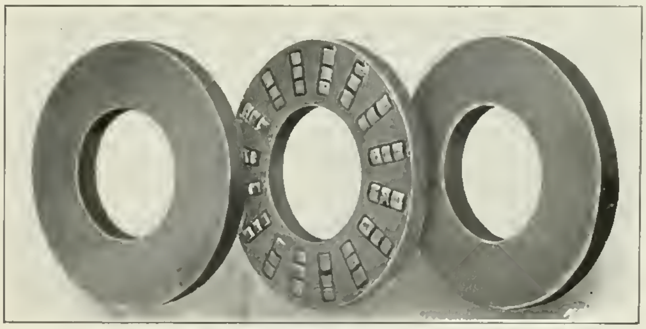
Fig. 16. Simple Form of Roller Bearing

Applications of Ball Thrust Bearings

For convenience in assembling and handling ball bearings, the self-contained thrust bearing is the most satisfactory. It is necessary to have the surfaces against which the bearing rests perfectly parallel with each other. Many bearings do not give satisfaction on account of the poor methods employed in their application to the machinery on which they are to be used. In order to overcome the results of neglect on the part of the user, leveling washers are often provided on one side of the bearing to take care of any lack in alignment and insure that the entire surface of the thrust washers will take its proportion of the load. This method prevents breakage and should be universally adopted. It adds but little to the cost of the bearing and saves the user much trouble.

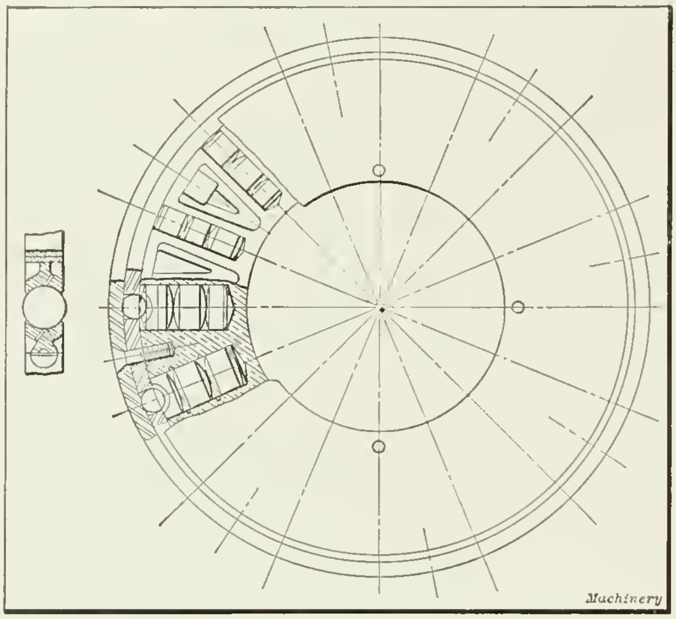

Fig. 17. Means for Taking Care of End Thrust of Rollers in Roller Thrust Bearings

The leveling washer, sometimes termed "radius washer," is made in two ways. In Fig. 12 it is made integral with the lower thrust bearing washer. This is done when the space for the bearing is limited. A corresponding concave surface must, of course, be provided in the housing or part which holds the thrust bearing. If there is plenty of space for the bearing, it is cheaper to use a standard grooved thrust bearing and a leveling washer with a slight recess beneath the lower bearing washer, as shown in Fig. 13.

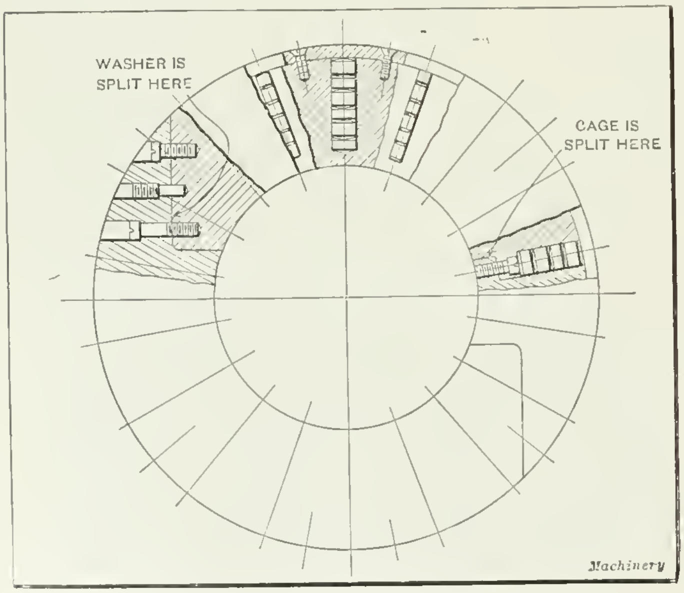

Fig. 18. Plain Roller Thrust Bearing made in Halves

In cases where it is necessary to take thrusts both ways, it is essential to use three washers, the central washer having grooves on both sides and the housing being made with a concave surface at the bottom and having a threaded concave nut at the top, as indicated in Fig. 14, which shows a bearing of very compact design. In high-speed bearings the weight of the cage is often objectionable, and a skeleton cage, as illustrated in Fig. 15, is employed. This cage is made in two sections, riveted together, and the only surfaces that are finished are those on which the balls and the shaft bear.

Roller Thrust Bearings

The principle of the roller thrust bearing, as shown in Fig. 16, is not theoretically correct, as apparently the rollers must slip to a certain extent. The outer and inner ends of the cylindrical roller roll along paths of different circumferences, and, hence, there cannot be a perfect rolling action. In fact, the rollers follow the path of a polygon with a great number of sides and a slight slippage takes place each time the roller changes its course. From a practical point of view, however, this bearing has proved a great success. Fig. 16 shows the simplest form of plain roller thrust bearing. The rollers are straight and cut into short sections so that they will turn readily. A bearing of this type will sustain loads from four to eight times greater than that carried by a ball thrust bearing of the same dimensions. The slippage that takes place as the rollers change their course in short, jerky movements around the circular path, has proved an advantage in that it partly takes care of the outward thrust caused by the centrifugal force. In large thrust bearings this outward thrust is very great and must be taken care of in other ways besides this.

One of the greatest advantages of this bearing is its simplicity, and the ease with which it can be manufactured. The washers and rollers can be readily ground. A high degree of accuracy is also possible as all parts can be easily measured. The type of bearing shown in Fig. 16 is made by drilling holes into the periphery of the washer at equal distances around the circumference. The rollers are then inserted, allowing them to project a trifle beyond the sides of the washer; an annular ring or band is then forced onto the washer and is drilled and riveted in place.

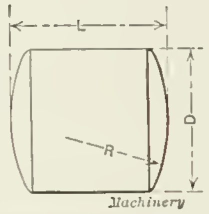

TABLE II. DIMENSIONS OF ROLLERS FOR ROLLER THRUST BEARINGS

Long Type			Short Type		
Diam. D	Length L	Radius R	Diam. D	Length L	Radius R
1/8	3/32	3/16	1/8	1/16	1/2
5/32	7/64	3/16	5/32	5/64	1/2
3/16	9/64	3/16	3/16	3/32	1/2
1/4	3/16	3/8	1/4	1/8	1
5/16	15/64	3/8	5/16	5/32	1
3/8	9/32	3/8	3/8	3/16	1
7/16	21/64	5/8	7/16	7/32	2
1/2	3/8	5/8	1/2	1/4	2
5/8	15/32	5/8	5/8	5/16	2
3/4	9/16	1	3/4	3/8	3
7/8	21/32	1	7/8	7/16	3
1	3/4	1	1	1/2	3
1 1/8	13/16	2	1 1/8	9/16	4
1 1/4	7/8	2	1 1/4	5/8	4
1 1/2	1	2	1 1/2	3/4	4
1 3/4	1 1/8	3	1 3/4	7/8	5
2	1 1/4	3	2	1	5

The cages, of course, can be made in a great number of different ways. One company makes the slots the full size of the roller and then peens over the sides to retain the rollers. Another company used to make their cages by broaching rectangular holes through the washers and then staking them over to prevent the falling out of the rollers. In all the early types of ball bearings the rollers were all the same length, thereby allowing the roller to cut a path into the washer. To overcome this difficulty two widths of rollers were made, as shown in Table II. It will be noticed that the rollers are rounded on the ends so as to reduce the friction between them. The corners are also slightly rounded so as to prevent crumbling or chipping, which is apt to occur on account of the slippage of the rollers. With these two different lengths of rollers put into the cage alternately, the whole surface of the washer can be covered.

In fast running roller thrust bearings, it is necessary to take care of the outward thrust of the rollers by placing a ball at the end of the rollers to take the thrust, as shown in Fig. 17. Two bands are placed on the outside of the cage instead of only one; the first band is a soft steel ring and the second is hardened to take the thrusts. The outside roller in each pocket is countersunk to receive the ball. In Fig. 17 is also shown a small section of the cage indicating its skeleton form in order to provide for a light construction. In high-speed horizontal bearings of this class a small thrust bearing is often used to carry the cage. In slower running bearings there is usually a small shoulder on the cage upon which it revolves. Large roller thrust bearings of this class can seldom be used without leveling washers, as already described in connection with ball thrust bearings.

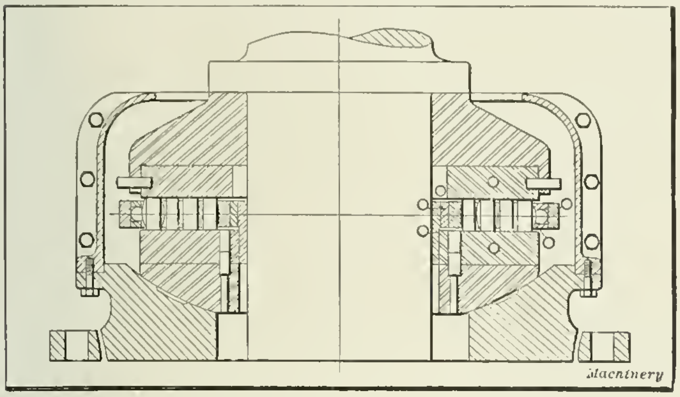

Fig. 19. A Complete Design of Roller Thrust Bearing

The ordinary form of bearing is made solid, but some are made in halves with all the joints accurately ground, and if properly designed will give as good service as those made from solid plates. The splitting, as shown in Fig. 18, is done in such a way that the rollers pass over the joint at an angle. Bearings made in this way are somewhat more expensive than solid bearings, but are especially desirable in cases where it may become necessary to remove them from the shaft without removing other parts.

Fig. 19 shows a roller thrust bearing with a leveling washer. The bearing washers are made reversible in case of wear. A complete housing is used so that the whole bearing can be run in oil; at the same time the bearing can be easily taken apart, if necessary. The upper washer is held from the outside so as to prevent wear on the shaft. The housing, which is concaved to receive the bottom or leveling washer, is recessed at this joint so as to reduce the bearing surface. This is an example of a compact roller thrust bearing.

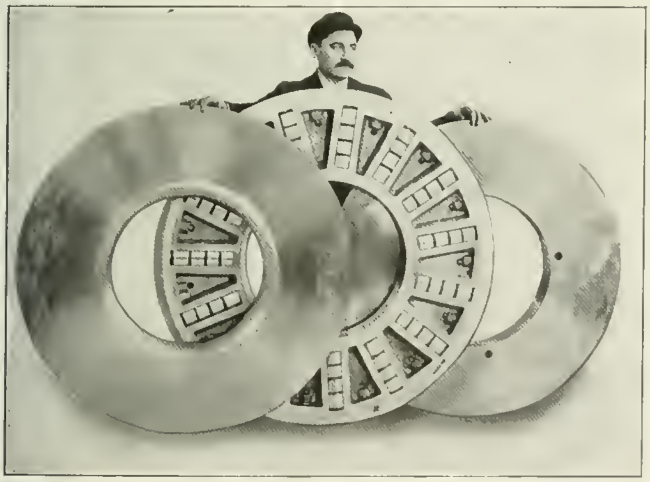

Fig. 20. Example of Unusually Large Roller Thrust Bearing

As an example of what has been done in large roller thrust bearings, that in Fig. 20 is shown. This is probably the largest bearing of this type ever made and it is installed at the Carnegie Steel Works. This bearing is capable of carrying a load of 1,500,000 pounds running at a speed of 100 R. P. M. The machine upon which this thrust bearing is used is designed for making steel car wheels by hydraulic pressure. The diameter of the washer of this bearing is 46 inches and the cage diameter, 50 inches. The washers, made from chrome-nickel steel, are 3½ inches thick and weigh nearly 1700 pounds. The cage is made in skeleton form from manganese bronze and is provided with 4-inch chrome-nickel steel rollers. At the end of each set of rollers a large ball is placed to take the outward thrusts, as shown in Fig. 17. These rollers were made from a bar, four at a time, and were not cut entirely apart but simply "necked" so that they would hold together during the hardening process. They were then ground to the same diameter and broken apart and oil grooves ground in the face so as to prevent their cutting the washers. Oil holes were also drilled at the bottom of the recess in the cage from the bore to the pockets which hold the rollers. The pockets in the cage were carefully bored so that the rollers would have a running fit.

For hardening these thrust washers, a track was provided in the furnace, the door of which was made level with the floor, and a truck was made with a table on ball bearings; then a hole was cut in the side of the furnace so that the table could be revolved from the outside. The washers were allowed to heat for ten hours and the table was revolved at certain intervals to insure that they would be uniformly heated. In order to avoid confusion, the men in the hardening room had been previously drilled in removing the washer from the furnace to the hardening tank which was twenty-five feet long, four feet wide and ten feet deep. There was a track overhead with a pneumatic hoist and two ropes were attached to the hook so that the washer could be pulled back and forth in the water. Seventeen seconds was required for the first washer hardened, from the time it left the furnace until the time it was submerged in the water. It was then raised and lowered by one man while two other men pulled it back and forth in the tank. After the washer was perfectly cold, it was placed in an oil tank over night and upon inspection was found to be perfectly hard. It had warped only about 0.020 inch.

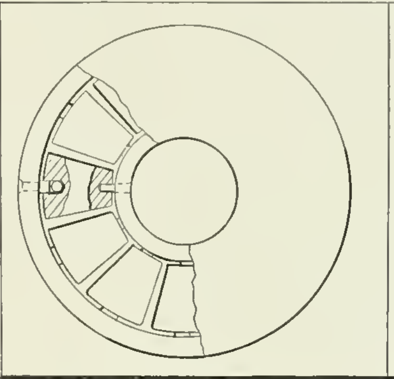

Fig. 21. Tapered Roller Thrust Bearing

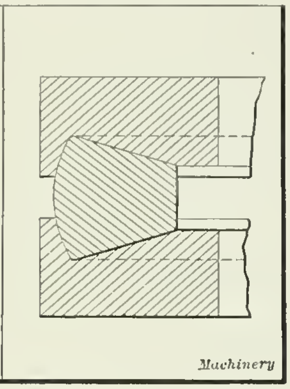

Fig. 22. Method of taking the End Thrust in a Tapered Roller Thrust Bearing

Tapered Rollers in Thrust Bearings

It would seem upon first consideration as if it would be better to use a tapered roller rather than a cylindrical one in a thrust bearing of the type described, in order that a perfect rolling action might be insured. Bearings provided with tapered rollers, however, have not, as far as the writer knows, proved successful, except in very rare cases where the load has been light, or, if the load has been heavy, where the speed has been very slow. The difficulty to be overcome with the tapered roller is the great outward thrust. Several methods have been used to overcome this difficulty. In Fig. 21 is shown a tapered roller thrust bearing with a hardened pin driven into the cage ring and a hole drilled into the end of the roller in which a ball is inserted. This would prove quite successful if every roller were of exactly the same diameter and could be drilled to the same depth, and if all the balls and pins were exactly alike, but, if they are not, the rollers nearest to the center will bear all of the load until some of the parts wear so as to bring the other rollers into action. The rollers must also all be of exactly the same angle, and, hence, a bearing of this type presents many practical difficulties in its manufacture.

Fig. 22 shows another method by means of which the end thrust of the rollers can be taken care of—that is, by having the washers extend over the ends of the rollers. This, however, is not a practical method for high-speed bearings, as it does not give the roller freedom of action. In cheap bearings, however, this method has proved quite successful. A great many different schemes have been evolved for this class of bearing, such as placing set-screws in the cage ring so that each roller could be adjusted to take its share of the load, etc. Methods of this kind may have worked well for a short time, but as the readjustment has to be done by an expert, the bearings have been considered impracticable for regular use.

* * *

BRITISH ENGINEERING STANDARDS COMMITTEE

In a report by Consul General John L. Griffiths of London, England, a brief history of the British Engineering-Standards committee is given.

The committee was originally appointed in January, 1901, by the council of the Institution of Civil Engineers, to consider the advisability of standardizing various kinds of iron and steel sections. It was then composed of seven members, and the first meeting was held in February, 1901, when it was decided to approach the councils of the Institutions of Mechanical Engineers, Naval Architects, and of the Iron and Steel Institute in order to secure, if possible, their cooperation. These invitations were accepted, and the reorganized committee began work in April, 1901. In November of the same year it was suggested that the standardization of electrical plants should be undertaken, with the result that the Institution of Electrical Engineers was also invited to nominate members of the committee, and in June, 1902, the committee was enlarged.

The work as originally undertaken has thus from time to time been expanded, and numerous subjects have been considered. Some idea of their diversity may be suggested by an enumeration of the several sectional committees. They are: Main; finance; publication and calculations; sections and tests for materials used in the construction of ships and their machinery; steel castings and forgings for marine work; iron for shipbuilding and ships' cables; bridges and building construction; railway rolling-stock under frames and locomotives, with subcommittees on component parts and types, tires, axles, and springs, steel plates, copper and its alloys, iron for railway rolling stock, railway rails, tramway rails, tire profiles, screw threads and limit gages, automobile threads, and also on small screws and screw heads, rolled and drawn sections, keys and keyways, pipe flanges, cement, vitrified-ware pipe, cast-iron pipes for hydraulic power, water, gas, and sewage, heating, ventilating, and house drainage, and for electrical purposes; electrical plant with subcommittees on generators, motors, and transformers, prime movers, physical standards, telegraphs and telephones, cables, electric tramways, and electrical plant accessories. The main committee, with the sectional and subcommittees, now has a membership of 321.

The various original standard specifications are carefully revised from time to time in order to keep abreast with new inventions and improvements. It is pointed out, on behalf of the committee, that perhaps its most salient feature is the advantage which accrues to Great Britain in that it possesses a central organization from which information may readily be obtained, both as to standards and as to the causes that led to their adoption.

Some fifty-seven reports on various subjects have been published and may be secured at prices ranging from 60 cents to $5.10 each. A minimum subscription of $51.10 entitles the subscriber to a copy of each report as published and of each revised report and to information two or three times a year concerning the various subjects dealt with by the committee and early information of any revisions in hand.

Steps have been taken for holding at an early date—probably in London—a conference on international electrical standardization.

NATURAL ALLOY STEEL[*]

By E. F. LAKE[†]

Natural alloy steel is rapidly becoming prominent in the manufacturing field. It derives its name from the fact that the steel is manufactured from an ore in which nickel and chromium are alloyed by nature. While such ores have been known to exist for some time, it is only within the last decade that ores were discovered that had a uniform composition and existed in quantities sufficiently large to warrant their manufacture into steel.

Shortly after the Spanish-American War, such ore was discovered at Mayari and Moa in the Province of Oriente, in the eastern part of Cuba. These ores showed a remarkable uniformity of composition and covered some 25,000 acres on a plateau on the northern slope of a mountain range. In this place there is something like 1,000,000,000 tons of ore in sight, low in phosphorus and sulphur. The Pennsylvania Steel Co., Steelton, Pa., obtained the control of these ore beds and is, besides the Maryland Steel Co. of Sparrows Point, Md., the only company manufacturing steel billets, blooms, bars, and miscellaneous forgings from the ore. The steel made by the Pennsylvania Steel Co. is known by the trade name "Mayari steel." Other companies purchase the billets, bars, etc., and roll and forge them into commercial shapes. The Philadelphia Steel & Forge Co., Philadelphia, Pa., is one of these firms and it has given the product the trade name "natural alloy steel," while the Carpenter Steel Co., Reading, Pa., calls it "Samson steel." Both of these latter firms make a specialty of rolling and forging shapes suitable for automobile parts, but they also manufacture the steel into bars and shapes that can be used for die-blocks, spindles, tools, and numerous other purposes.

Composition

The various grades of steel into which this ore is manufactured contain from 1.00 to 1.50 per cent of nickel; from 0.20 to 0.70 per cent of chromium; and from 0.30 to 1.50 per cent of carbon; the manganese runs from 0.50 to 0.80 per cent; while the silicon is kept below 0.20 per cent and the phosphorus and sulphur below 0.04 per cent. These two latter elements, however, seldom reach 0.035 per cent, and a phosphorus content that is below 0.02 per cent is often obtained. The commercial stock is manufactured into two types, one of which contains between 0.20 and 0.40 per cent of chromium, and the other between 0.40 and 0.70 per cent. Both of these can be obtained in any of the following carbon percentages: 0.15, 0.20, 0.25, 0.30, 0.35, 0.40, 0.45 and 0.50 per cent. Another brand that is used to a large extent for leaf springs, and also for other purposes, contains from 0.90 to 1.50 per cent of carbon and between 0.20 and 0.40 per cent of manganese, which is in accordance with the spring steel specifications of the Pennsylvania Railroad Co. Titanium, vanadium and other purifying materials can be added to the steel if it is so desired, and thus further enhance the physical properties.

These natural alloy steels are carefully made by the open-hearth process and are, in the heat-treated condition, in every way the equal to 3½ per cent nickel steel. In some ways they are superior to this steel and especially is this so of the type that contains the higher percentages of chromium, or when they are manufactured into parts that have a comparatively large sectional area. They are also cheaper than the nickel steels made by the same process, and in the billet form they are but little higher than the ordinary carbon steels. The high-grade and high-priced nickel-chrome steels are the only ones that are superior to the natural alloy steels in static strength, and this is largely due to the fact that they are usually made by the crucible process and contain a higher percentage of chromium, this being approximately 1.00 and 1.50 per cent in the two best brands.

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[*] The following articles on alloy steels and kindred subjects have previously been published in MACHINERY: September, 1911, engineering edition, "Titanium Steel," and "Composition and Heat Treatment of Carbon and Alloy Steels"; May, 1911, engineering edition, "The Properties of Vanadium Steel;" April, 1911, engineering edition, "Manganese Steel"; October, 1909, "Heat Treatment of Alloy Steel"; June, 1909, "Remarkable Physical Characteristics of Rolled Manganese Steel Rails"; May, 1909, "The Machining of Manganese Steel"; October, 1907, engineering edition, "Vanadium Steel"; September, 1907, "Nickel Steel." See also the note referring to other articles, published in connection with that last mentioned.

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Properties of Natural Alloy Steels

For comparing the static strength, a large number of tests were made with natural alloy, nickel and carbon steels that contained 0.40 per cent of carbon and were hardened at the critical point and then drawn at various temperatures between 500 and 1500 degrees F. The average results obtained from these three kinds of steels are shown in Fig. 1. The steels compared all contain 0.40 per cent carbon. The natural alloy steel was quenched at 1520 degrees F.; the 3½ per cent nickel steel at 1500 degrees F.; and the carbon steel at 1530 degrees F. The average strength of each steel at a given drawing temperature can be obtained by following the line indicated by the desired number of degrees downward, until it meets the curve of the tensile strength, elastic limit, elongation or contraction, according to which is to be found, and from this point following the horizontal line to the left, where the number of pounds per square inch, or the percentage, is recorded. In Table I are shown the average elastic limit and ultimate strength of the fiber stress as ascertained in some torsional tests made at the Pennsylvania State College. All heat-treated specimens were hardened and drawn to develop the best properties for driving shafts, axles, etc.

Much care has to be used in manufacturing the ordinary nickel or nickel-chrome steels to prevent either of these elements from segregating in the bath or when teeming it into ingots. This is largely due to the fact that the nickel and chromium are additions and the bath must be heated to a comparatively high temperature just before teeming. In the natural alloy steel, however, the nickel and chromium are alloyed in the ore and are present in the bath from the time the melting operation starts until the finished steel is poured into ingots. Hence the bath does not have to be heated to any higher temperature at the time of tapping than do ordinary steels, and any tendency towards segregation is largely overcome. Thus, the elements are more uniformly distributed throughout the mass, and a homogeneous metal is obtained. When such elements segregate and the steel is rolled, they produce laminations in the metal which have a very injurious effect upon its strength, especially at right angles to the direction in which they are rolled.

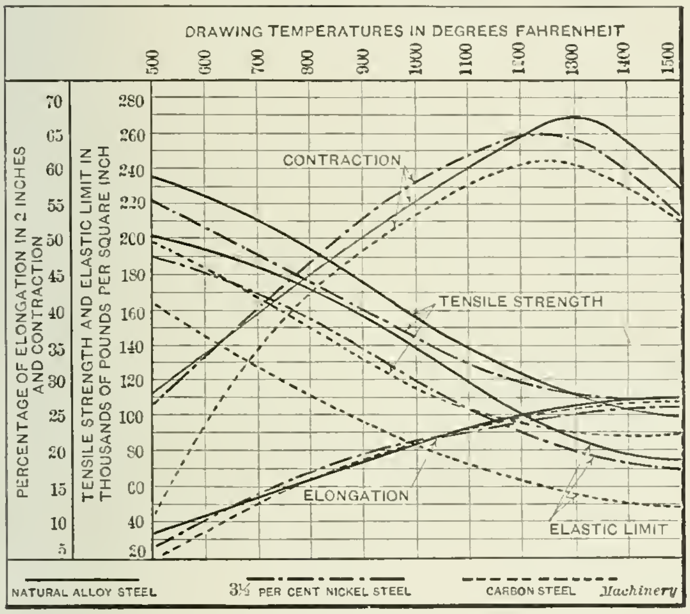

Fig. 1. Comparison of Characteristics of Natural Alloy, Nickel and Carbon Steels

The chromium gives the steel a mineral hardness and refines the grain remarkably, owing to its tendency to prevent the development of a crystalline structure. In the annealed state, every increase of chromium up to a content of 6.50 per cent raises the tensile strength, while the elastic limit is gradually raised until a chromium content of 3.00 per cent is reached. This latter remains constant until the chromium content has passed 9 per cent, but after this a rapid reduction takes place. In the hardened steels, both the tensile strength and the elastic limit increase until a chromium percentage of 5.00 per cent has been reached, and beyond this point both gradually decline.

When 2.00 per cent of chromium has been added to a steel that has a carbon content between 0.75 and 1.50 per cent, it combines great hardness with ability to resist shock. It is one of the best materials for piercing armor plate, and is also used in making projectiles. A chromium content of 3.50 per cent in a tool steel that contains 8.25 per cent of tungsten, gives the steel the well-known property of red hardness; that is, the hardness is not drawn and the cutting edge is maintained when using the tool at a red heat. A high percentage of chromium is also added to a steel that is forged between layers of wrought iron or soft steel and hardened in water. This is used in safes, vaults, etc., to make them burglar proof, and is also used for ploughshares and similar work.

TABLE I. AVERAGE FIBER STRESS IN POUNDS PER SQUARE INCH OF TORSIONAL TESTS MADE AT PENNSYLVANIA STATE COLLEGE

Kind of Steel		Natural Alloy Steel	3½ % Nickel Steel	Carbon Steel
Annealed	Elastic Limit	41,500	40,800	32,500
	Ultimate	93,400	78,200	75,100
Heat-treated	Elastic Limit	93,600	76,400	60,500
	Ultimate	130,200	108,000	102,400

Extreme hardness may be obtained in chromium steels, as the chromium intensifies the sensitiveness of the metal to quenching and greatly reduces the liability to fracture that is found in carbon steels. This is due to the fact that in chromium steels the critical changes that take place when heating all steels to the hardening temperature take place more slowly. Chromium is also one of the best elements in a steel that is to be carbonized or casehardened, as it greatly increases the susceptibility of steel to heat-treatment and acts as a carrier of the carbon. Thus, in steels containing chromium, the carbon will penetrate to a much greater depth, and a higher percentage will be absorbed by the outer layer in a given time, than with any other kind of steel, especially carbon steel. The increase in depth of penetration of carbon is about 30 per cent of the penetration in ordinary carbon steels.

The extreme hardness produced by chromium makes it necessary to use comparatively small percentages in steels that are to be machined. When the chromium content reaches 2.00 per cent, the steel is very difficult to cut when cold, and when higher percentages are used, the steel cannot be cut with any kind of cutting tools and must be ground to shape, this latter being an expensive method to pursue. Thus, in the high-grade nickel-chrome steels that are to be manufactured into parts of machines or instruments, the chromium is usually at or below 1.50 per cent. Owing to the difficulty of working even this steel, however, many grades of steel have been made with a chromium content of 0.25, 0.50 and 0.75 per cent, and it is for these grades that the natural alloy steel can be used.

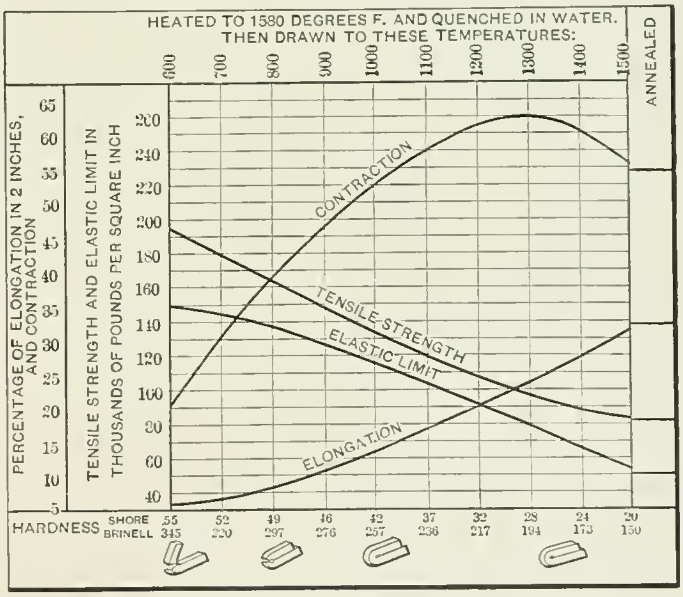

Fig. 2. Physical Properties of 0.20 Per Cent Carbon Natural Alloy Steel

In steel, the chromium gives the metal a hardness similar to that given by carbon, but to a lesser degree for the same percentage. It is a hardness, however, that makes the cohesion of the molecules much greater and thus greatly increases the static and dynamic properties. Chromium also greatly retards the formation of any grain or fiber, and thus makes the steel practically grainless. All of these effects of chromium upon steel cause it to increase its tensile strength, elastic limit, hardness, resistance to torsion, shocks, vibrations, or other stresses, and also increase its wearing qualities and prolong its life.

Influence of Nickel

Nickel increases the ductility, toughness and resiliency of steel, and also increases its susceptibility to heat-treatment. It reduces the size of the crystalline structure and microscopic cracks that are liable to develop into large cracks and produce ruptures. It was first added to steel to overcome the property of "sudden rupture" which is inherent in all carbon steels. It reduces the tendency of steels to become damaged by overheating in hardening, and shows its effect in the hardening operations by making the tensile strength and elastic limit two and three times that of the un-treated, or annealed steel. Nickel raises the elastic ratio in steels, *i. e.*, the elastic limit is raised to a higher percentage of the tensile strength. This condition is always sought for in the better grades of steel.

The tensile strength is rapidly increased with each increase in the percentage of nickel until a content of about 8 per cent has been reached. From that point to 15 per cent it makes the steel so brittle that it can be powdered under a hand-hammer, but after 15 per cent has been passed, the tensile strength returns, but not to quite as high a figure as is reached with an 8 per cent content. The elastic limit also continues to rise until 8 per cent has been reached and after the zone of brittleness has been passed, it again returns, but in a much smaller ratio than the tensile strength. From 20 per cent of nickel, upwards, the elastic limit cannot be made much greater than that of steels that do not contain nickel.

The elongation shows a slight rise until about 3 per cent of nickel is added to the steel, and after that it shows a rapid decrease, until the zone of brittleness is reached, when it becomes nil. With from 20 to 25 per cent nickel, the elongation again rapidly rises and from that point to 100 per cent it shows a slight increase. The best results, therefore, in steels that are used for machine parts, are obtained with a nickel content of 3½ per cent, although for some purposes 5 per cent nickel steel is used at a sacrifice of the elongation.

The two above elements in natural alloy steel, therefore, greatly enhances the value of this material for the various parts of machinery that are submitted to severe stresses. These steels also resist corrosion much better than other steels, the sulphuric acid test showing that they corrode from 10 to 20 per cent less than the low carbon and manganese, basic and open-hearth metals with nearly all of the impurities removed, and which have been given such names as "pure ingot iron," "old-fashioned iron," "toncan metal," etc. While there are some that doubt whether this test agrees with the actual weather conditions, it is generally conceded that steels containing nickel, corrode less rapidly than carbon steels and wrought iron.

Working Alloy Steels

Natural alloy steel can be hammered, rolled, drop-forged, pressed, stamped, or machined with the same ease and at the same temperatures as carbon steel; no special precautions are necessary. The high-grade nickel-chrome steel, however, must be heated to a white heat before being hammered, rolled, or drop-forged. The high temperature must also be maintained during this mechanical working, and if it falls very much, the steel must be reheated. Nickel steels must also be carefully handled when thus working them, and hence it will be seen that natural alloy steel is more cheaply worked into shape than other alloy steels. Natural alloy steel is similar to other alloy steels, however, in that it is very difficult to weld by ordinary methods; parts that are to be submitted to great strains should not be welded together. Like other alloy steels it can be welded with more or less success by the various electric welding processes and machines that are on the market. The electric machines that squeeze the parts together are preferable, as these prevent the grain from becoming coarse, as it does when other methods are used. If the steel is hammered after welding, this will aid in refining the grain that has become coarse at the weld. By careful workmanship with the electric process it is often possible to obtain from 70 to 80 per cent efficiency at the weld, whereas an efficiency of between 30 and 40 per cent is all that can be obtained by ordinary welding methods.

Natural alloy steels, like all other steels, will attain the highest strength only when properly heat-treated. In the untreated or annealed state, they show a tensile strength and elastic limit that is from 8000 to 10,000 pounds per square inch higher than carbon steels of the same carbon content, but when properly heat-treated they compare favorably with other alloy steels. Some figures that were obtained from annealed and heat-treated forgings are given in Table II.

TABLE II. EFFECT OF HEAT-TREATMENT ON FORGINGS OF NATURAL ALLOY STEELS

Per Cent of Carbon	Annealed				Heated to 1550 F. and Quenched in Water											
					Tempered at 1050 F.				Tempered at 1000 F.				Tempered at 600 F.			
	Pounds per Sq. Inch		Per Cent		Pounds per Sq. Inch		Per Cent		Pounds per Sq. Inch		Per Cent		Pounds per Sq. Inch		Per Cent	
	Tensile Strength	Elastic Limit	Elongation	Contraction	Tensile Strength	Elastic Limit	Elongation	Contraction	Tensile Strength	Elastic Limit	Elongation	Contraction	Tensile Strength	Elastic Limit	Elongation	Contraction
0.30	89,500	57,500	28.0	51.9	106,500	76,000	21.0	51.9	131,000	114.000	17.5	51.9	193,000	177,000	8.5	30.7
0.40	88,500	56,000	29.0	51.9	112,500	83,000	23.0	59.8	130,500	118,500	18.5	51.9	209,000	188,000	10.5	37.1
0.50	119,500	68,000	18.0	37.1	135,000	107,000	16.5	46.2	155.000	138.500	14.0	43.0	252,000	232,000	7.0	24.0

Heat-treatment

The heat-treatment is practically the same as that given other steels. The hardening temperature may vary somewhat, but not to any great extent. The brands containing from 0.15 to 0.20 per cent carbon should be heated to 1500 degrees F. and quenched in brine to obtain the best results. Those with a carbon content between 0.30 and 0.50 per cent should be heated to 1550 degrees F. They can then be quenched in water as readily as carbon steels, although oil and special liquid compositions can be used for the quenching bath with equally good results. The temperature at which they are afterwards drawn, of course, varies with the kind of work that the finished piece would be called upon to perform.

When hardening steel, a cold piece should never be put in a highly heated furnace, as it is liable to crack. It should either be preheated to above 600 degrees F., or it should be put in a cold furnace and heated up slowly. It should soak in the heat at the hardening temperature long enough for the piece to heat clear to its center. The work should never lie directly on the hearth of the furnace, but should be raised sufficiently to allow the heat to attack it from all sides, and it should be supported in a way that will not allow it to sag, as hot steel is soft and pliable and likely to bend. The axis of the piece should be vertical when plunging it into the quenching bath to prevent unequal contraction in cooling. The work should never have sharp grooves, corners, or other features, that easily develop cracks when the steel is heated and quenched.

In drawing steel, a furnace should never be used that is hotter than the drawing temperature. It is difficult to judge the temperature that the work has attained in such a furnace and get within 50 degrees of the desired results. If the piece attains too high a temperature, it will be softer than that required, and if the drawing is too low, it will not be soft enough. With a tempering furnace held at the correct temperature, the work can be allowed to remain in it until it has absorbed the heat of the furnace and then accurate results can be obtained. A difference of 50 degrees in the drawing temperature is of much more importance than 50 degrees in the hardening temperature, and it is more difficult to estimate.

Casehardening

Carbonizing or casehardening can be performed in any of the various ways that are now used for other steels. Pieces can be heated to a red heat and quenched in cyanide to give them a depth of casehardened surface of a few hundredths of an inch; or they can be packed in iron boxes with bone and charcoal, or other carbonizing materials, and then heated in furnaces for a time that is sufficient to give them a greater depth of penetration. Where the output would warrant it, however, the special furnaces that have been designed for carbonizing with gas would probably give the most uniform results, if the work is properly done. This is also the cheaper method when large quantities are worked or handled.

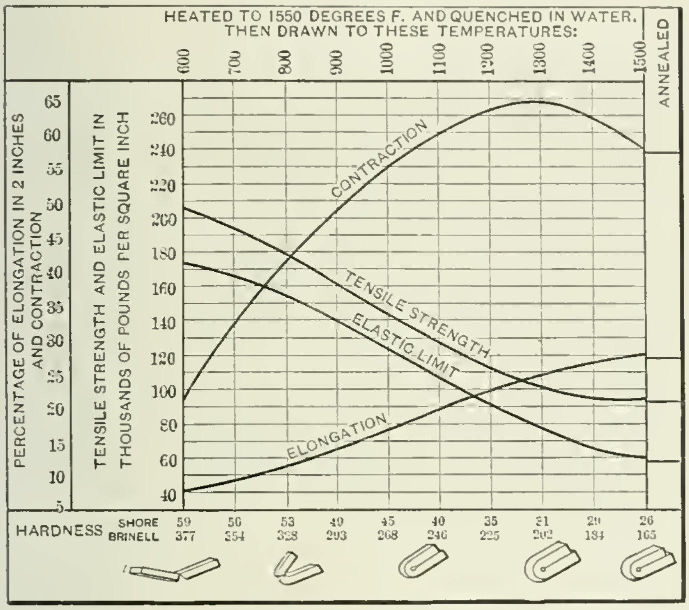

Fig. 3. Physical Properties of 0.30 Per Cent Carbon Natural Alloy Steel

In any case, however, the carbonizing mixtures should not contain over 15 per cent of moisture or 0.50 per cent sulphur. Moisture might cause a pitting of the steel which is liable to cause it to chip on the surface, while the sulphur soaks into the casehardened shell to a considerable extent. A carbonizing temperature of from 1750 to 1800 degrees F. can be used, and this will probably give the most rapid absorption and most uniform composition of the case. The time the steel is submitted to this temperature depends upon the depth of carbonized case desired.

After carbonizing, the work should be allowed to cool slowly until it becomes black in daylight. It should then be reheated to 1500 degrees F. and quenched in either oil or water. After this it should again be reheated to 1350 degrees F. and again quenched in either oil or water. This double quenching gives much better results on all steels than does the ordinary practice of quenching directly from the carbonizing furnace and reheating but once to about 1375 degrees F. and quenching in oil.

In casehardened work, the core of the piece has a carbon content of about 0.20 per cent while the carbonized shell contains about 1.00 per cent. Thus, there are two steels of a different nature and these should be given different heat-treatments. In the double quenching, the first heating and quenching hardens the core but overheats the case and makes it brittle. The second re-heating restores the case to its finest grain structure and also toughens the core, and the final quenching hardens the case.

Uses of Natural Alloy Steels

Natural alloy steels are largely used in the manufacture of automobile parts. A grade containing 0.15 per cent of carbon is often used for carbonized parts where the toughness of the core is of more importance than the strength or ability to resist shocks. When parts are required to withstand severe shocks or strains and have a good wearing surface, steel containing 0.20 per cent of carbon is used. This grade responds more readily to heat-treatment. Thus the change-speed gears, differential gears, drive gears, etc., are made from this steel. It is used without carbonizing where considerable toughness is required rather than strength, as in various structural parts. It is also used for cold rolling or cold pressing, and for such work as seamless tubes, small drop forgings, etc.

Tensile Strength. Elastic Limit, etc.

The tensile strength, elastic limit, elongation and contraction of this steel, as affected by various heat-treatment temperatures are shown in Fig. 2. The vertical lines show the drawing temperatures which are marked in degrees at the top, while the horizontal lines represent the tensile strength and elastic limit and the percentage of elongation and contraction. Below the chart are given the hardness scales of the steels, at these temperatures, taken from both the Shore and Brinell instruments. The cold-bend testing properties at the various temperatures are illustrated by the sketches below the chart.

From this diagram the heat-treatment that should be given this steel to obtain any of the properties that are within its range, can readily be ascertained. Thus if an elastic limit of 144,000 pounds per square inch, with a contraction of 31 per cent, is desired, the vertical line will show that the drawing temperature should be 700 degrees F. This would also give a tensile strength of about 177,000 pounds per square inch, and an elongation of about 6.5 per cent. The diagrams are based on 7/8-inch round stock; if larger pieces are used, the drawing temperature should be lowered.

The grade containing 0.25 per cent carbon is usually used for such parts as can be cold pressed, for instance, such parts as brake drums, frame members, axle housings, etc. These parts require all the strength that can be obtained in combination with enough toughness to withstand the operation of bending into shape without developing cracks or checks. Steel 1¼ inch round, of this grade, when made into bolts, has a tensile strength of 106,000 pounds per square inch, an elastic limit of 87,500 pounds, an elongation of 26 per cent, and a contraction of 69.5 per cent.

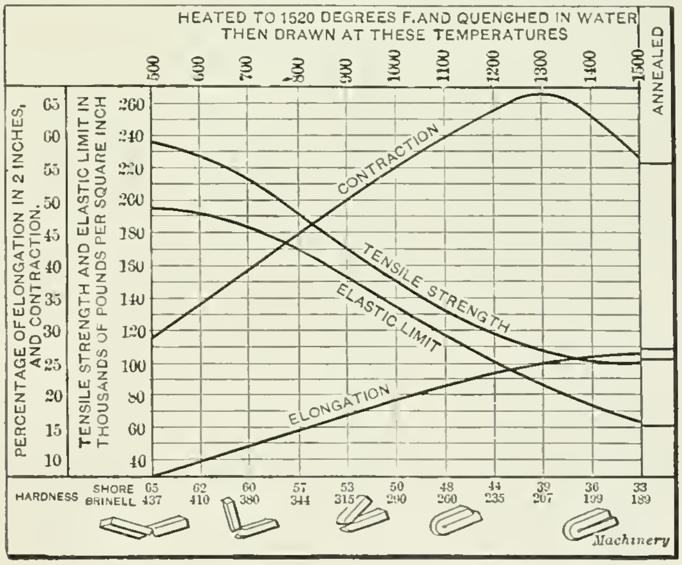

Fig. 4. Physical Properties of 0.40 Per Cent Carbon Natural Alloy Steel

The grade containing 0.30 per cent carbon is still harder and more applicable to heat-treated parts. Hence it is made into axles, connecting-rods, jack-shafts, drive shafts, and other parts that require considerable strength and at the same time a high degree of toughness. It is also used for drop-forgings, heavy forgings and numerous other things. The strength, hardness and cold bending properties of the 0.30 per cent natural alloy steels are shown in Fig. 3. That still greater strength can be obtained than shown in this chart was proved by a test made by one of the automobile manufacturers. The test bar was properly hardened and drawn at 600 degrees F.; the tensile strength was found to be 236,000 pounds per square inch, the elastic limit, 215,000 pounds, the elongation in two inches, 10.8 per cent, and the contraction, 36 per cent.

The grades containing 0.35 and 0.40 per cent carbon are usually used for spindles, rear axles, crankshafts, etc. From the 0.40 per cent grade are also made locomotive driving axles and heavy automobile truck axles, connecting-rods, piston-rods, steering knuckles, etc. The properties of the 0.40 per cent carbon grades are shown in Fig. 4. Some finished cranksnafts, 2½ inches in diameter of the 0.35 per cent grade, had a tensile strength of 148,400 pounds per square inch, an elastic limit of 127,300 pounds, an elongation in two inches of 15.3 per cent, and a contraction of 53.8 per cent.

The 0.45 and 0.50 per cent carbon grades are used where extreme strength is needed in combination with considerable ductility. Thus, transmission gears that are to be heat-treated without carbonizing are usually made from this brand. The strength when heat-treated will, of course, be greater than shown in Fig. 4, but the ductility will be reduced.

At the present time there seems to be a tendency to "load" steels with alloying materials, and thus make them difficult to forge, weld, machine, or heat-treat; the results obtained do not always warrant the high prices of the finished parts. This natural alloy steel, however, is not overloaded with such alloying materials, but at the same time has properties that are well within the specifications for which many manufacturers are using much more expensive steels.

* * *

LIMITS FOR VARIOUS KINDS OF FITS*

The accompanying table gives the limits of accuracy used by the firm of Ludwig Loewe & Co., Berlin, Germany. The tabulated values are directly "translated" from the metric system, which accounts for the use of four decimal places in practically all instances. The table on which the one here published is based was published by *Verkstäderna* (Stockholm, Sweden). Only a few words are necessary to explain the use of the table.

ALLOWANCES FOR VARIOUS KINDS OF FITS

	Diameter		1/4–7/16	15/32–3/4	25/32–1 1/4	1 9/32–2	2 1/32–3	3 1/32–4 1/2	4 17/32–7	7 1/32–10
	Hole	Min.	−0.0004	−0.0006	−0.0006	−0.0008	−0.0008	−0.001	−0.0012	−0.0015
		Max.	+0.0004	+0.0004	+0.0006	+0.0006	+0.0008	+0.0008	+0.001	+0.0012
Shaft	Loose Fit A	Max.	−0.0004	−0.0006	−0.0008	−0.001	−0.0012	−0.0014	−0.0017	−0.0021
		Min.	−0.001	−0.0012	−0.0014	−0.0018	−0.002	−0.0024	−0.003	−0.0036
	Loose Fit B	Max	−0.0008	−0.0012	−0.0016	−0.002	−0.0024	−0.0028	−0.0034	−0.0042
		Min.	−0.0014	−0.002	−0.0024	−0.0028	−0.0032	−0.0038	−0.0044	−0.0052
	Loose Fit C	Max.	−0.0012	−0.0014	−0.0016	−0.002	−0.0024	−0.0028	−0.0034	−0.0042
		Min.	−0.002	−0.0028	−0.0032	−0.0037	−0.0041	−0.0052	−0.0064	−0.008
	Sliding Fit	Max.	−0.0002	−0.0002	−0.0003	−0.0003	−0.0004	−0.0004	−0.0006	−0.0007
		Min.	−0.0004	−0.0006	−0.0008	−0.001	−0.0012	−0.0014	−0.0017	−0.0021
	Drive Fit	Max.	+0.0004	+0.0004	+0.0004	+0.0004	+0.0003	+0.0002	+0.0002	+0.0002
		Min.	−0.0002	−0.0002	−0.0002	−0.0003	−0.0003	−0.0004	−0.0004	−0.0005
	Press Fit	Max.	+0.0016	+0.0021	+0.0028	+0.0034	+0.0044	+0.0054	+0.0072	+0.010
		Min.	+0.0008	+0.0011	+0.0014	+0.0018	+0.0022	+0.0026	+0.0034	+0.0044
	Shrinkage Fit	Max.	+0.001	+0.0014	+0.0018	+0.0024	+0.0032	+0.0044	+0.0058	+0.008
		Min.	+0.0006	+0.0008	+0.0008	+0.0012	+0.0014	+0.0018	+0.0036	+0.0052

It will be noted that three kinds of loose fits are specified. Loose fit *A* is for shafts resting in a single bearing; loose fit *B* for shafts resting in two or more bearings; and loose fit *C* for shafts with large clearance, lubricated with heavy lubricants, such as grease, etc. The sliding fit indicates a fit where the parts can be moved by hand, but without shake or play. The drive fit indicates a fit where it is necessary to assemble the parts with simple means, such as light blows or easy pressure. The press and shrinkage fits have their ordinary significance. By using this table, it is not necessary to put the limits on every dimension on the drawing, but simply to specify the kind of fit required.

FOUNDRY AND MACHINE SHOP STATISTICS

The thirteenth census statistics of factories engaged in the manufacture of foundry and machine shop products are summarized in an advance bulletin issued by the director of the Bureau of the Census, Department of Commerce and Labor. These statistics show the number of establishments, the number of persons engaged, capitalization and value of the manufactured products. In the statistics are included all industries in the machinery field except those which manufacture distinctive products individually classified in the statistics, such as cash registers, calculating machines, sewing machines, and electrical machinery. The statistics are for the year 1909.

In this year there were 13,253 establishments, employing 615,485 persons, of which number 9851 were proprietors and firm members, 21,754 were salaried officers, superintendents, and managers, 42,242 were male, and 10,627 female, clerks; the average number of wage-earners was 521,011; the number of wage earners in the maximum month, December, being 597,234, and in the minimum month, January, 482,080. The total number of wage earners on December 15, 1909, or the nearest representative day, was 604,167, of which 587,636 were males and 11,895 were females, all 16 years of age and over; while 4093 were males and 543 females, under 16 years of age. The capital invested was $1,514,332,273. The total expenses were $1,077,736,456, of which $47,817,236 were paid officials, $45,977,781 clerks, $321,520,917 wage-earners, $23,750,838 fuel and rent of power, $516,260,301 other materials, $5,970,800 rent of factory or works, $6,269,172 taxes, including internal revenue, $6,653,816 contract work, and $103,515,297 other miscellaneous expenses. The value of products was $1,228,475,148. The value added by manufacture, which is the difference between value of products and cost of materials, was $688,464,009.

The states which lead in this industry are, in the order of their importance: Pennsylvania, New York, Ohio, Illinois, Massachusetts, Connecticut, New Jersey, Wisconsin, Michigan, Indiana, Rhode Island, California, and Missouri. The average number of wage-earners employed in 1909, the total number of products, and the value added by manufacture (value of products less cost of materials) for these states, is tabulated in the accompanying table.

State	Average No. of Wage Earners	Value of Products	Value added by Manufacture
California	8,377	$26,730,891	$13,830,000
Connecticut	37,736	65,535,155	40,715,099
Illinois	52,266	138,578,993	74,768,805
Indiana	15,809	39,883,774	21,265,086
Massachusetts	44,179	86,925,671	55,743,781
Michigan	21,649	45,399,023	26,688,471
Missouri	7,443	19,975,149	10,819,432
New Jersey	27,815	65,398,437	35,458,387
New York	64,066	154,570,346	92,749,146
Ohio	64,817	145,836,648	81,276,753
Pennsylvania	86,821	210,746,257	109,735,517
Rhode Island	10,937	20,611,693	12,598,192
Wisconsin	24,219	54,124,000	31,590,264

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* See MACHINERY, engineering edition, April, 1912: "Table of Allowances and Limits." See also MACHINERY'S Data Sheet Book No. 7, pages 26 to 31, inclusive: "Allowances and Tolerances for Various Kinds of Fits."

ANALYSIS AND HEAT TREATMENT OF LOW-CARBON AND ALLOY STEELS*

PRACTICE FOLLOWED BY THE FROST GEAR AND MACHINE CO., JACKSON, MICH.

By DOUGLAS T. HAMILTON†

The heat treatment of low-carbon steel differs considerably from that used for hardening ordinary tool or high-carbon steel. To begin with, low-carbon steel must be carburized, so that its outer surface will harden when the steel is again heated and dipped in oil. With tool steel it is only necessary to heat the steel to the desired temperature and plunge it in oil or water, after which the temper is usually drawn.

To obtain the best results when heat treating the modern alloy steels, the percentage of the constituent elements must be definitely known, and, therefore, a sample of each bar of steel should be analyzed before any parts are made from it. The greatest difficulty encountered in heat treating alloy steel is that if the carbon content varies but a few points, unsatisfactory results will be obtained unless this variation is taken into account. This is particularly true in heat treating drop forgings for automobile gears, which are subjected to heavy duty. The very best steel obtainable is of little value unless properly heat treated. The annealing, hardening and tempering must be attended to with great care and thoroughness. Drop forgings are more difficult to heat treat properly than parts made from bar stock.

Fig. 1. Samples of Bar Steel and Milling Chips used in obtaining Chemical Analyses

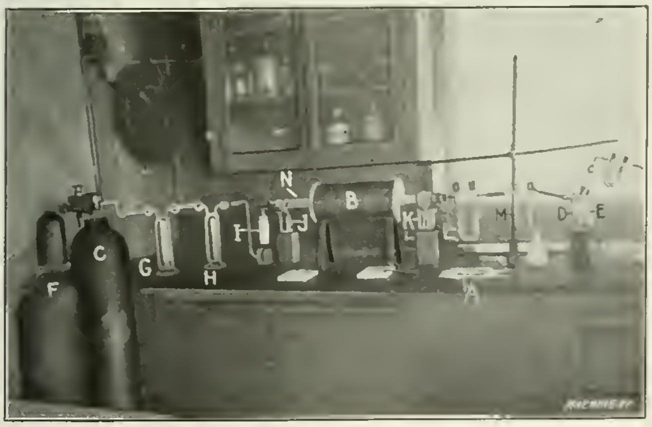


Fig. 2 Electric Furnace and Combustion Train used in determining Carbon Content of Milling Chips from Sample of Bar Steel

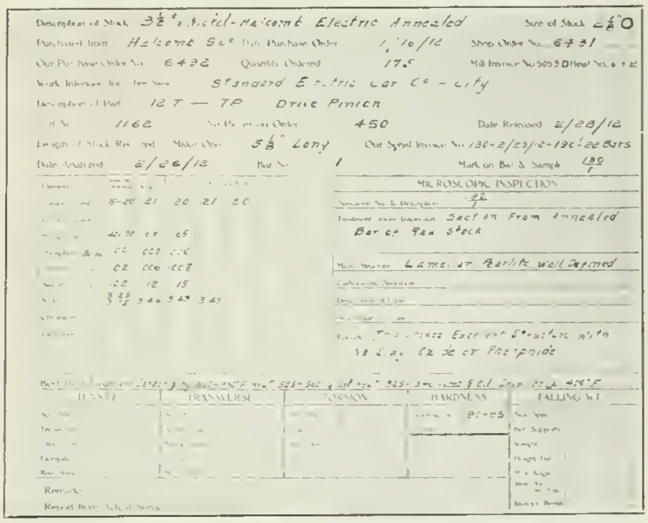
In no branch of the metal working industry is greater care given to the heat treatment of steel than in automobile manufacture. This industry has practically revolutionized former methods of making and heat treating alloy steel. In the following article a description is given of the heat treating methods employed by the Frost Gear & Machine Co., Jackson, Mich., which firm makes a large number of gears for the automobile trade. After having had considerable difficulty in heat treating automobile parts, owing to the variations in the carbon contents, and often to variations in the entire chemical composition, this firm installed a chemical laboratory in connection with its hardening department. Now, before any material is made up into gears or other parts, it is analyzed and its chemical composition ascertained.

In order that a manufacturer may be able to guarantee that all parts turned out by him are up to a certain standard, it is absolutely necessary that he follow some definite plan of analyzing and heat treating the different grades of steel. It is not wise to rely solely upon the steel mills for the correct analysis, for the simple reason that it is difficult to keep defective material from getting mixed up with the good stock. This is not always due to negligence on the part of the steel mill, but sometimes happens during transportation, unloading, etc.

Grading and Analyzing Steel

In ordering steel, the Frost Gear & Machine Co. gives the steel mill a complete analysis of the steel required. When the steel is received the bars are painted according to a certain standard. For gear stock the following colors are used to designate the different grades of steel:

Grade of Steel	Color
3.5 per cent nickel..................	Lemon yellow
0.15-0.20 per cent carbon, open-hearth machine steel	Pale green
0.30-0.40 per cent carbon, open-hearth	Medium green
0.40-0.50 per cent carbon, open-hearth	Dark green
Chrome-nickel steel	Deep red
Vanadium steel	Black



Description of Stock 3½% Nickel-Halcomb Electric Annealed
Purchased from Halcomb St. Co. Date Purchase Order 1/10/12 Shop Order No. 6431
Our Purchase Order No. 6432 Quantity Ordered 17.5
Description of Part 12 T — 7 P Drive Pinion
1162 450 Date Released 2/28/12
5⅛" Long
Date Analyzed 2/26/12 Bar No. 1
MICROSCOPIC INSPECTION
Section from Annealed Bar of Gear Stock
Laminar Pearlite well Defined
TENSILE TRANSVERSE TORSION HARDNESS FALLING WT.
Remarks

Fig. 3. Record of Analysis of a 3 1-2 per cent Nickel Halcomb Electric Annealed Alloy Steel—Actual Size of Record Sheet, 9 by 7 3-4 inches

A wide stripe denoting the character of the steel is painted longitudinally on the bar, and a narrow diagonal stripe, of a different color, is used to designate the steel maker's name.

There are at the present time three common methods for determining the carbon contents of steel. The first and possibly the most common method is the use of the electric furnace and combustion train; the second is microscopic analysis; and the third, color comparison.

To obtain the carbon contents by means of the electric furnace and combustion train, a sample must be cut from each bar and chips obtained from these samples by milling or drilling. Milling chips are to be preferred, as these can be obtained quickly and can be taken from the entire cross-section. In milling off the chips, no oil should be used on the cutter, because a drop of oil in the chips would raise the carbon content far above its true percentage, due to the fact that oil is composed largely of carbon.

These chips are placed in small bottles labeled as shown in Fig. 1, the labels carrying the serial invoice number and the number of the bar. For example, suppose twenty-two bars of a certain brand of steel have been ordered, and that the serial invoice number is 130; then the first bottle, containing the chips from bar No. 1, would be labeled $\frac{130}{1}$, and the following bars and bottles would be marked consecutively

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*See MACHINERY, June 1912, engineering edition: "Society of Automobile Engineers Specifications for Steel," and the articles there referred to.

† Associate Editor of MACHINERY.

$\frac{130}{2}$, up to and including $\frac{130}{22}$. The sample from which the chips are taken is also marked, and kept on the shelf with the bottles, as shown in Fig. 1. A sheet, as shown in Fig. 3, is made out for each bar of which an analysis is made, and this is filed away for future reference.

Obtaining the Carbon Contents by Means of the Electric Furnace and Combustion Train

The distinctive features of the different grades of steel are due more to variations in the carbon contents than to variations of any of the other elements, so that the carbon analysis is really the most important point to consider. A very small percentage of carbon makes a considerable difference in the quality of the steel after hardening.

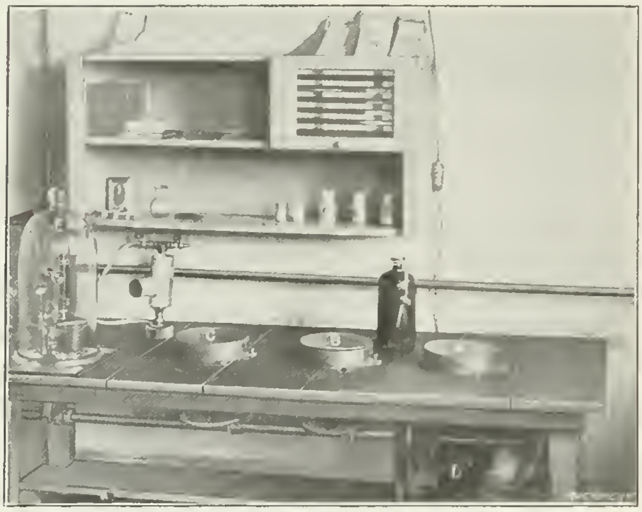


Fig. 4. Polishing Disks for Polishing the Specimen of Steel and Microscope used for Determining Structure of Steel

To obtain the carbon analysis by the electric furnace and combustion train, the milling chips are put in a small alundum boat *A*, containing aluminum oxide, as shown in Fig. 2. The latter is placed in the electric furnace *B*, where the chips are heated to about 1800 degrees F. A stream of oxygen from tank *C* is passed over the chips until the carbon has been burned out, the resulting gas—carbon dioxide (CO$_2$)—being collected in a liquid, potassium hydrate, in the potash bulb *D*. Now, after all of the carbon has been burned out of the milling chips, the weight of bulb *D* is compared with that of counterpoise bulb *E*, and its gain in weight noted; before burning out the carbon of the chips the difference in weight between bulbs *E* and *D* was ascertained. By a simple calculation, taking into account the weight of the milling chips, which have also been weighed before being put into the furnace, the percentage of carbon in the steel is obtained.

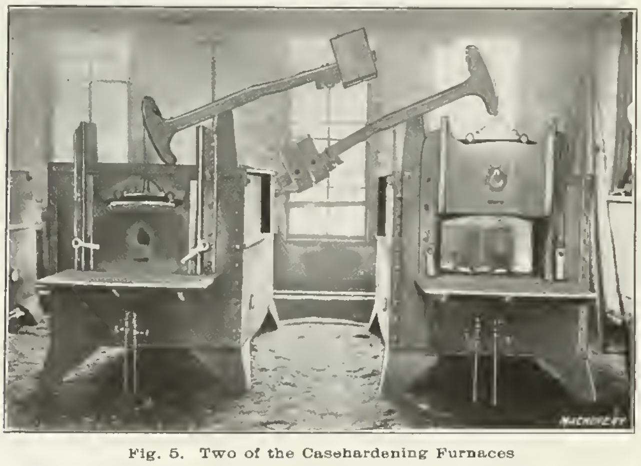


Fig. 5. Two of the Casehardening Furnaces

The names of the various tubes and devices used in connection with the electric furnace and combustion train shown in Fig. 2, starting at the left, are as follows: *F*, extra oxygen tank; *C*, oxygen tank; *G*, concentrated potassium hydrate bulb; *H*, concentrated sulphuric acid bulb (these two bulbs are called gas washers and act as the purifying train for the oxygen); *I*, granulated calcium chloride tower; *J*, cooling wick for the terminal of the quartz combustion tube; *N*, quartz combustion tube; *B*, electric furnace; *K*, another cooling wick; *L*, a U-tube containing granulated zinc; and *M* a U-tube containing calcium chloride. U-tubes *L* and *M* comprise the purifying train for the carbon dioxide collected from the milling chips being heated in the electric furnace. Finally, *D* is the weighed potash bulb and *E* the counterpoise bulb.

Analyzing Steel by Microscopic Inspection and Chemical Analysis

The microscopic examination of steel is of the utmost importance, as it reveals the nature of the metal to such an extent that the knowledge obtained thereby can be used to good advantage for practical purposes. Some of the problems which previously were beyond the scope of chemical analysis have been elucidated by means of the microscope. Of course, to use a microscope to the best advantage, it is necessary that the characteristics of steel and their relation to the appearance of a section when greatly enlarged, be understood.

To prepare the steel for microscopic examination, a small piece of the required size is cut from the bar and then ground as smooth as possible. After this, it is polished by means of different abrasive materials on the small polishing stands shown in Fig. 4. The first stand *A* consists of a disk covered with canvas and charged with fine alundum. The disk on stand *B* is covered with ordinary pocket lining, and is charged with lenigated alumina, while the disk on stand *C* is covered with broadcloth and charged with rouge. These polishing stands are driven from a shaft located beneath the bench, which, in turn, is operated by a small electric motor *D*. The disks are used in the order in which they are placed, starting at *A*. Covers are placed over these disks to prevent dust and dirt from collecting on the abrading surface.

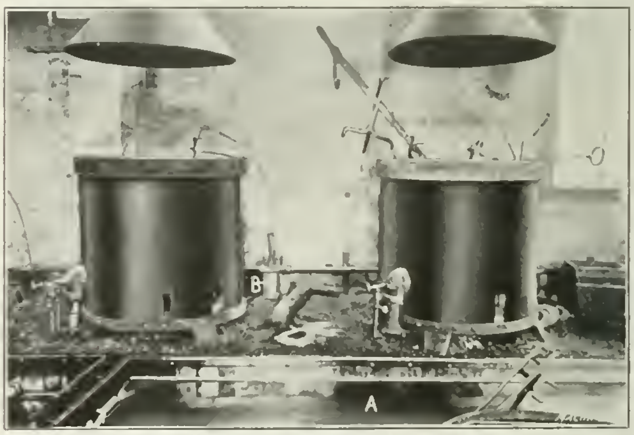


Fig. 6. The Lead Baths used for Heat-treating the Parts

After the piece to be examined under the microscope *E* has been polished to a high degree, it is etched with a five per cent solution of picric acid, in alcohol for annealed steels. This brings the structure of the steel into prominence, the less readily attacked constituents being left standing in slight relief, and the structure thus rendered visible. One of the most striking objects which appears under the microscopic treatment, sometimes causing a beautiful play of colors, is pearlite, which has a pearly lustre, from which it derives its name. Pearlite is an intimate mixture of ferrite and cementite and consists of 87 per cent of ferrite and 13 per cent of cementite. Lamellar pearlite, which was clearly defined in the analysis recorded in Fig. 3, is a formation which consists of alternate plates of ferrite (pure iron) and cementite (carbon of iron Fe$_3$C). The ferrite is readily attacked by the etching acid, leaving the cementite standing out in relief.

The other constituents in the steel, such as nickel, manganese, sulphur, etc., are generally obtained by chemical analysis. This method can only be carried on successfully by an experienced metallurgist, as the determination of the percentage of any one constituent usually is obtained by volumetric titration with standard solutions of reagents.

Carburizing

When the material has passed analysis and is found to be "O. K.," the blueprint number of the piece for which this grade of steel is to be used is painted on the end of each bar.

This gives the foreman authority to use it. Any bars found to be of wrong chemical composition or difficult to machine, or that do not show up properly under microscopic inspection—showing slag and defects—are picked out and returned to the mill. After the part is made that is to be carburized, it is painted with fire clay where a hardened surface is not required, and then put in a carburizing compound, composed of charred leather, crushed charcoal and ammonium carbonate.

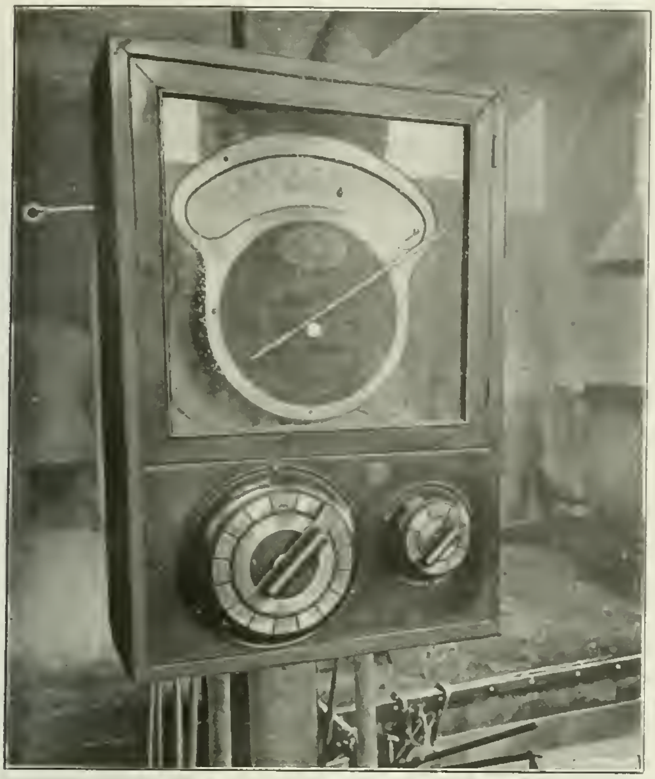


Fig. 7. Hoskins Electric Pyrometer used for Regulating the Temperature of Casehardening, Heat-treating and Tempering Furnaces

The work is packed in pots in this mixture, the lids put on and sealed with fire clay, and then the pots are put in the carburizing furnaces, two of which are shown in Fig. 5. The temperature in these furnaces is raised to the desired point and maintained for a sufficient length of time to let the carbon penetrate into the steel about 0.02-0.04 inch. This generally requires from three to five hours after the correct temperature has been reached. Of course, the length of time depends entirely upon the depth of casehardening desired and the size of the piece to be treated. The temperature in the pot is slightly greater than that near the walls of the furnace, and is consequently greater than that registered on the pyrometer.

The carburizing furnaces are heated by high-pressure fuel oil burners having a pressure of 18 pounds on the oil and 40 pounds on the air for atomizing, and about 12 ounces for supplying air for combustion through a two-inch pipe. The temperature is recorded on a Hoskins electric pyrometer, Fig. 7, which is provided with "reading contact points" for all the furnaces in the room. After the parts have been left in the furnace for a sufficient length of time, the pots are taken out of the furnaces and allowed to cool down gradually, the covers not being removed until the pots are perfectly cold; then the covers are taken off and the parts unpacked and heated to treat the core, and plunged in oil; they are then again heated to from about 1350 to 1425 degrees F., to harden the case, dipped in oil, and tempered.

Heat-treating Automobile Drive Gears

Automobile drive gears which contain 3½ per cent nickel, are put in a lead bath after carburizing (see Fig. 6), and are heated from 1550 to 1600 degrees F. After the gear is brought to this temperature it is taken out and quenched in the bath of running oil shown at *A*, Fig. 6. Charcoal is put on top of the lead to prevent it from oxidizing. This also helps to keep the temperature even and prevents the lead from sticking to the gear. After quenching, the gear is again heated to a temperature of from 1325 to 1350 degrees F., so as to harden the case. After the gear is brought to the proper temperature, it is quenched in the running oil bath.

Tempering

Most automobile gears and other parts require to be tempered after being heat treated. The tempering is accomplished in an oil bath shown in Fig. 8. The work is placed in the basket shown and the latter lowered into the oil, which is a grade of fish oil, called "No. 11 tempering oil." This is heated to from 325 to 400 degrees F. for nickel steel, and from 550 to 600 degrees F. for oil-hardening chrome-nickel steel. After the work has been brought to the same temperature as the bath, it is allowed to remain for a certain specified time, and is then removed and allowed to cool off gradually. It is then washed in a lye solution and sand blasted.

All of the oil tempering, casehardening and heat treating furnaces are supplied with the same type of oil pressure burners. The cold ends of the thermo couples are surrounded by water jackets in which cool water is circulated as indicated at *B* in Fig. 6. This water jacket keeps the couples at an exact temperature and thus makes possible correct reading on the pyrometer. The pyrometer is tested from time to time and is automatically regulated according to the temperature of the room.

Examining the Fracture of a Broken Gear

After a sample is carried through in the manner previously described, it is broken with a sledge hammer to determine if the core has been heat treated properly, or whether crystallization has taken place. This process of breaking and examining is carried on until a piece is obtained which shows that it has been properly heat treated. The operations are slightly varied until a satisfactory final result is obtained.

Fig. 9 shows a drive pinion for an automobile, which has been broken to show the fracture. This pinion was made from a drop forging as is clearly indicated in the illustration, where the grain of the steel is seen to follow closely the shape of the gear. The depth of the case also stands out very prominently. At *B* are shown cracks which illustrate that the case, which is extremely hard, cracked when breaking the gear, but the core still remained intact. A tooth broken off by the sledge is shown at *C*.

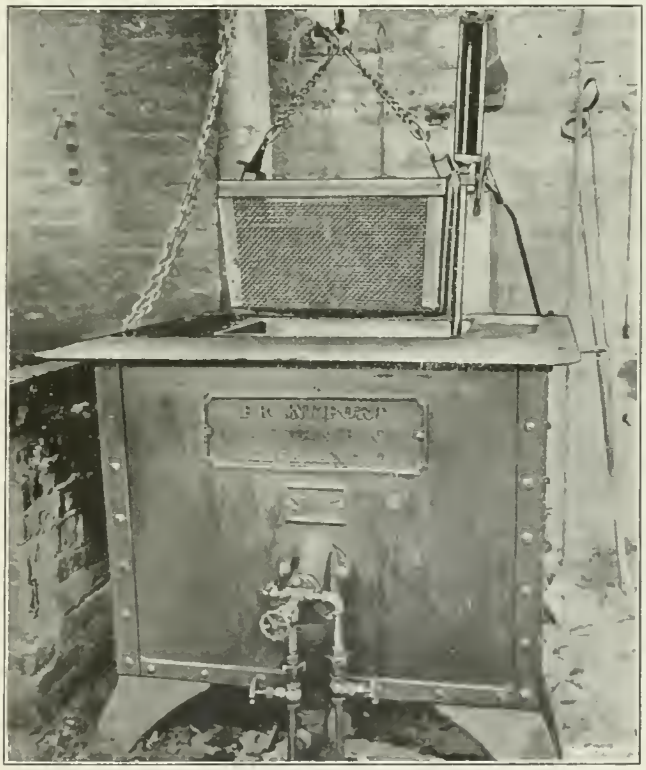


Fig. 8. Oil Bath for Drawing the Temper after Hardening

The scleroscope is used to determine the hardness of a gear after being heat treated, but it is not relied upon altogether. Sometimes a gear can be "touched" with a file after a high reading has been obtained by the scleroscope. The main point in heat treating steel is to get a close-grained and "velvety" structure. If the structure is coarse, the part will not be strong and will be easily broken. After a piece has been carried through the process previously outlined, broken and found to be all that is desired, all parts made from the bars containing the same percentages of the various ingredients are given the same treatment. The data thus collected, are tabulated, and filed away for future reference, as shown on the chart in Fig. 3.

Heat-treating a Main Drive or Ring Gear for an Automobile

The main drive or ring gear used on an automobile is considered by most automobile manufacturers as one of the most difficult parts to make, and more money is being spent on perfecting this one gear than on any other part. It is very difficult to turn out a gear which has not been slightly distorted during the heat treating operations; such gears will produce considerable noise when running at a high speed. This is a very objectionable feature, and every possible means is devised and employed to obviate it.

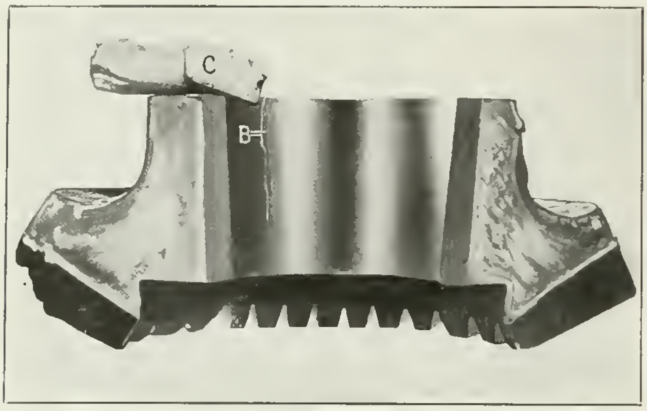


Fig. 9. An Automobile Drive Pinion broken to show Structure of Steel after Heat-treating

The gear shown in Fig. 10 is made from 3½ per cent nickel steel, containing 0.18 per cent carbon. The blank is cut from flat stock of oblong section, split in the center and then expanded to form a ring. This ring is then heated and finished to the desired shape by drop forging. It is evident that the grain of the steel will practically form a complete circle when worked in this way, and this tends to prevent the finished piece from distorting much during the heat treatment. After being drop-forged, the gear is annealed and allowed to cool off gradually; then it is sent to the machining department where it is machined to the correct shape, the teeth cut and all the operations, except grinding, performed. It is then painted on the back with fire clay, put in the carburizing furnaces, and passed through the operations previously outlined.

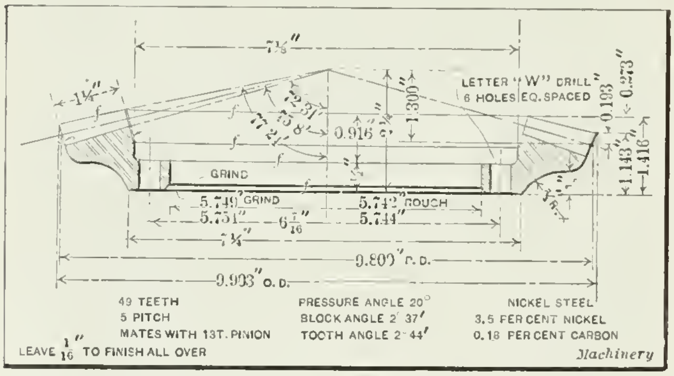


Fig. 10. Automobile Main Drive or Ring Gear to be heat-treated

The heat treatment for this particular gear was as follows: Heated in carburizing compound for four hours at a temperature of 1650 degrees F. and allowed to cool off in the pots; then heated in lead pot to a temperature of 1580 degrees F. and quenched in oil; heated in lead to 1325 degrees F. and quenched in oil; after this, allowed to remain in the oil tempering furnace for one hour at a temperature of 375 degrees F., taken out, allowed to cool off gradually, washed and sand blasted.

It has been found from actual experience that the best way to determine the proper heat treatment for any particular grade of steel or parts made from it is to put a sample through the regular heat treating process, break it and examine the structure. By following this method and using the tabulated data obtained when making the analysis as a guide, very satisfactory results are secured without recourse to any "rule of thumb" methods.

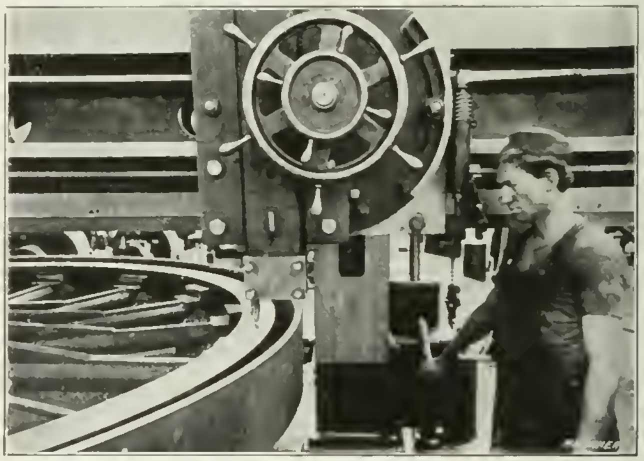
In closing, the writer wishes to express his appreciation of the assistance given him in the preparation of this article by Mr. E. J. Frost, president of the Frost Gear & Machine Co.

* * *

CUTTING AN OIL GROOVE IN A BORING MILL

A simple but rapid method of producing a zig-zag oil groove in a circular piece of work is shown in the accompanying illustration. The work is a 10-foot table for a Cincinnati boring mill, and the machine in which this unusual feat is being accomplished is a Cincinnati 10–16-foot boring mill. The oil groove is 1/4 inch wide and about 3/32 inch deep, and is completed in one minute—the time required for the table to make one revolution. The zig-zag path of the groove is the result of the combined movements of the work and tool-head.

In action, the operator after setting the tool and feeding it down to the proper depth, grasps the shifting lever for operating the rapid power traverse of the tool-head (as shown in the illustration), and then starts up the machine. He watches the cutting tool closely, and as it approaches the edge of the circular bearing, shifts the lever to traverse the tool-head in the opposite direction. This procedure is followed until the table has made one complete revolution, when the oil groove is completed. Formerly this oil groove was laid out, and then chipped with a chisel and hammer, the time required being about six hours.



Set-up and Method of Cutting an Oil Groove 1-4 inch wide by 3-32 inch deep, and over 32 feet long in One Minute on a Cincinnati 10-16-foot Boring Mill

The cutting of this oil groove in the manner described, illustrates the ease of control of the boring mills manufactured by the Cincinnati Planer Co., Cincinnati, Ohio. D. T. H.

* * *

THE BEGINNINGS OF MONEL METAL

About seven years ago one of the large smelting companies began investigating the chemical and physical properties of an alloy that had been reduced directly from a nickel-copper matte without the previous separation of the two metals. This alloy was found to possess not only the valuable properties of nickel, but also other desirable properties in addition, that would insure a wide usefulness, and owing to the simple method of production, was obtainable at about one-third the cost of nickel. In 1905-6 the International Nickel Co. considering, no doubt, that for many purposes there was no need to separate the amicable metals nickel and copper, took up the problem of reducing them together and obtaining an alloy of the two metals in the proportions in which they occur in the ore. The alloy thus obtained was named Monel metal, after Mr. Ambrose Monel, the president of the International Nickel Co.

BOSTON GEAR WORKS NEW FACTORY

LAY-OUT AND MACHINE EQUIPMENT

Of the few large plants in the United States devoted exclusively to the manufacture of gears the Boston Gear Works probably is the largest manufacturing such a great variety of gears. This firm started business in Boston in May, 1891, with twelve men, under the management of Mr. Frank Burgess. The business gradually grew so that during the spring of 1906 an enlargement became necessary, and a modern one-story factory of saw-tooth construction, with the exception of the office department, was built at Norfolk Downs, about six miles from Boston. This plant was completely destroyed by fire November 27, 1909.* In less than one week after this fire, gears were cut in a nearby building on machinery taken from the ruins.

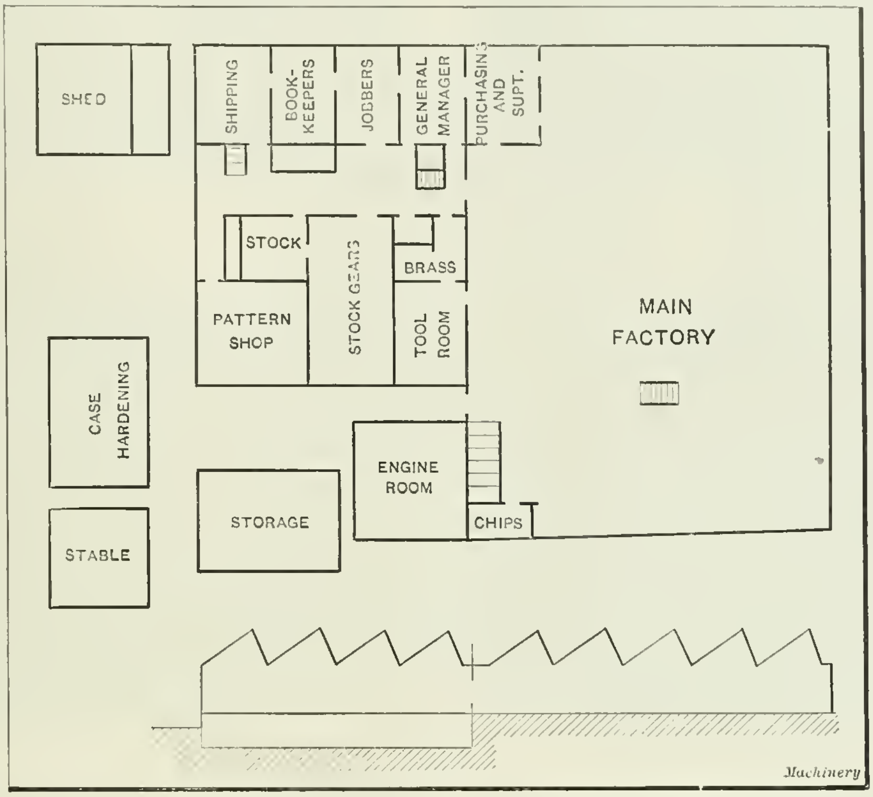


Fig. 1. Plan of Boston Gear Works

By February 10, 1910, a new and better factory was completed on the site of the old structure, and running on full time. This record was due to the great energy of Mr. Burgess, and the cooperation of his 125 employes. The new factory, like the old, is of saw-tooth roof construction, which had proved very satisfactory. The office is placed on the first floor in order to give more uniform light and direct communication with the factory. There is 29,000 square feet of floor space in the main building, and a total floor space, including other buildings, of 37,000 square feet.

The main building is divided into two parts by a fire wall, the factory section being 90 feet by 131 feet, and the office section 90 feet by 71 feet. In the office section are located the pattern shop, two gear stockrooms, toolroom, shipping room, and three offices, on the ground floor. The three offices, being those of the general manager, bookkeepers and jobbers, are so arranged that quick communication can be had with each other, as well as with the main factory section.

Fig. 2. General View of Boston Gear Works

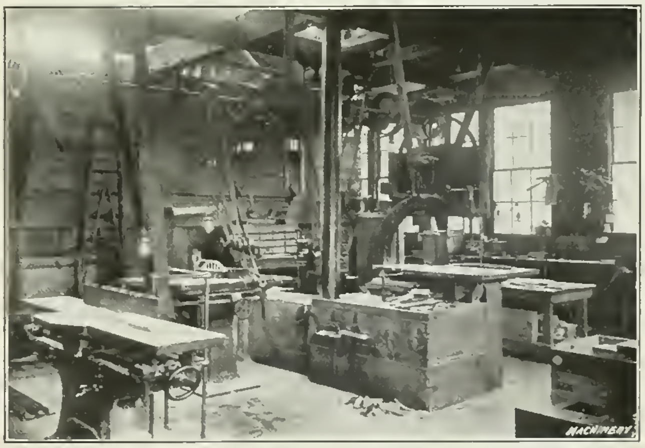


Fig. 3. The Pattern Shop

In the basement under the office section are storage, millwright and experimental rooms, a steam heating plant, and one 50 H. P. De LaVergne oil engine, and in the basement under part of the main factory building are located a 50 H. P. De LaVergne oil engine generator, pumps, etc., several cutting-off machines, and steel racks. In 1910 a power plant was erected in a new building 31 feet by 32 feet, adjacent to the fire wall of the main factory building, and an 85 H. P. Hornsby-Akroyd-De LaVergne oil engine installed.

The main factory is divided into about fourteen separate departments, each under a working foreman, scientifically arranged so that the work may progress in the most systematic manner. The entire equipment consists of about 225 machines, seventy-five of which are automatics, most of them being of the latest design. The equipment by departments is as follows:

The model, or small gear department, consists of over forty turning and gear cutting machines, ten of which are automatics. Most of these machines were designed and built by the Boston Gear Works. The Cleveland automatic section consists of seven Cleveland automatic turning machines, handling bar stock up to six inches diameter. This department also includes four Acme and two Hartford automatic screw machines. The Potter & Johnston section contains three Potter & Johnston automatic chucking machines, one plain chucking machine, one Jones & Lamson, one Prentice, one Bullard and two Fay lathes. The Gleason gear planing section consists of six bevel gear generators and three single tool planers, taking in work up to forty-eight inches diameter. The Whiton section comprises nine automatic milling machines for cutting sprockets, spur and bevel gears of small diameters. The spiral section contains ten machines for cutting spiral and worm gears up to thirty-six inches diameter. The hobbing department includes seven machines for cutting spur, helical and worm gears, up to ten feet in diameter. The Fellows and Gould & Eberhardt department consists of six Fellows gear shapers, including one rack cutter; seven Gould & Eberhardt automatic spur and sprocket gear cutters, and

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* See "New Plant of the Boston Gear Works," November, 1906, for description of the plant destroyed by fire.

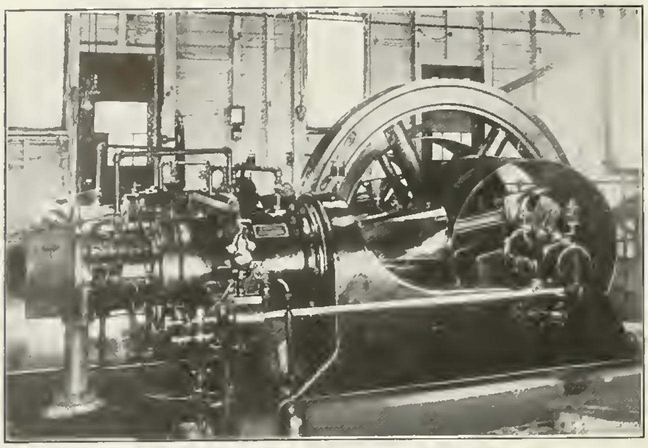


Fig. 4. Eighty-five H.P. Hornsby-Akroyd Oil Engine Power Plant

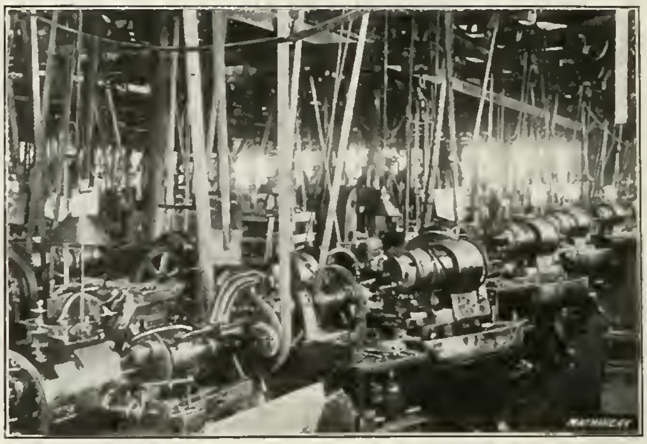


Fig. 5. Cleveland Automatic Department

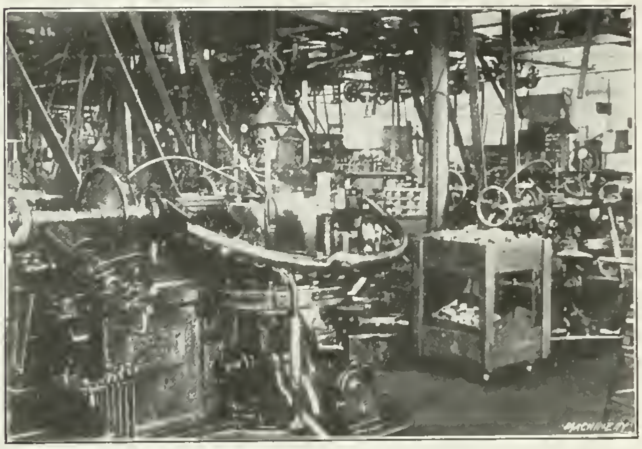


Fig. 6. Gleason Gear Planing Department

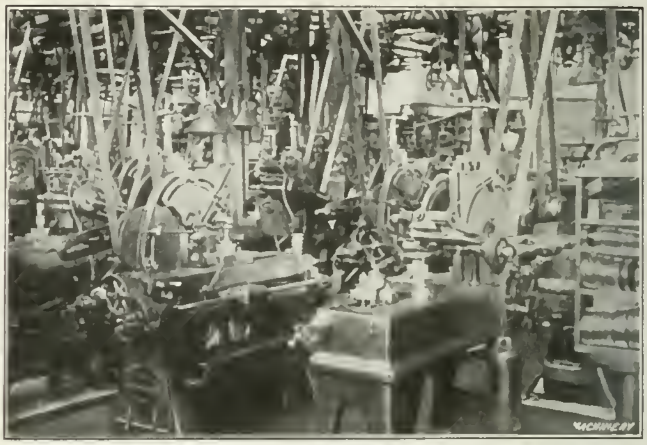


Fig. 7. Whiton Gear Cutting Machine Department

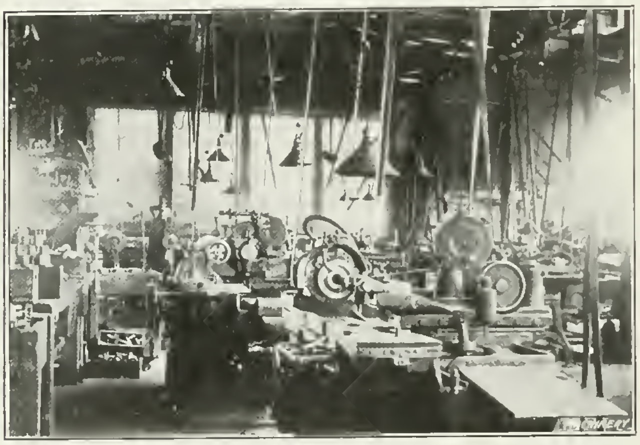


Fig. 8. Grinding Department

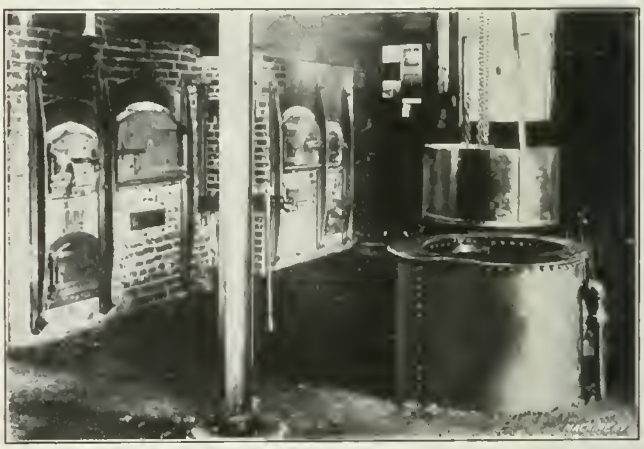


Fig. 9. Coal Carbonizing Furnaces

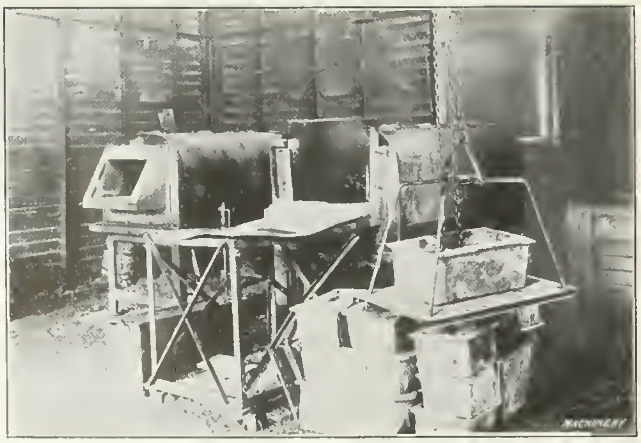


Fig. 10. American Gas Furnaces equipped for burning Oil

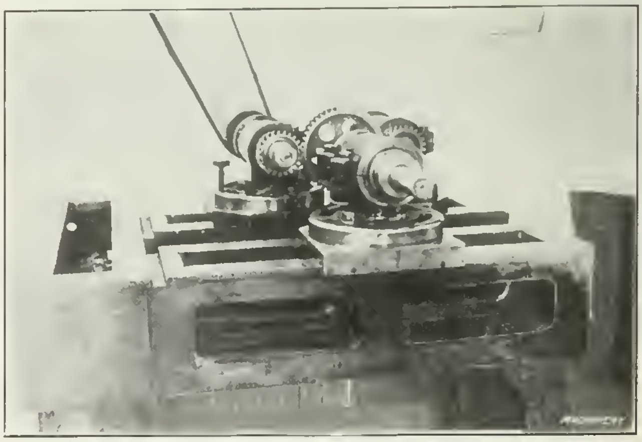


Fig. 11. Universal Gear Testing Machine

one Brainard machine. Gears up to seventy-four inches diameter can be cut in this section. The lathe, drill and miscellaneous department contains twenty-two machines. The tool section consists of twelve machines, among which are milling and special hobbing machines. The grinding department comprises nine universal, plain and internal grinding machines.

In 1911 a new casehardening plant, 26 by 45 feet, of fire-proof construction was built, consisting of a steel frame covered with asbestos protected metal. This plant is equipped with two modern brick coal carbonizing furnaces, two of the American Gas Co.'s furnaces equipped for burning fuel oil, and lead reheating and oil tempering furnaces, also using fuel oil. The temperatures are recorded by a Bristol pyrometer, and the very latest and best methods are used for treating all kinds of steel.

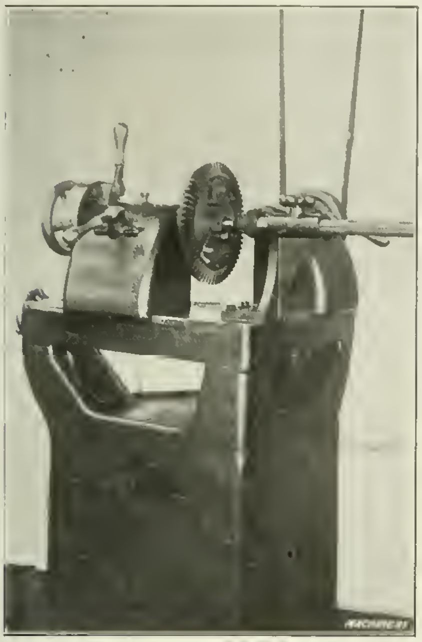


Fig. 12. Bevel Gear Testing Machine

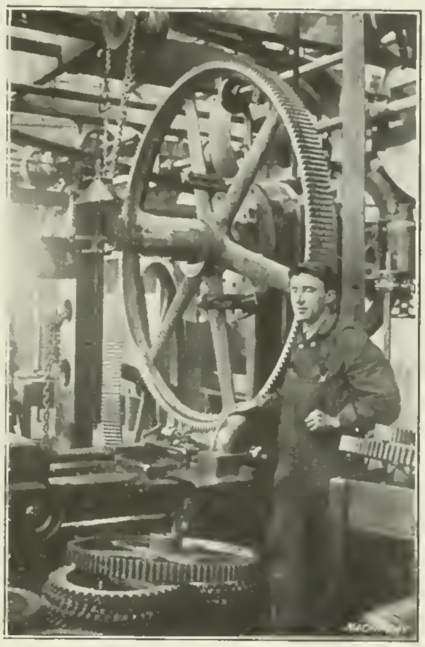


Fig. 13. Gould & Eberhardt Department

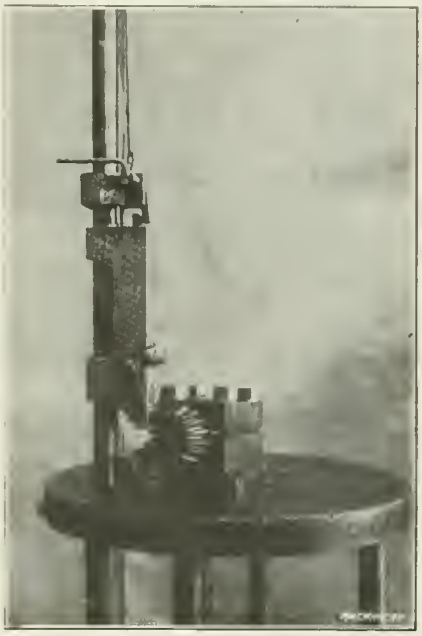


Fig. 14. Drop Hammer Testing Machine

The inspection department is equipped with the latest and best machines for testing gears under actual running conditions; there are also all kinds of measuring tools, such as plugs, micrometers and tooth vernier calipers, drop hammer machine and scleroscope for testing heat-treated gears. Back of all this equipment is thirty-two years experience in the manufacture of all kinds of gears.

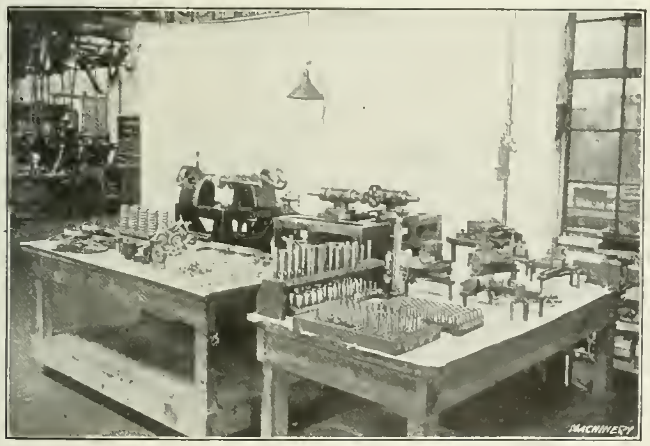


Fig. 15. Inspection Department

The works are prepared to handle large or small quantities of special gears from one-eighth inch to ten feet diameter. They make a specialty of all kinds of steel gears, including automatic differential and transmission gears, as well as fan, cam, timer, and pump gears for engines. Recently a number of worm and helical gear cutting machines were developed to manufacture special worm gear combinations both small and large to transmit light and heavy power. They will also soon be prepared to manufacture in large quantities worm gears for automobile rear axle drives, both of the straight and Hindley types.

IRON AND STEEL INDUSTRIES IN U. S.

The director of the Bureau of the Census, Department of Commerce and Labor, has issued an advance bulletin giving a summary of the thirteenth census statistics with relation to the number of establishments, persons engaged and capital invested in the steel works and rolling mill industry in the United States. This industry, considering the value of the products, ranked fourth among the industries of the country in 1909.

In that year there were 446 establishments with a total number of 260,762 persons engaged, of which 47 were proprietors and firm members, 4239 salaried officers, superintendents and managers, 14,613 male, and 1767 female, clerks. The average number of wage-earners was 240,076; the number in the maximum month, December, was 283,629, and in the minimum month, March, 215,076. The primary horsepower was 2,100,978. The capital invested was $1,004,735,111. The total expenses were $889,501,220. The value of products was $985,722,534. The value added by manufacture, which is the difference between cost of materials and value of products, was $328,221,678.

With regard to the number of wage-earners employed, the leading states in the order of their importance were as follows: Pennsylvania, Ohio, Illinois, Indiana, New York, West Virginia, New Jersey, and Massachusetts. The accompanying table gives the average number of wage-earners, the value of the products, and the value added by manufacture in these states.

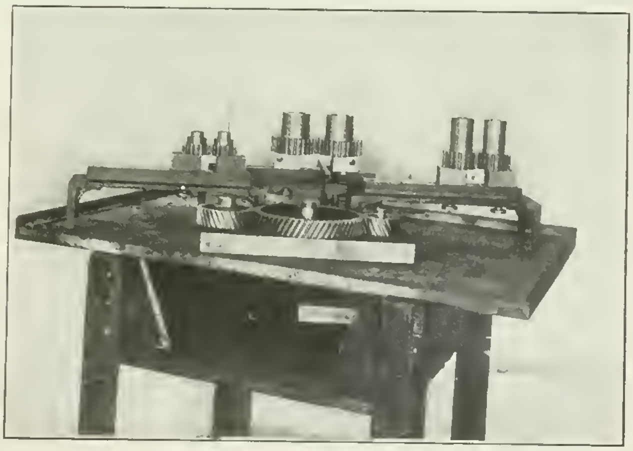


Fig. 16. Spur and Spiral Gear Testing Apparatus

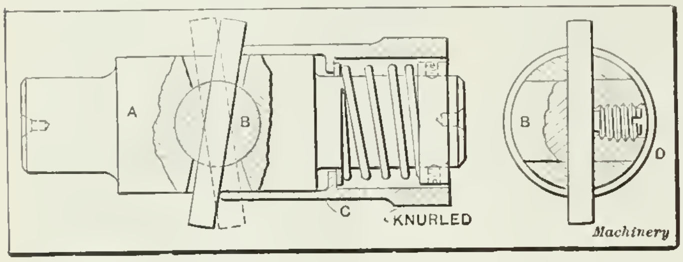
States	Average No. of Wage Earners	Value of Products	Value added by Manufacture
Illinois	17,584	$86,608,137	$30,363,674
Indiana	12,255	38,651,848	12,553,089
Massachusetts	3,115	13,567,628	3,535,355
New Jersey	4,671	12,013,719	5,378,679
New York	10,091	39,532,414	13,643,244
Ohio	38,586	197,780,043	58,536,888
Pennsylvania	126,911	500,343,995	171,330,574
West Virginia	5,060	22,435,411	6,539,111

LETTERS ON PRACTICAL SUBJECTS

We pay only for articles published exclusively in MACHINERY.

GRINDING GAGES WITH SPHERICAL ENDS

A number of spherical end gages, from 2½ to 6 inches long, were to be made, and the device shown in the accompanying engraving was designed for grinding them so that they would be of the correct length when measured anywhere over the ends. This device can be used on any grinding machine having ordinary centers. The illustration practically explains itself. One end of bar *A* is turned down to suit the ordinary driving dog. The other end is turned down for a spring and provided with a stop-collar. The central portion is bored and ground to fit the swiveling plug *B*, and has a slot cut through it at right angles to the plug. This slot should be of the same width as the diameter of the gage to be ground. The swiveling plug is drilled and reamed to fit the gage and provided with a clamping screw *D*.



Device for Grinding Gages with Spherical Ends

A piece of round steel of the same diameter as the gage to be ground and with a length equal to the diameter of the bar *A*, is inserted through the slot and clamped in the swiveling plug. The outside of the bar and the ends of the plug are now ground up together to suit the bore of sleeve *C*. This sleeve keeps the plug in position when the gage is removed, and, being provided with a cam surface on its end, gives the required motion to the gage being ground. The right-hand end of this sleeve is knurled so that the operator can grip it and hold it stationary while the remainder of the device rotates.

The gages to be made are rough-turned, cut off to the required length with proper allowances, and the diameter ground to suit the slot and the bore of the swivel. Then the centers are removed and the gage inserted in the fixture and clamped central by screw *D*, and finish-ground on the ends. Only a slight grip on the sleeve is required to hold it stationary, so that the gage to be ground will swivel to and fro against the cam surface on the end of the sleeve.

G. R.

SEASONING CAST IRON

In the June number of MACHINERY, R. L. S. asks for some method for quickly seasoning castings. The writer would advise him that the quickest way of removing the internal strains is to anneal the castings, provided facilities for this process are at hand. Mr. George M. Bond of Hartford, Conn., whose work in connection with accurate measuring machines is well known, first has the beds of the machines rough-planed and then anneals them in the Jones process furnace. In this furnace, which is the invention of Mr. H. K. Jones of Hartford, Conn., the work to be annealed is kept in a closed receptacle. This prevents oxidation and the work will come out as bright as it goes in.

The measuring machine beds mentioned are of box section about three feet long; 1/16 inch is allowed for the finishing cut after annealing. The planing is practically all on one side and none of the castings have warped in the annealing process to such an extent that they would not finish up properly in the subsequent replaning; *i. e.*, they have sprung much less than 1/16 inch.

The special skill in connection with annealing lies in choosing proper points for supporting the casting and heating it to a low red heat only. It has not been found necessary to run the heat higher in order to eliminate all the internal strains. At the higher heat the casting would undoubtedly sag out of shape by its own weight.

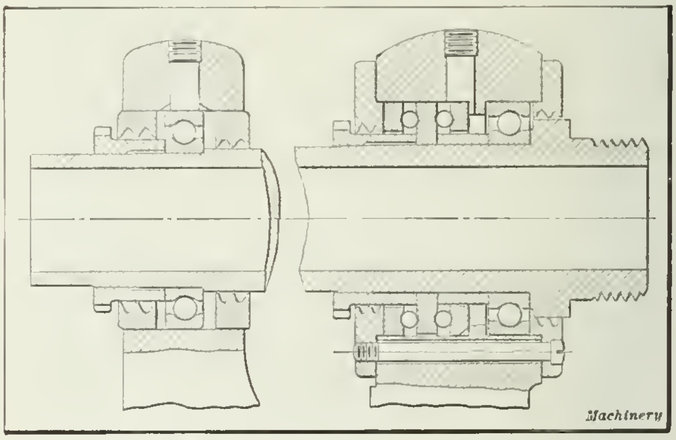
New Britain, Conn. R. S. BROWN

BALL-BEARING LATHE SPINDLE

Frequent references have been made of late in MACHINERY to the use of ball-bearings for the spindles of heavy machine tools. The accompanying drawing shows an example from actual practice of a spindle of a lathe of 16-inch center (32-inch swing) which has been in constant use for about two years. During the preliminary tests it was found that about 25 horsepower was needed for some of the cuts taken, although probably a 10-horsepower motor would have been ample for the ordinary duties of the machine.

The spindle runs at a speed varying from 22 to 505 revolutions per minute and has so far given no trouble whatever and has never required adjustment. The outside diameter of the front end of the spindle is 4¼ inches, and in addition to chucking work it can take bars up to 2½-inch diameter through the spindle. No vibration is felt under the heaviest cuts or during forming operations.

It will be seen that the thrust is taken at the front end by a double thrust bearing, the middle unit of which, together with the journal bearing, is clamped solidly to the front shoulder of the spindle by a notched nut, the bearings being retained at correct distances by sleeves or bushings. The retaining plates are clamped to the headstock by four fillister-head screws, as indicated. The one at the left-hand end of the bearing is adjusted once for all, it being considered advisable to make it impossible for the workmen to tamper with the adjustment. The argument for absence of facilities for adjustment is as follows: If adjustment should prove to be necessary after running, it would indicate that wear had taken place and if this happened it would only serve as a proof that the scheme was a failure—at any rate, as regards the thrust bearings; and if the thrust bearings were subject to wear, the journal bearings would, in all probability, be subject to wear also. In fact, it may be said generally of ball bearings that wear proves that either they are unsuitable or the bearing is too small. In the particular arrangement shown it was thought that since the thrust bearings were very closely adjusted this had some influence in restraining vibration.



Mounting of Ball Bearings for Lathe Spindles

S. PINDLE

LOCALLY CASEHARDENING GEAR AND CUTTER TEETH

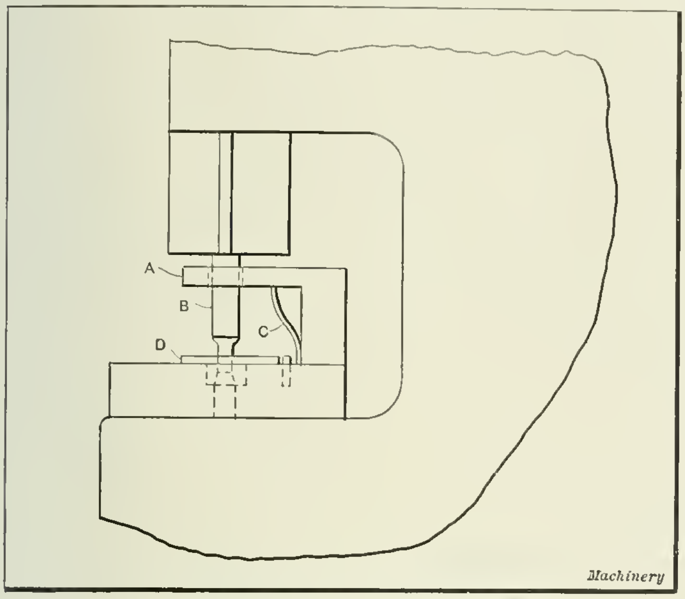
In the May number of MACHINERY I noticed an item on casehardening gears without distortion, stating that the Cadillac Motor Car Co., of Detroit, Mich., has solved the problem by copper plating the teeth after the roughing cut, and then taking a finishing cut which removes the copper plating from the faces of the teeth; then when the teeth are casehardened only the faces of the teeth harden, the remainder staying soft.

This process may be new to the Cadillac Motor Car Co., but not to me and many other skilled mechanics. As long ago as ten years I made long reamers that way and later I made broaches 4 feet long for broaching keyways in automobile gears, hardening them by this process. The only parts of the broach that were hardened were the teeth, and it worked very successfully in the shop of which I was then foreman.

J. A. L.

SPRING EJECTOR FOR PIERCING DIE

The accompanying illustration shows a device which in certain instances is useful in connection with piercing dies. With this device in use, flat blanks being pierced will be thrown out in front of the machine. The construction is simply as follows: The piece *D* when punched sticks to the punch *B* on the upward stroke, until it strikes stripper *A*, when it is stripped off. On its upward way, however, it compresses spring *C*, and is, therefore, suddenly pushed outward by the spring as soon as it is released from the punch. This device, while not new, may be of interest to many who have not seen it employed.



A Spring Ejector Arrangement for a Piercing Die

W. Alton

SUPERSTITION VS. COMMON SENSE

It is true that we no longer burn witches at the stake as did our Puritan forebears in Salem but superstitious beliefs are still too common to let us be very proud of our superiority. Common sense is a trait so uncommon that people endowed with it are regarded as uncommonly smart if not actual geniuses. In the past, Machinery has expressed a few ideas on the prevalence of superstition among engineers and others in charge of machinery. An engine or pump may have run satisfactorily for several years and then without apparent reason it goes wrong. After perfunctory tinkering and a half-hearted attempt to find the cause and correct it, the job is given up in despair by those immediately responsible for its operation. If it be a small, comparatively cheap apparatus it may be unceremoniously dragged out and replaced with a new one on the assumption that the old one is beyond hope, and a lurking belief is betrayed that no amount of repairs could have made the thing go. The men in charge may be able to learnedly discuss steam engine diagrams, heat units in steam, condenser capacity, etc., and would be righteously indignant if called superstitious.

To illustrate the attitude of workmen toward apparatus I will mention a case of an ordinary kitchen range in a rented house which gave trouble to the good housewife who essayed to use it. It would not bake or boil. The fire burned red and lifeless. Plumbers, experts and non-experts examined and agreed on a common verdict, "That range is no good; it must be replaced." Replaced it was, but the owner who is not a believer in witchcraft and who holds that the laws of nature operate without regard to location, set the stove up in his own house and quickly discovered the cause of the trouble—a wide gap between the water back and the casing that let the air pass which should have gone through the fire and supported combustion. A few handfuls of furnace cement stopped the air leak and converted a worthless range into a thing of joy and a household delight.

No, superstitious beliefs in the mechanical world are not dead. They will live as long as ignorance exists and men are not taught to seek diligently and intelligently for causes and effects.

F. E. R.

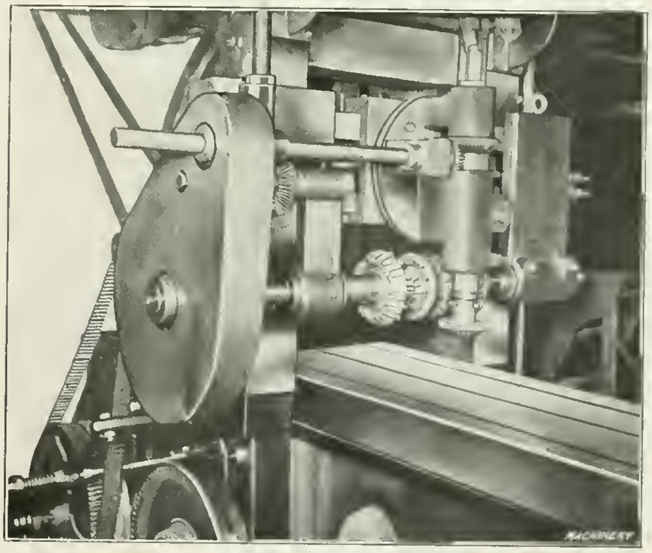
PREVENTION OF RUST ON TOOLS

No doubt a great many of the readers of Machinery have noticed the rust formation that takes place on tools within a few hours after they have been hardened in brine or in any of the numerous hardening solutions containing different salts used for this purpose. To counteract this rusting of tools, they should be boiled in a strong solution of soda water for fifteen or twenty minutes after having been hardened. Sal-soda (common washing soda) is the kind to use for the solution. A kettle holding about six or eight gallons of water may be used. About five pounds of soda are put in at the start, and after that about one to one and one-half pound is added every day. In this way the strength of the solution is kept about right. The addition of soda is necessary on account of the overflow which is required because of the method used for heating, the solution being brought to the boiling point by introducing steam. The work should always be boiled before being put into the tempering furnace and the latter should be at a temperature of about 212 degrees F. when the tools are changed from the soda kettle to the furnace. A basket arrangement with windlass may be used for raising and lowering the work to prevent scalding the hands. The directions given, if followed, will prove of advantage in hardening and tempering tools, in that the formation of rust will be prevented.

Decatur, Ill. George Coles

A MILLING ATTACHMENT FOR THE PLANER

The accompanying halftone illustrates a milling attachment designed for, and mounted on, a Putnam planer. This attachment is used for milling a great variety of work. It consists mainly of a horizontal head, a vertical head, a tailstock, and driving mechanism. The cutter heads are driven from the regular planer countershaft by means of a cone pulley mounted on the countershaft and belted to a cone pulley on the main driving shaft of the attachment. A planetary gearing mechanism is provided to reduce the table travel to a rate suitable for milling. This mechanism is also driven from the regular countershaft on which is placed a small two-step cone pulley belted to a large two-step cone pulley on the planer, which carries the planetary pinion. The motion is then transmitted to the planer table by a Morse silent chain and sprockets, in addition to the regular gearing. The planetary gearing is of such a ratio that the



A Milling Attachment for the Planer

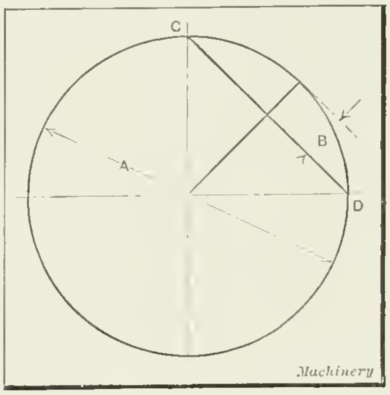
driven gear makes one revolution for every fifty revolutions of the cone pulley.

The attachment is very convenient and durable and has been in operation for eight years without any repairs. It is used on a planer with a 16-foot table. It is easily attached and detached. The planer is run back with the regular planer reverse belt, and, in general, is operated with the regular equipment for table travel, such as stops, etc.

Seneca Falls, N. Y. W. H. Runge

LAYING OUT THE CIRCUMFERENCE OF A CIRCLE ALONG A STRAIGHT LINE

The accompanying illustration indicates a simple method for laying out the circumference of a circle along a straight line. This is frequently required in laying out cylindrical grooved cams, and in finding, graphically, the angles of thread helixes or spirals. The method is, briefly, as follows: Divide the circle by two diameters into four equal parts; then draw a line *CD*, bisect this line, and measure the distance *B*. This distance, added to three times the diameter, is a close approximation of the total circumference.



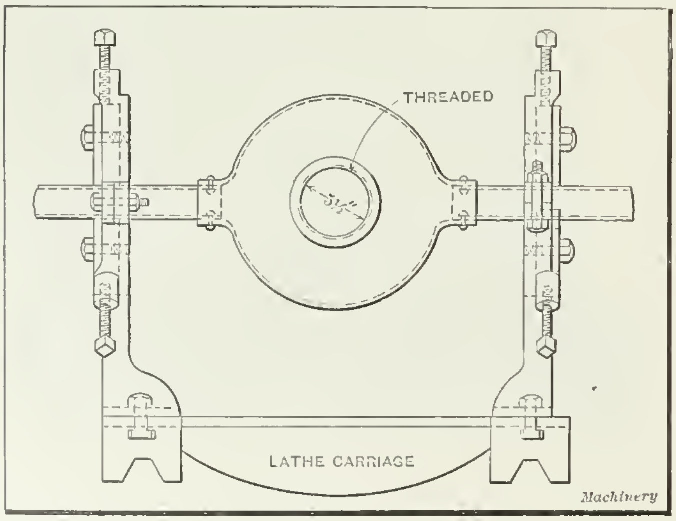
Laying Out Circumference of Circle

The accuracy of the method may be easily investigated. The distance *B* is the versed sine of 45 degrees, which equals 0.29289. This multiplied by the radius of the circle, plus three times the diameter, gives the approximate circumference obtained by this method. Assume, for example, that the circle is 4 inches in diameter; the actual circumference then equals $4 \times 3.1416 = 12.5664$. By the approximate method we obtain $3 \times 4 + 2 \times 0.29289 = 12.5858$. The difference between these two dimensions is negligible in ordinary drafting-room lay-out work. I believe this will be found helpful to readers who are looking for a simple graphical method which saves calculation or reference to tables.

Christchurch, New Zealand. Percy W. Frampton

THREADING A DIFFERENTIAL GEAR CASE IN THE LATHE

The writer was recently confronted with the task of cutting an internal thread in a differential gear case for an automobile. The axle casings were riveted into the case as shown in the accompanying engraving, which prevented swinging the case in the lathe; hence, it was necessary to clamp the work to the carriage and use a rotating tool fastened to one of the chuck jaws. The clamping of the case was done as shown, the work being performed in a 28-inch lathe. Steadyrests, which supported the work, were taken from two smaller lathes in the shop. These rests were bolted to the 28-inch lathe carriage. The jaws of the steadyrests clamped the work very securely, and furnished a simple method for setting the work central.



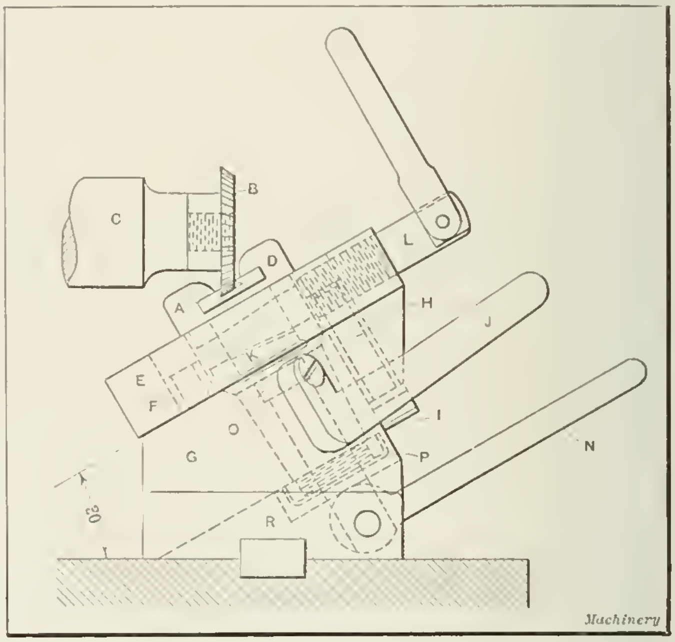
Threading a Differential Gear Case in the Lathe

Denver, Colo. Stanley Edwards

FIXTURE FOR MILLING DOVETAIL SLOTS

Previous to the design of the fixture, the principle of which is shown in the accompanying engraving, the dovetail slot in the steel block *A* was cut with a 60-degree angular cutter, 7/32 inch in diameter, having a neck about 5/32 inch in diameter, and a No. 4 Brown & Sharpe taper shank; or in other words, a cutter was used of the same size and shape as the slot. A roughing cut was first taken with an ordinary slitting saw. The finishing mill in that case, of course, had to be exactly to size, and to run true. High-speed steel was used for the mill, and a fine feed was required; the operator also had to exercise considerable care in starting the cut, as otherwise the cutter was likely to break.

By milling these pieces as indicated in the illustration, the cutter *B* can be made large in diameter; it is easily ground to the required angle and can be re-ground without materially affecting its efficiency; a coarse feed can also be taken. Another favorable feature of the fixture is that the slot is finished at one handling, although, of course, two cuts are taken. As will be seen, the cutter is mounted on a threaded arbor *C*. The work is held in block *D*, which is the end of the spindle of the fixture. The square indexing plate *E* is keyed to this spindle. In this plate there are two bushed indexing holes *F*, 180 degrees apart. Chips are prevented from getting into these holes by plugs at the top of the plate. The base casting *G* is provided with the usual tongue to locate it in alignment with the milling machine table. The upper surface of this casting is machined at an angle of 30 degrees as indicated. As the axis of the spindle is inclined at right angles to the 30-degree surface of the base, one edge of the dovetail slot is brought at right angles to the center line of the cutter arbor. A 60-degree cutter is used, and as its width is a little more than one-half the distance across the bottom of the dovetail, the two cuts, the second of which is taken after indexing the work around, finish the piece. The index pin *H* is held in bushing *F* by a flat spring *I*. Lever *J* is used for pulling the pin *H* out before indexing.

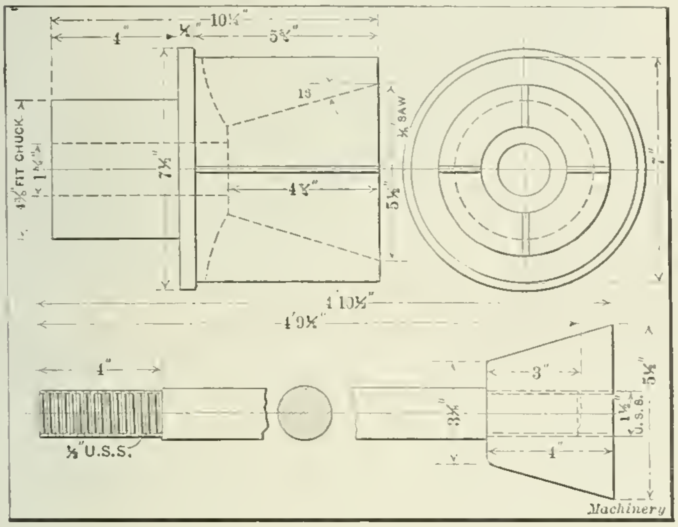


A Fixture for Milling Dovetail Slots at a Rapid Rate

The work *A* is clamped against the upper side of the slot in *D* by means of the plunger *K*, which is actuated through screw *L*, the handle of which acts as a wrench. The clamping is done by means of the wedge action due to the taper of screw *L* on that part of it which is inside of *K*. The spindle and plate *E* are clamped in position before taking a cut by means of cam lever *N* acting through cam-shaft *O*, which has on its upper end a head for pulling the spindle down. Some of the details are rather obscure in this view, but it is all that is necessary to explain the principle involved.

East Orange, N. J., J. W. Weed and
Tottenville, N. Y. S. J. Putnam

EXPANDING ARBOR FOR HEAVY TURRET LATHE WORK

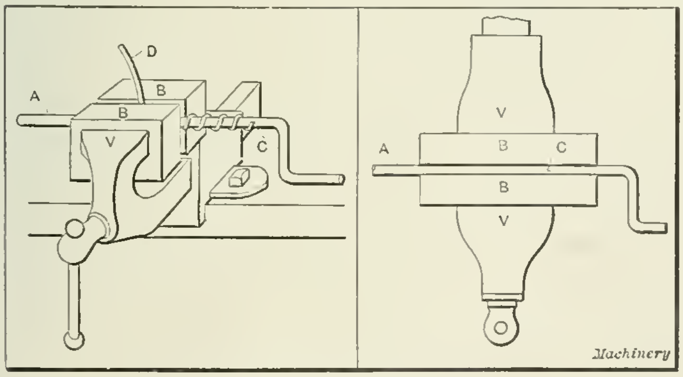


Expanding Arbor for Heavy Turret Lathe Work

The accompanying engraving shows an expanding arbor of heavy design which has proved satisfactory for rapid and accurate work on a heavy turret lathe. As will be seen, the arbor is intended to fit the chuck on the machine, and is provided with an expander having a bolt which extends through the entire spindle, this arrangement allowing for quick expansion by means of a handwheel and washer on the end of the bolt. By means of this arbor the work is secured and held central for facing, turning or counterboring, independently of the chuck jaws, and the jaws are needed only to act as drivers. Whether the chuck is of the independent or universal type, it is possible to hold the casting true to the bore by means of this arbor, and a great deal of time is saved that is ordinarily spent in truing up work held by the chuck jaws only. At the same time, variations in the bore are taken care of by the expansion feature. M. W. W.

METHOD OF WINDING SPRINGS IN A VISE

The accompanying illustrations show a method of winding springs in a vise. The writer has used this method for a number of years, but has never seen it described in Machinery. In the device, *A* is a rod so selected that it will give the correct inside diameter to the spring. The diameter of this rod must be determined experimentally, as there must be some compensation for the enlarging of the spring when released. This rod is bent at one end to form a crank. A hole *C* is drilled near the crank end. This hole should be large enough to allow the end of the spring wire to enter. At *B* are shown hard-wood blocks, *V* being the vise jaws.



Winding Springs in a Vise

The rod *A* is clamped between the wooden blocks with the crank as close to the blocks as possible, and with the hole *C* in a vertical position. The end of the spring wire is inserted into the hole. At the start the wire *D* must be guided so as to give the correct pitch. If held in a vertical position, the spring will be close-coiled. If inclined to the left, the coils will be open; the more the inclination, the wider the spacing. The first turn determines the pitch. After the first turn, a groove is formed in the wooden blocks and the wire will follow this groove. When the rod has passed through the blocks, or the wire has come to an end, release the blocks and cut the wire at hole *C*, thus allowing the spring to slide off the rod.

When springs are wound in this manner it seems that they do not enlarge as much in diameter when released as they do when wound in the lathe. The reason for using hard-wood blocks is that the wire "beds" into soft wood too easily.

Ft. Atkinson, Wis. E. L. White

HANDY TOOL-HOLDERS

The three tool-holders shown in the accompanying engravings have proved a valuable part of a toolmaker's equipment. In Fig. 1 is shown a splining-tool holder used for work where an ordinary holder cannot be used to advantage. The tools are made of 5/16-inch drill rod, forged to the desired shape, and are firmly held in place by the clamping arrangement shown in the engraving. In Fig. 2 is shown a tool-holder for forming tools, when the cutters are made in quantities. This tool-holder is of considerable value; the forming tools may be made at low cost, and in case of breakage can be easily replaced.

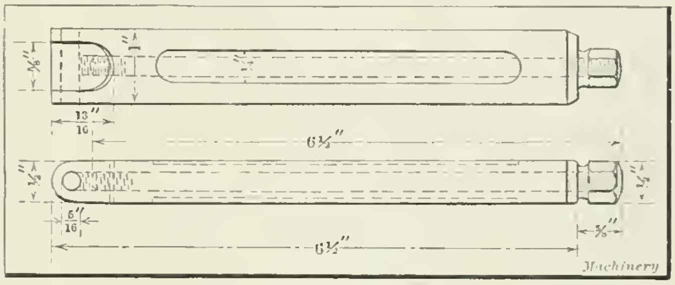


Fig. 1. Splining Tool Holder

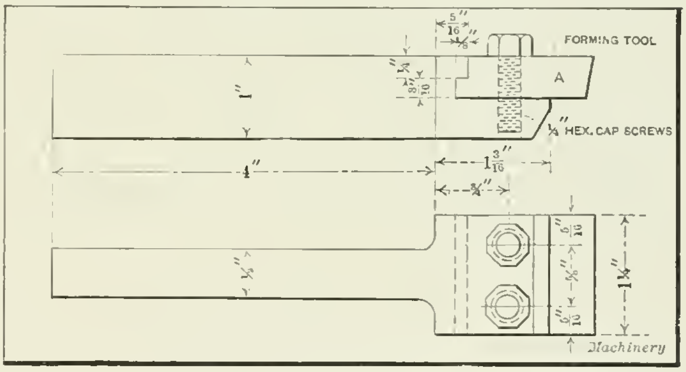


Fig. 2. Forming Tool Holder

In Fig. 3 is shown a tool intended primarily for threading operations, but it can also be used for light forming work. All parts of this tool are made of steel and casehardened. This tool is adjustable to three positions, right-hand, left-hand, and central. The head *B* is made a snug fit in body *E*, and is held in place by rod *G*, which is forced against it by set-screw *C*. Three flats are ground on head *B* so that it may be held rigidly in any of the three positions. Three holes *F* are drilled in the body *E*, one central, and the others at an angle of 30

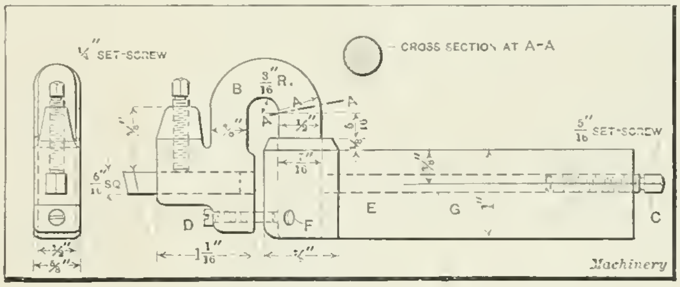


Fig. 3. Spring Threading and Forming Tool Holder

degrees, on each side of the center, for the adjusting screw *D*. When the tool is used for threading, screw *D* does not reach fully down to part *B*, but a clearance of 1/32 inch is left. In this way the required elasticity of the threading-tool is provided for. When a rigid tool is wanted, it is only necessary to screw *D* tightly into place.

New Britain, Conn. J. M. HENRY

A DRILL JIG FOR A NUMBER OF LEVERS

Fig. 1 shows four levers, *M*, *N*, *O* and *P*. The length *l*, the width of the hub *h*, the hole *a*, and the position of the lever arm in relation to the hub, are different in all cases, while the hole *b* is the same for all. The levers are machined in sets of four (one of each kind), which go through all operations together until they are ready for the machine for which they are designated.

The hole *a* is simply bored in the center of its hub, while *b* must be drilled by means of a jig, since the distance *l* from center to center must be absolutely correct. It would mean a considerable loss of time, however, to change the jig for every lever, and the necessity arose, therefore, to design a jig which would allow the drilling of all the levers without taking the jig from the drill press table.

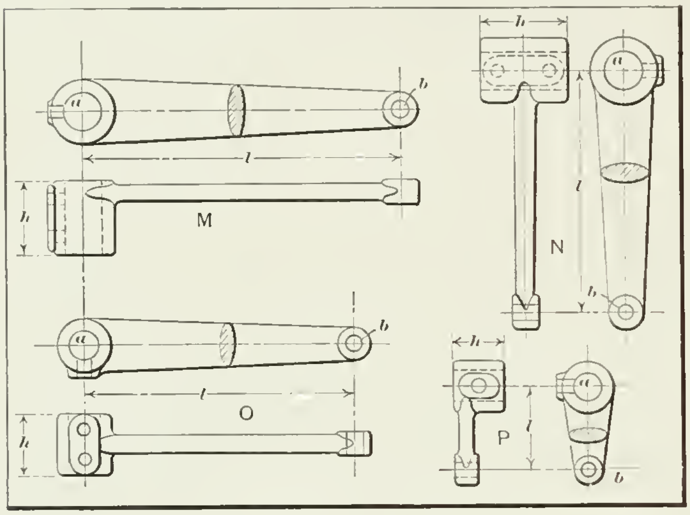


Fig. 1. The Four Levers to be drilled

Figs. 2 and 3 show a jig constructed for that purpose. Fig. 2 shows a top view, a longitudinal section and a cross section, while Fig. 3 shows a general view of the jig with lever *M* in place. The jig consists of a cast-iron base-plate *A* which is cast with a projection *B*. This projection has three ribs *L*. The center rib is worked out to receive a hardened steel hinge *C* which swings about a pin *R*; *C* may be laid over to both sides, which are also worked out to suit the hinge. Each side is provided with a small steel lever *D*, with handle *S*, which serves to hold the hinge in its position while the jig is in operation. The guide hole *T* for the drill is used in both positions. The V-shaped part of *B*, directly underneath the guide hole (see section along *a-a*) aids the chips in falling off. Screws *U* are provided to adjust the levers sideways. The correct distances for the lengths of the various levers are laid off, as shown. At the points thus found, studs *E*, *F*, *G* and *H* are provided to suit the respective levers. A collar *K* is fitted to each of these studs. Every collar suits the hub of the lever which it is supposed to support, and may be fastened at any height by means of a screw *V*. The hardened center-point of the latter slides in a V-shaped groove provided for that purpose, thus preventing the collars from turning, and the handles of the screws from interfering with the body of the jig. Collars *K* hold the levers in the correct horizontal position.

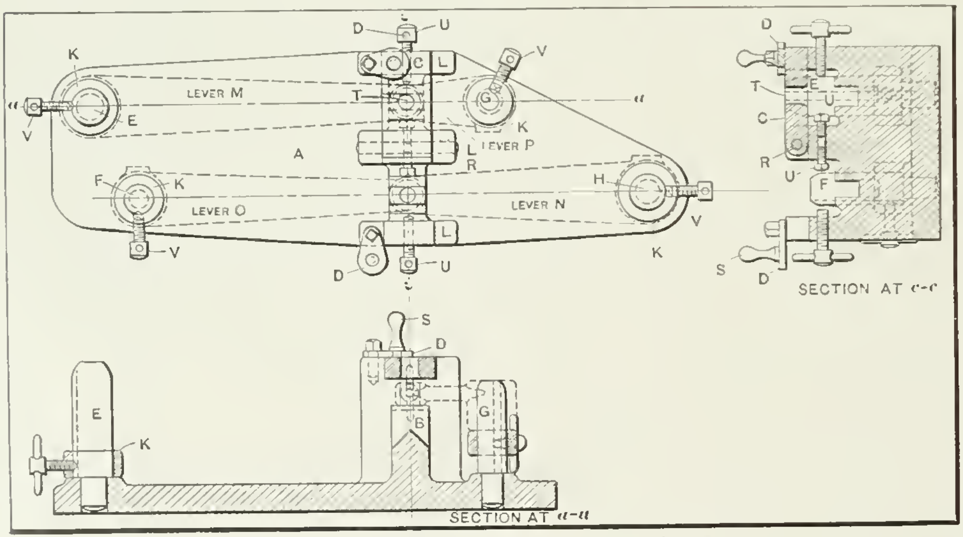


Fig. 2. Plan and Section of Drill Jig for Levers in Fig. 1

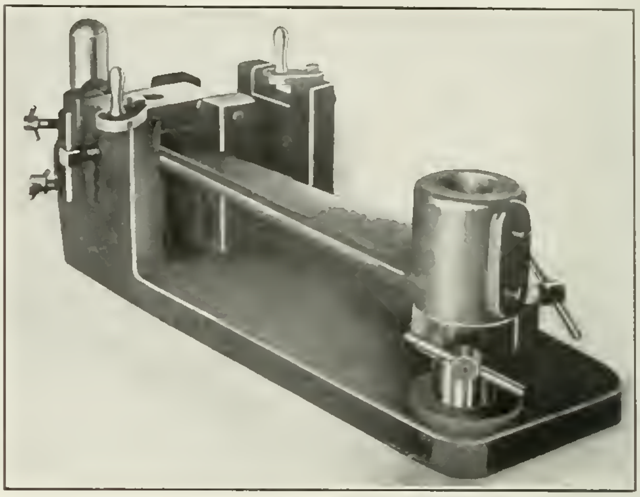


Fig. 3 General View of Drill Jig

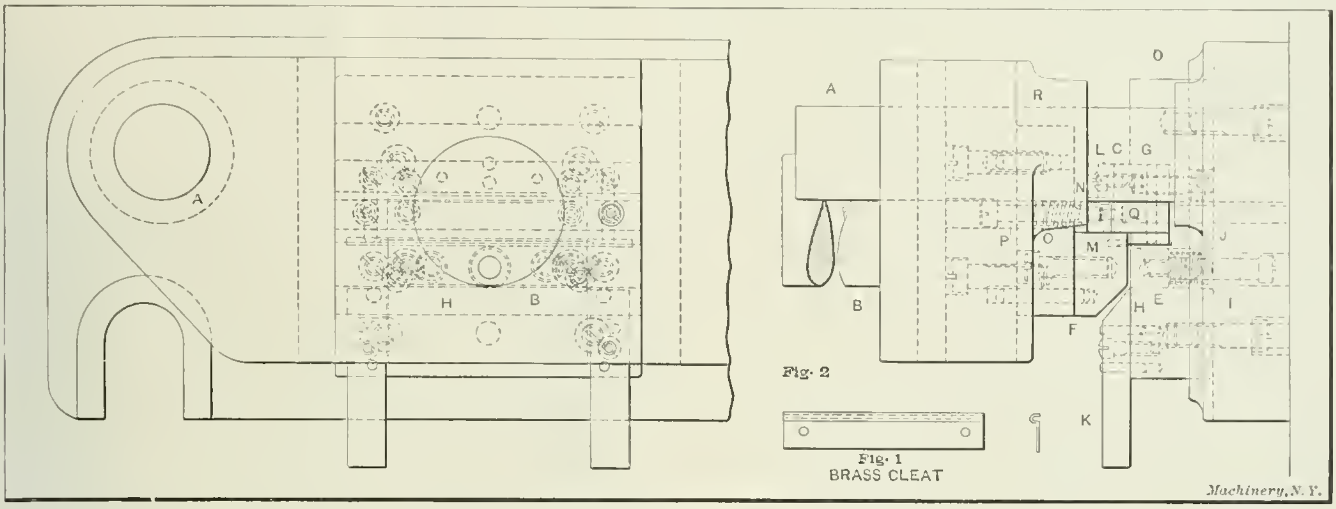
Wyomissing, Pa. CHRISTIAN F. MEYER

SUB-PRESS DIE FOR MAKING A CLEAT

The sub-press die shown in Fig. 2 was designed for producing the brass cleat shown in Fig. 1, this die superseding a set of simple dies previously used for the purpose. With the dies previously made, it required three operations to produce a cleat, the rehandling necessary causing considerable loss of time.

The base and upper portions of the sub-press die are made of cast iron, in the usual form, and are equipped with hardened and ground pins *A* to preserve the alignment of the upper and lower members. A cast-iron shank *B*, fitted in a T-slot cut in the upper member, serves to connect the latter with the ram of the press. Attached to the lower member or base is a hardened tool-steel block *C* mounted by means of screws and dowels on a soft-steel shoe *D*, and entering into a slot cut in the latter as shown. To the block *C* is held a "ribbon bar" *E*, which, in conjunction with the slot in the block *F*, serves to fold the edge of the cleat. The ribbon bar is held to block *C* by two horizontal dowel pins *G*, so that in case of breakage a new strip may be quickly inserted.

The lower member of the die is cut out to receive a spring pad *H*, which acts as a stripper for removing the cleat from the ribbon bar *E*. This pad is actuated by three helical springs *I*, and is limited in its upward movement by the shouldered screws *J*. The two guide strips *K* make provision for the entrance of the strip into the dies. A feed stop-bar *L*, mounted on the block *C*, controls the width of the finished cleat, and a stripper-plate *M*, sliding on the piercing punches *N*, holds the stock while the holes are being pierced. On the ascent of the press, stripper-plate *M* strips the cleat from the piercing punches. The stripper *M* is pressed downward by coil springs *O*, and is retained from further movement by the shouldered screws *P*. The block *F* which acts as a bending punch is mounted on a soft-steel block *R* which, in turn, is attached to the upper member of the sub-press die.



Figs. 1 and 2. Cleat and Sub-press Die for Producing it

The operation of this sub-press die is as follows: Stock of the correct width is fed in until the front edge of the strip is slightly beyond the shearing edge *Q* of blocks *F* and *C*. The first stroke of the press shears off the front edge of the strip, thus straightening it, and at the same time forming the bend in the blank. When the ram of the press ascends, pad *H* forces the bent strip from the ribbon bar *E*, so that the strip can be fed forward against the stop *L*. When the ram again descends, the holes in the blank are pierced, the first blank cut off, and the part for the next blank bent to the required shape. The finished cleat is ejected by means of a wooden pencil or rod, and the stock is fed in continuously in the manner described.

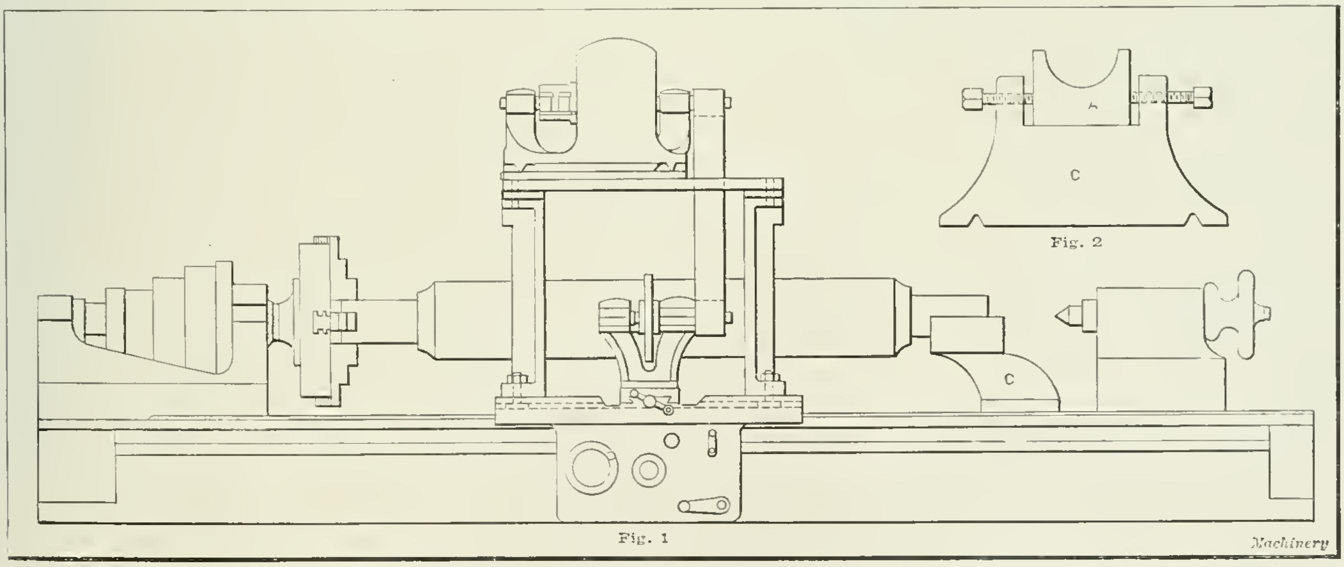
It will be noticed that the only scrap made is the small disks punched out of the strip by the piercing punches *N*. In practice, about 100,000 cleats may be punched without sharpening the die, for which, it will be noticed, due provision has been made.

Aron Lawrence

Detroit, Mich.

GRINDING CALENDER ROLLS

In a small job shop in which the writer was recently employed some paper mill calender rolls were to be ground.



Figs. 1 and 2. Method of Grinding Calender Rolls in a Lathe

The machine in which the work was done was an 18-inch lathe with double back-gears. The length of the lathe over all was about 14 feet, and both ends and the middle support were set on masonry. The length of the face of the rolls to be ground was 74 inches, and as the width of the paper was 72 inches, there was left a margin of about one inch at each end of the roll which had not been subjected to wear, but from which it was possible to approximately obtain the alignment in setting up. After removing the compound rest on the cross-slide, an emery-wheel stand made for the purpose was securely mounted in its place, and so adjusted that the axis of the emery-wheel shaft was in the same horizontal plane as the axis of the spindle. A stand was also set up on the carriage and secured to it by means of bolts in the T-slots of the saddle. This formed a support for a 3 H. P. motor for driving the emery-wheel.

As calender rolls cannot be ground on their centers, but must be ground to their bearings, a bracket *C* was made, the face of which had grooves fitted to the ways of the lathe and which was clamped in the same manner as a steadyrest. On the top of this was a skeleton pillow-block *A* (see Fig. 2) that could be moved and secured by means of set-screws. The first roll to be ground was the top roll, which was about 12 inches in diameter and weighed about 3700 pounds. One end was chucked as indicated in the illustration, and the other end was temporarily held by the tail-center, while the chuck end was trued up accurately. The pillow-block was then put under the bearing at the tail-stock end and babbitt was poured into it, after which the tail-center was withdrawn.

As the roll did not need to be ground to any specified dimension, but the one consideration was absolute parallelism, any instrument by which this latter could be ascertained could be used. In this case we used a homemade measuring device which looked like an overgrown micrometer, for it had a range up to 16 inches. The measuring screw had 40 threads per inch and could be clamped in its nut. Both ends of the roll were trued up, that is, ground to equal size within a limit of less than 0.001 inch, this limit being obtained when the micrometer readings on the cross-feed screw coincided at both ends. Then the entire length was ground, but, for some reason, the first roll was badly out of round and some time was consumed before the wheel would take an even cut over the entire length. On testing, we found the difference in diameter to be equal to six thicknesses of cigarette paper (the thickness of each paper was less than 0.001 inch). It took more than thirty hours to grind this roll. It was run at about 40 R. P. M., and the emery wheel was run at 1800 R. P. M. The diameter of the wheel was 10 inches, the face 1/2 inch, and the feed 3/16 inch. No water was used at any time.

Two wheels were used, the first a hard one but not very coarse, for the rough-grinding, and the second, a softer one, but somewhat coarser, for the finishing. The rough-grinding showed even "checks" about ½ inch wide all over the roll, and neither variation in the speed of the roll nor in the feed would eliminate them. In the writer's opinion, the comparatively slow speed of the wheel was the cause of this. The wheel should be run from 500 to 800 more revolutions per minute. After finish grinding with the softer wheel, the rolls were polished with fine emery dust and oil on a pine board. The other rolls, two of which were 6 inches, and two, 9 inches in diameter, were finished in the same way but at a comparatively higher speed. During the operation the oil holes were carefully plugged and the ways covered with canvas strips to protect them from the emery dust.

This was the third job of the same kind done in this shop. The owner said that he had been told, over and over again, that calender rolls could not be ground on engine lathes. He had, however, been able to accomplish this work satisfactorily. The only difficulty he met with was that on the first roll he found that the machine continued to grind several thousandths of an inch smaller in the middle, although sparks indicated an even cut the entire length. This difficulty he succeeded in eliminating by blocking up with paper between the frame and the middle leg on the back side of the machine. It took him, however, nearly two weeks to find this error and correct it.

It may be considered a good method to have one end of the roll gripped in a chuck as indicated. Personally the writer thinks that it would have been better if the roll had been placed in a bearing at the front end similar to that at the back. In one case, when a very heavy roll was ground, a dog engaged in the faceplate and gripping the neck of the roll—the latter being supported in bearings at each end—was used in order to relieve the spindle of the weight. This method, however, did not prove entirely satisfactory, as there seemed to be a certain spring in the tail of the dog that caused the drive to be uneven and produced something like corrugations in the roll, which were difficult to eliminate; hence, it was considered better to grip one end of the roll in a chuck.

As already mentioned, in truing up the chuck end of the roll, the other end was supported by a tail center. After truing the end as close as possible with chalk, the chuck and bearing were cleaned and covered with a thin film of lamp black, evenly smoothed out and neatly wiped off. A finely pointed scriber was clamped to the end of the emery-wheel stand and run up by the cross-feed screw. The roll was then revolved and adjusted by the chuck jaws until the scriber point traced a line evenly in the film all along the bearing.

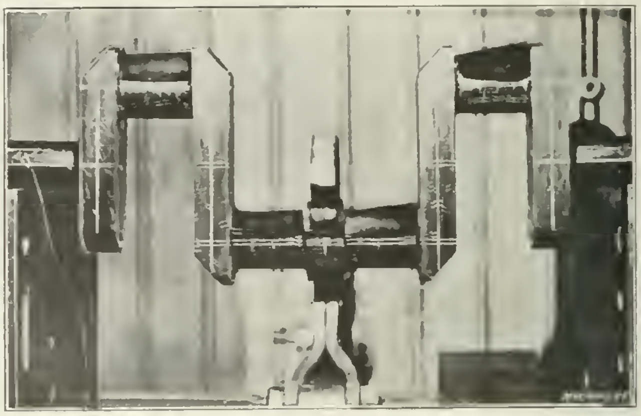
Clinton, Iowa. Olof N. Nord

OBSERVING THE DEFORMATION OF MACHINE PARTS BY PHOTOGRAPHY

It was required to study the deformation caused by deflection in a motor car crankshaft, in order to determine which of the parts should be strengthened. A photographic method was tried and found to be very successful. The crankshaft was covered all over with white enamel, followed by a light coat of a black, opaque varnish; then, by the sharp point of a surface gage, lines were traced on the crankshaft showing the various axes, these lines removing the black varnish wherever drawn, and showing white on a black background.

The crankshaft to be experimented with was of the two-throw type for a four-cylinder motor. The shaft was placed on a cast-iron bed in such a way that it had only two bearing points at the center of its outside bearings, and so that the throws were in a vertical plane. Weights could be applied by means of a hook and a lever, the load being applied to the shaft at a central point. The weights could be attached without moving the shaft in its bearings.

A camera was then placed in front of the crankshaft in such a way that the plate was parallel to the plane of the shaft, and then one photograph was taken without any load on the crankshaft; then without shifting the camera and after having suspended the load from the center of the crankshaft, a second photograph was taken on the same plate, the result being a composite photograph, as shown in the illustration. It will be seen that the white lines traced on the shaft are double, and the distances between two corresponding lines represent the deformation caused by the load at each point of the shaft. It will be seen that it is easy to determine which parts are the weakest, and, therefore, need strengthening. The lines on the central throws remain parallel to each other, which means that this part has not undergone any appreciable deformation. On the two vertical uprights, again, the lines are at an angle with each other which indicates that they have yielded and require greater strength. The distance between the two parallel lines at the place where the weight was attached was 1/8 inch under a load of 6600 pounds.



Deformation of a Motor Car Crankshaft as observed by Means of the Camera

Turin, Italy. C. Boella

AN ADJUSTABLE PIERCING PUNCH

To pierce a number of strips, as shown at A and B in Fig. 1, the adjustable piercing punch shown in Fig. 2 was designed, which obviated the necessity of making two separate piercing punch holders. This adjustable piercing punch was made so that the punch C could be forced back out of the way when it was necessary to pierce only one hole in the strip, as shown at B in Fig. 1. This was accomplished by holding the punch C in a bushing D which is counterbored to receive the spiral spring E, the bushing D being screwed into the punch holder.

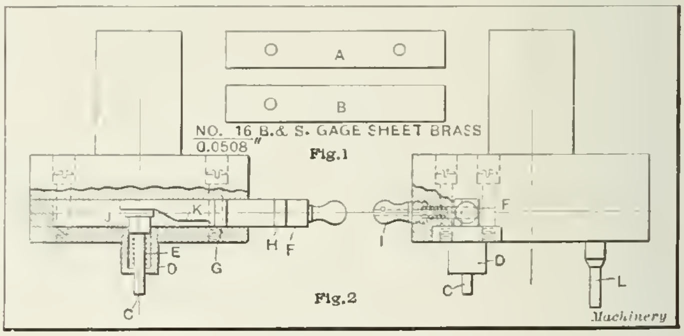


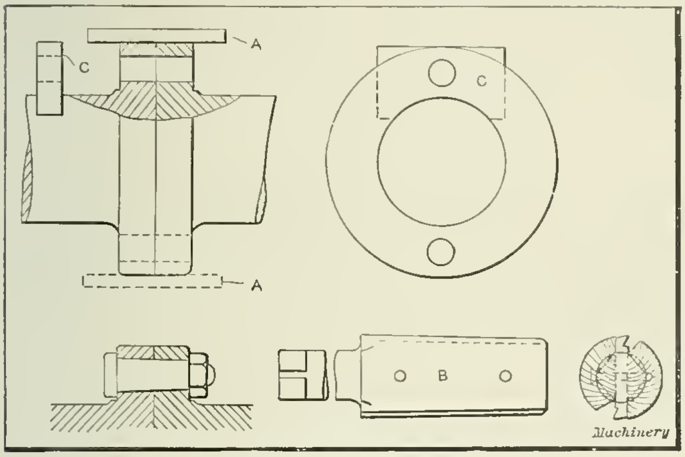
Fig. 1. Blank to be pierced. Fig. 2. Adjustable Punch used in piercing the Blanks

The punch C is provided with a head and is brought into or out of action by means of the cam plunger F, the latter being provided with two slots G and H in which the spring-actuated plunger I fits. When the punch is out of action it rests on the cam face J, the spring-actuated plunger I fitting in the slot G, and when it is in action the cam plunger F is pushed in so that the head of the punch C bears against the cam face *K*, the spring-actuated plunger *I* fitting in the slot *H*. The other piercing punch *L* is fastened in the punch holder in the usual manner. The die, of course, is provided with two holes. As can be seen, it is a simple matter to make this punch either into a one- or two-hole piercing punch.

Rochester, N. Y. W. R. Humelbaugh

REAMING MARINE ENGINE SHAFT COUPLINGS

As shown in the accompanying engraving, solid flange couplings are used for connecting marine engine shafts. Tapered bolts fasten the flanges together and keep the shafts in alignment. If there is a sufficient amount of work of the same size, a jig may be used for drilling the coupling holes; if not, the holes are marked off and drilled as accurately as possible without a jig. After removing the burrs from the coupling faces, temporary bolts are used to fasten the couplings together, and the edges of the couplings and the holes are brought into alignment. An ordinary steel straightedge *A* when tried at top and bottom and on both sides of the edges of the couplings will show when they are in line. This part of the work must be carefully done; otherwise the journal portions of the shaft will not run true. The bolt-holes are then reamed, a reamer often used for this work being shown at *B* in the engraving. It is tapered and consists of a two-edged cutter with pieces of hard wood packing, the whole arrangement being held together by screws. The hard wood pieces steady the cutting edges, and the shank is supported, during the reaming operation, in a plain bearing block *C* of hard wood or cast iron. A slight clearance should be allowed under this bearing block, as the holes may vary slightly in their distance from the shaft center, and the bearing block can be adjusted to the correct distance from the center by packing pieces of tin or sheet iron. If greater accuracy is required, a roughing and finishing reamer may be used, although one reamer is often sufficient. For small holes the reamer is frequently turned by a hand ratchet, no support being required, while, in the larger sizes, some portable means for driving that is available may be used. While reaming the holes, the alignment of the reamer should be tested two or three times to see that it is square with the flange. If the holes are not drilled exactly in line, the reamer may have a tendency to draw to one side. After fitting a tapered bolt in the first hole, the hole opposite should be reamed next and also fitted with a bolt; afterwards there will be no danger of the couplings shifting while reaming the remainder of the holes. The bolts are driven in tight with a heavy hammer. This type of coupling is used when a three-throw crank is built up of separate parts.

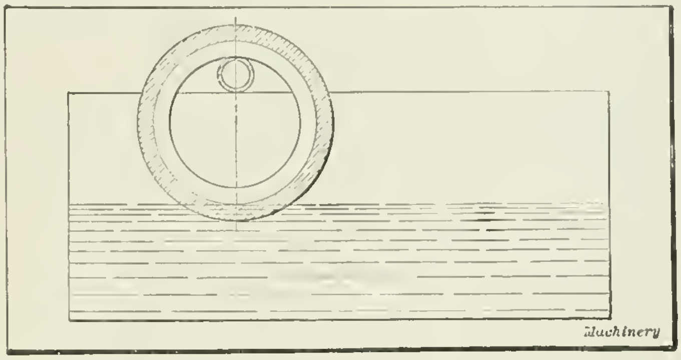


Method of Connecting Marine Engine Shafts, and Reamer used for Reaming the Taper Bolt Holes

Govan, Scotland W. Burns

REDUCING THE DIAMETER OF A RING

The writer recently met with an interesting job in the form of one thousand cast-steel rings that were to be shrunk on to the hubs of motor truck wheels. The rings were of rectangular section, 10⅝ inches inside, and 16½ inches outside diameter. The thickness was 1¾ inch. These rings were faced on one side and bored to within a limit of 0.002 inch. The work was done in small lots, covering a period of more than six months, and different men and machines were employed on the work; hence, quite a number of the rings were bored too large. The specifications in connection with this work did not permit any forging to be done on these castings, and the appearance of any hammer marks would not have been permissible. A satisfactory method for shrinking the diameter of the rings, however, was developed. The rings were heated to a bright cherry red in a furnace, and then hung on a piece of pipe laid across a tank of water as indicated in the accompanying illustration. The level of the water in the tank was so gaged that the outer edge of the ring only was immersed. As the pipe was rolled along the tank, the outside of the ring was rapidly cooled, and in shrinking forced the inside stock inward so as to allow enough stock for reboring.

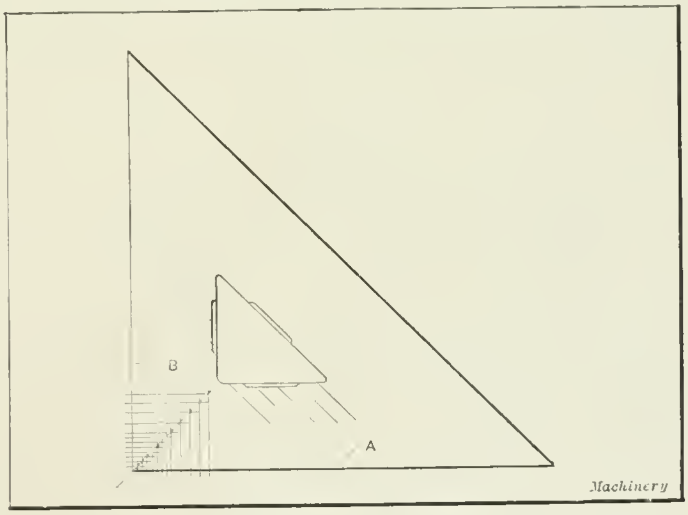


Method of Reducing the Bore in a Ring

Rochelle, Ill. J. H. Maysilles

USING A TRIANGLE TO FIND CENTERS OF RADII

Anyone who has parts to draw requiring a number of radii no doubt will appreciate this method of locating the centers. An ordinary draftsman's triangle is laid out as shown in the accompanying illustration, for radii varying from 1/16 to 1/2 inch, advancing by sixteenths of an inch, and from ½ to 1 inch, advancing by eighths of an inch. An easy way to lay out the holes in the triangle is to use a surface gage to scribe the lines, placing the triangle on a surface plate. The holes drilled in the triangle should be of the same diameter as the needle point on the compass.



Triangle for Locating Centers of Radii

To use the triangle, place the sides *A* and *B* tangent to the lines to be connected with the radius, usually a quadrant, and prick the center with a needle point. If the holes in the triangle are accurately spaced, any radius within the range of the triangle can be easily and quickly laid out.

New Britain, Conn. J. M. Henry

* * *

A writer in the *Iron Age* states that by the extrusion process zinc may be transformed into a fine, crystalline structure, the tensile strength of which is 23,000 pounds per square inch.

SHOP KINKS

PRACTICAL IDEAS FOR THE SHOP AND DRAFTING-ROOM

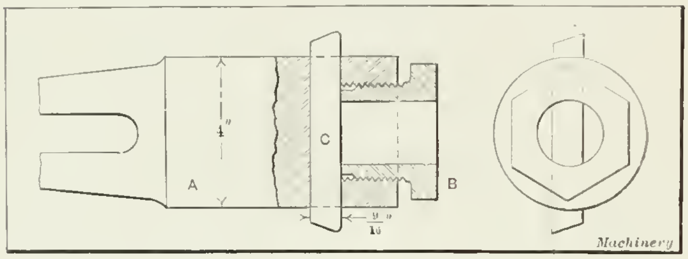
Contributions of kinks, devices and methods of doing work are solicited for this department. Write on one side of the paper only and draw sketches on separate sheets.

TO PREVENT THE FILE FROM CLOGGING

The following kink is probably known by most machinists but it may be helpful to some of the young fellows. When filing a poor quality of wrought iron in the lathe I had much trouble with the file clogging up, until I found that by bearing down slightly on the return stroke the offending chips would be removed. W. K.

EFFECTIVE MEANS OF HOLDING A CUTTER IN A BORING-BAR

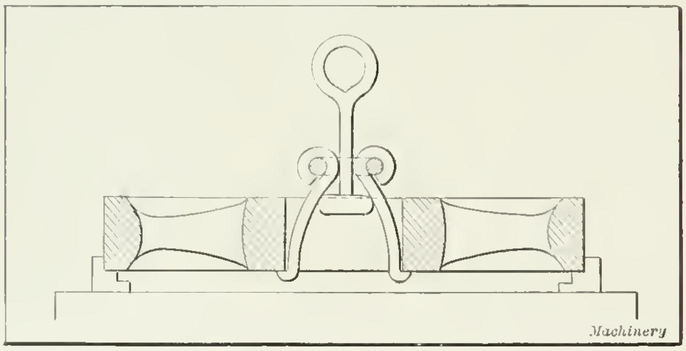
The accompanying illustration shows a simple and effective means of holding a cutter in a boring-bar, which has been used successfully for boring car-wheels. The end of the boring-bar *A* is tapped out to receive the hexagon clamping screw *B*, which holds the cutter *C* firmly in the bar, preventing it from chattering or moving. The clamping screw *B* is casehardened on the end, and is made hollow so that the cutter will be held more firmly.



Vancouver, B. C. J. C. Mattison

DEVICE FOR LIFTING LOCOMOTIVE DRIVING WHEELS

The accompanying illustration shows a simple device which the writer recently saw employed in a Western shop for lifting locomotive driving wheels. This device could also be used to advantage for lifting large pulleys, etc. It consists essentially of three prongs or hooks (one of which is not shown) made from $\frac{3}{4}$-inch round iron, a welded ring and an eye having an enlarged end for opening the hooks which grip the wheel by the hub. M.



BABBITTING BOXES

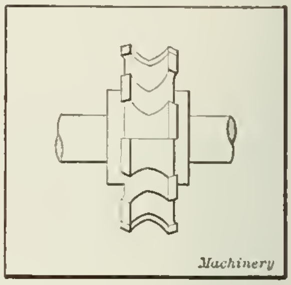
In using a shaft as a mandrel to babbitt boxes with, I have found from experience that wrapping a piece of paper around the shaft before placing it in position will make a good clean piece of work—smooth and glassy. The paper may be pasted on the shaft with shellac or glue where the edges meet. Let the paper extend the full length of the box and the edges just meet on the shaft. The paper, besides making the babbitt run smooth, also provides a little clearance, and the bearing does not require so much scraping. Those who do not care to use paper will get a smooth bearing by rubbing chalk on the shaft before babbitting.

I have seen a good many mechanics pour babbitt in boxes without venting them and then wonder why it is that they have to patch so much. I have always worked under these rules in running babbitt and have had good success: First, always have plenty of vents; second, make the babbitt good and hot; third, pour the babbitt as fast as it will flow through the pouring hole, and always use a few drops of oil on the risers.

Montpelier, Ind. J. T. Cromack

PREVENTING A ROUND BELT FROM SLIPPING ON A GROOVED PULLEY

It is sometimes found necessary to use a round belt and a V-pulley in order to avoid a complicated mechanism. One of the difficulties which arises from using a small V-pulley is the slipping of the belt. This can be avoided by making the pulley as shown in the accompanying illustration. It is made in the ordinary manner but is provided with spaces which are cut out at intervals in the sides of the face. This type of pulley completely overcomes any slipping of the belt. F. D.



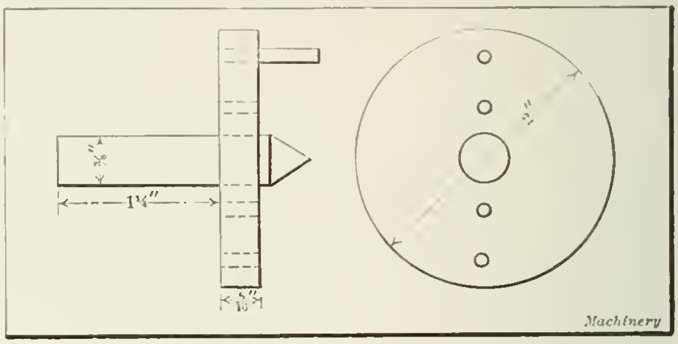
TO PREVENT SCALE ON DIES WHEN HARDENING

A good way to prevent scale on dies when hardening is to dip them in water before they are heated and then put them into dry salt, letting all the salt that will, cling to them. After this the pieces are heated and immersed in brine as usual. The scale or crust of salt will fall off in the water. The piece so treated will have the appearance of a piece which has been heated in cyanide. Donald Baker

Syracuse, N. Y.

HANDY CENTER FOR SMALL WORK

The writer recently had occasion to turn some small work in a regular 16-inch lathe. It was difficult to drive this work when mounted on the regular centers. Therefore, a small center with a miniature faceplate, as indicated in the accompanying engraving, was made, this center being held in a collet chuck in the lathe. The holes in the faceplate were drilled to fit a standard size wire, the wires being used to drive the work. This device was found to be very handy in turning and threading small thumb-screws and similar work. S. C.



TURNING SOLID DISKS

I had to make six disks about $2\frac{1}{4}$ inches in diameter from sheet brass; they had to be turned true to size, and as there was no hole through them they could not be placed on an arbor. I cut them out with the shears, about 1/16 inch large, and then put them between two disks of wood a little smaller than the finished size of the brass disks. After knocking out the live center of the lathe, the disks were pressed firmly against the faceplate with the "dead" center. Of course, a steel disk was placed between the "dead" center and the wood, so that the center would not cut into it. After truing the disks central, I found that they could be turned very nicely by taking a light chip, as the pressure of the center against them was sufficient to prevent them from slipping. The object of using the wooden disks was to increase the friction, so the brass disks would not slip.

Mansfield, Mass. Lester P. Brown

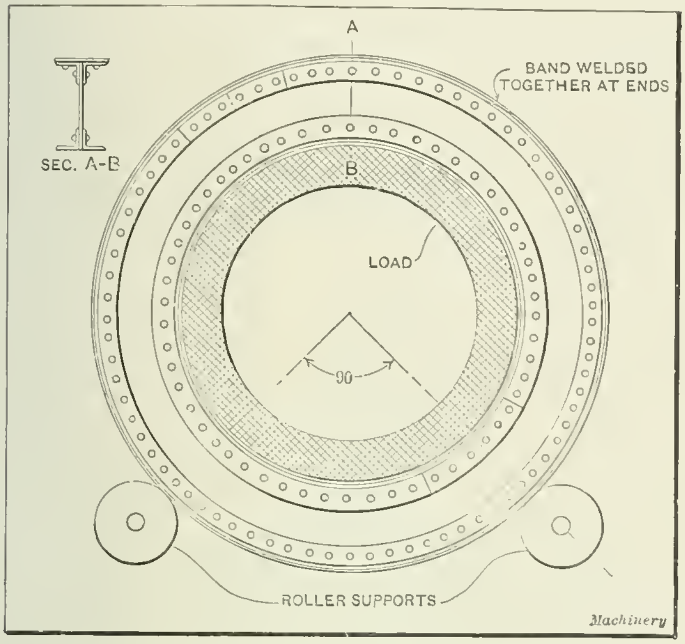
HOW AND WHY

DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST

Give details in full and name and address. The name and address will not be published with the answer.

TO DESIGN A CIRCULAR BEAM

G. A. W.—I have a circular beam made of steel angles and plates in I-beam section to design, and would like to know how to calculate the bending moment for a uniformly distributed load around the inside of the ring; also the pitch of rivets in the angles. The illustration shows the method of loading and supporting the ring. The ring revolves once in ten minutes and then stands stationary for twenty-four hours.



Circular Beam to be designed to support Load in Rotation

The question is an interesting problem in machine design which would form the subject of a good article. An answer is desired in this form.

CHANGE GEARS FOR SPIRAL GEAR-HOBBING MACHINE

R. E. N.—Two spiral gears are to be cut on a gear-hobbing machine. Gear No. 1 has 30 teeth, 24.549-inch lead, and a feed of 1/24 inch. The change gears used on the machine for cutting a spur gear with 30 teeth have 48 (driving gear) and 60 (driven gear) teeth, respectively. The hob and gear are of the same "hand."

Gear No. 2 has 60 teeth, 49.098-inch lead and is cut with a feed of 1/16 inch. The change gears used to cut a spur gear with 60 teeth, on this machine, have 48 and 40 teeth, for the driving gears, and 60 and 80 teeth, for the driven gears. The hob and gear are of the same "hand."

A.—The method to follow for calculating these gears was explained in the December, 1911, number of MACHINERY, engineering edition, and the formula there given for calculating gears to use for hobbing spiral gears, was as follows:

$$\frac{L \div F}{(L \div F) \pm 1} \times \frac{P}{p} = \frac{S}{s}$$

in which

$L =$ lead of spiral,
$F =$ feed per revolution,
$P =$ product of driving gears for cutting spur gears with same number of teeth,
$p =$ product of driven gears for cutting spur gears with same number of teeth,
$S =$ product of driving gears for cutting spiral gears,
$s =$ product of driven gears for cutting spiral gears.

Use + sign when gear and hob are of opposite "hand," and — sign when they are of the same "hand."

In the problems given the data are as follows:

	30-tooth Gear		60-tooth Gear
L	24.549	L	49.098
F	1/24	F	1/16
P	48	P	40 × 48
p	60	p	60 × 80

Calculations for Thirty tooth Gear

By inserting the values given, we find that:

$$\frac{L \div F}{(L \div F) - 1} = \frac{589.176}{588.176}$$

For our purpose, the ratio written above can be simplified to the form $\frac{589}{588}$. Factoring, we have:

$$\frac{589}{588} = \frac{19 \times 31}{12 \times 49}$$

Now, multiply this value with the ratio of the gears for a 30-tooth spur gear:

$$\frac{19 \times 31}{12 \times 49} \times \frac{48}{60} = \frac{76 \times 31}{60 \times 49}$$

Having obtained the gears that should be used, we may now investigate what lead these gears will give. Apparently they will not give the exact lead desired, as we have used an approximate ratio instead of the exact one.

To prove, assume $F = 1/24$ and solve for L.

$$\frac{L \div F}{(L \div F) - 1} = \frac{589}{588}$$

From this we find $L = 24.541$, which is very nearly equal to the required lead.

Calculations for Sixty-tooth Gear

By proceeding in the same way for the 60-tooth gear we have:

$$\frac{L \div F}{(L \div F) - 1} = \frac{785.568}{784.568}$$

We then factor the fraction $\frac{785}{784}$, thus:

$$\frac{785}{784} = \frac{5 \times 157}{4 \times 196}$$

As 157 is a prime number, and gives too large a number of teeth for any of the gears in the train, we try $\frac{784}{783}$ which ratio is very nearly equivalent to that required.

$$\frac{784}{783} = \frac{49 \times 16}{29 \times 27}$$

Multiply this value with the ratio of the gears for a 60-tooth spur gear:

$$\frac{49 \times 16}{29 \times 27} \times \frac{40 \times 48}{60 \times 80} = \frac{49 \times 32}{29 \times 135}, \text{ or } \frac{49 \times 32}{87 \times 45}$$

Possibly the 135-tooth gear is impracticable, on account of being too large, in which case the other combination must be tried.

If the lead resulting from the gears found is calculated in the same manner as in the previous case, we find that

$$L = 49.001$$

Influence of Small Changes in the Ratio on the Lead

It is interesting to note that a comparatively slight change in the ratio $\frac{L \div F}{(L \div F) - 1}$ makes a very decided change in the lead obtained. To illustrate, assume that in the first example given the ratio $\frac{589}{588} = 1.001701$ were changed to 1.002; let us see what effect this change would have on the lead obtained ($F = 1/24$):

$$\frac{L \div F}{(L \div F) - 1} = 1.002$$

If we solve for L in this equation we find $L = 20.875$, which is a very different lead from the one we wish to obtain.

DROP-FORGING A WRENCH BAR

B. L. E.—I desire to make drop-forging dies for the piece shown in Fig. 1. This piece is to be a steel forging and the principal point on which I desire information is the proper shaping of the breakdown in order to distribute the stock so that I can get the head. Also advise me what size bar steel to use and to what length the bars should be cut for forging.

Answered by J. W. Johnson, Revere, Mass.

A.—For drop-forging the piece shown in Fig. 1 a pair of drop-forging dies fitted with forming and finishing impressions, breakdown and anvil will be required. The lower half of a suitable pair of dies is shown in Fig. 2. Fig. 3 shows the right-hand side elevation of the dies, giving an idea of the shape of the breakdown, and Fig. 4 is a left-hand side elevation to show the general proportions of the anvil required for drawing out the stock. The principal requirements of a pair of dies for drop-forging this piece are that the stock be so distributed by means of the breakdown and anvil that there will be little for the face impressions to do except to shape the sides of the piece. Referring to Fig. 2, the anvil shown on the left-hand side of the die should be given the first consideration. The function of this anvil is to draw the steel out for the handle of the wrench to such dimensions as will fill the face impressions when struck therein. Thus, as the size of stock to be used will be approximately 2 by ¾ inches, it is evident that a section of the two-inch width must be drawn down by means of the anvil to such size as will just fill the face impression of the wrench handle. Referring to Fig. 1, it will be seen that the section of the handle of this wrench measures approximately ½ by ⅞ inch. It is not necessary, however, that the stock be drawn to these exact dimensions but it must be drawn to a squared size whose section is about equal to ⅞ by ½ inch, which in this case would be about 11/16 inch. In making the anvil, therefore, the two faces should be shaped away until these faces are 11/16 inch apart when the dies meet. The removal of the stock back of the anvil faces is merely for clearance. As in all drop-forging operations, after the preliminary roughing down of the stock is accomplished by means of the anvil, it is necessary to strike the steel in the breakdown in order to approximately shape the forging. Referring again to Fig. 2 the lower half of the breakdown may be seen, and by referring to Fig. 3 the outline of the entire breakdown is seen. This breakdown should be about 1/16 inch smaller all around than the finished work is to be, in order to squeeze the stock so that it will lie in the impression for striking the final blows. All corners should be well rounded to avoid cold-shuts. It will be noticed that the width of the stock recommended is 2 inches while the height of the wrench bar head is 2½ inches. This is explained through the fact that the steel will spread the necessary amount to make up the difference. It would be possible to drop-forge this piece with but one face impression, but if many pieces are to be made it would be far more economical to provide the dies with forming and finishing impressions as shown in Fig. 2. The forming impression should have all corners and edges well rounded in order to facilitate the flowing of the metal. This impression should be "flashed" and the upper die provided with both flash and gutter. For information in regard to cutting the flash and gutter, see "Drop-forge Die-sinking," Parts 1, 2 and 3, commencing in July, 1911, engineering edition of MACHINERY. The finishing impression is, of course, made exactly as the finished part must be shaped and is only used in striking the few final blows.

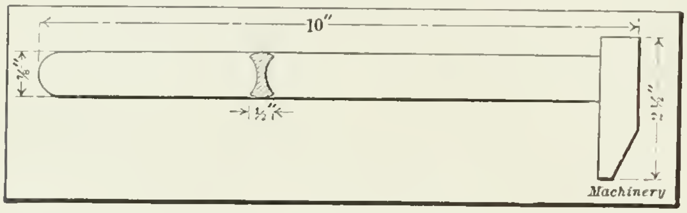


Fig. 1. Wrench Bar to be Forged

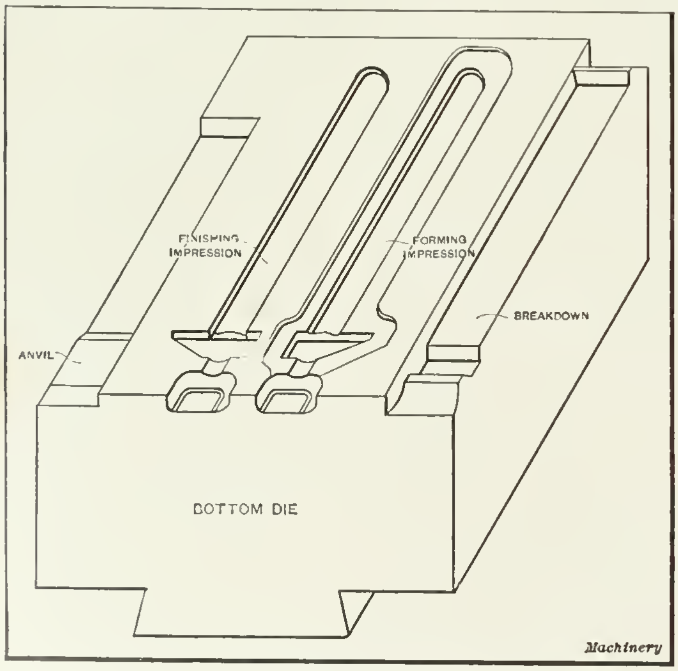


Fig. 2. Lower Half of Drop-forging Die

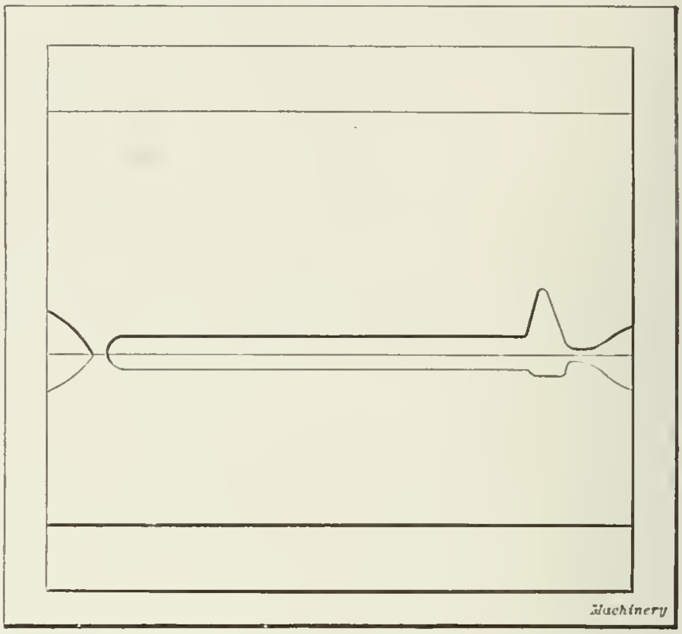


Fig. 3. Right-hand Side Elevation of Dies, showing Breakdown

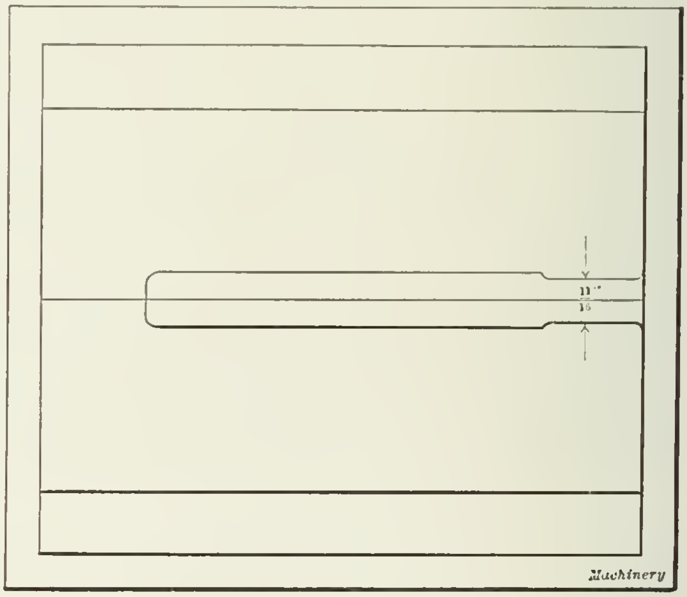


Fig. 4. Left-hand Side Elevation of Dies, showing Anvil

It is impossible to state the exact lengths to which the bars of steel should be cut for forging. This can best be determined by first cutting a length of stock from the bar as long as can be conveniently handled; say five or six feet in length. At the time of forging the last piece, it can then be seen if the bar could best be used slightly longer or shorter in order to come out with an even number of finished forgings.

* * *

Monel is said to be the only commercial metal that will resist the corrosive action of liquid soaps.

NEW MACHINERY AND TOOLS

THE COMPLETE MONTHLY RECORD OF NEW DESIGNS AND IMPROVEMENTS
IN AMERICAN METAL-WORKING MACHINERY AND TOOLS

WALKER "UNIMATIC" TOOL-ROOM GRINDER

The Walker Grinder Co., of Worcester, Mass., is now manufacturing a special grinder which is designed to meet all the requirements of modern tool-room practice. This machine, which is known as the "Unimatic" tool-room grinder, is not intended to replace the well-known No. 2 universal grinder built by this company, as it does not have as great a capacity. The new design embodies, however, all the universal features of the No. 2 size, with the addition of certain adjustments made possible by the novel construction.

The machine is very compact and entirely self-contained, no overhead works being required. The work-spindle is rotated by a flexible shaft, which is shown to the left of the machine in Fig. 1, so that the overhead belt drum is eliminated. The initial drive is from a shaft in the base which transmits motion to the grinding wheel, the work-spindle and the table reciprocating mechanism. The arrangement of the interior shafts and driving belts, is shown by the end and front elevations, Figs. 4 and 5. The main shaft *A* carries tight and loose pulleys at the rear end (see also Fig. 2) and a three-step pulley in the center, which drives another three-step pulley mounted on shaft *B*. Shaft *B* also carries a large pulley *C*, which connects by a belt with the grinding-wheel spindle. Shaft *A* drives the intermediate feed shaft *D* by means of step pulleys, and shaft *D*, in turn, transmits motion to the table feed shaft *E*, which is also provided with step pulleys.

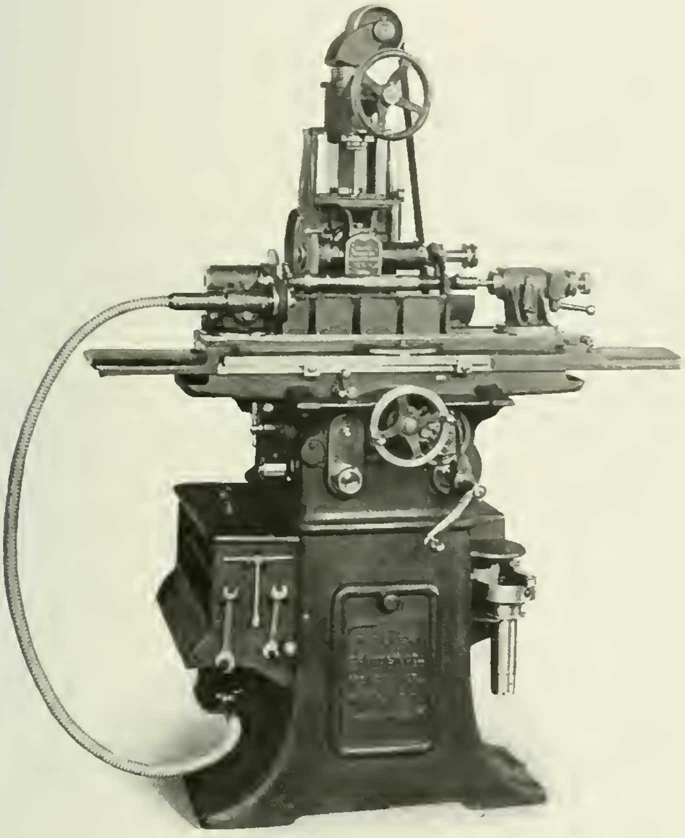


Fig. 1. Universal Tool-room Grinder, built by the Walker Grinder Co.

The initial driving shaft *A* connects with shaft *F* by means of step pulleys, and *F* is geared through fiber gearing to a second shaft *G*, which, of course, revolves in an opposite direction. The front ends of each of these shafts are recessed and arranged for attaching the flexible shaft *H*, which transmits motion to the work-spindle. This flexible shaft is clamped in place by screws and it can readily be attached to either *F* or *G*, according to the direction of rotation desired. The motion of the flexible shaft is controlled by handle *I* which connects with a friction clutch operated by a coil spring.

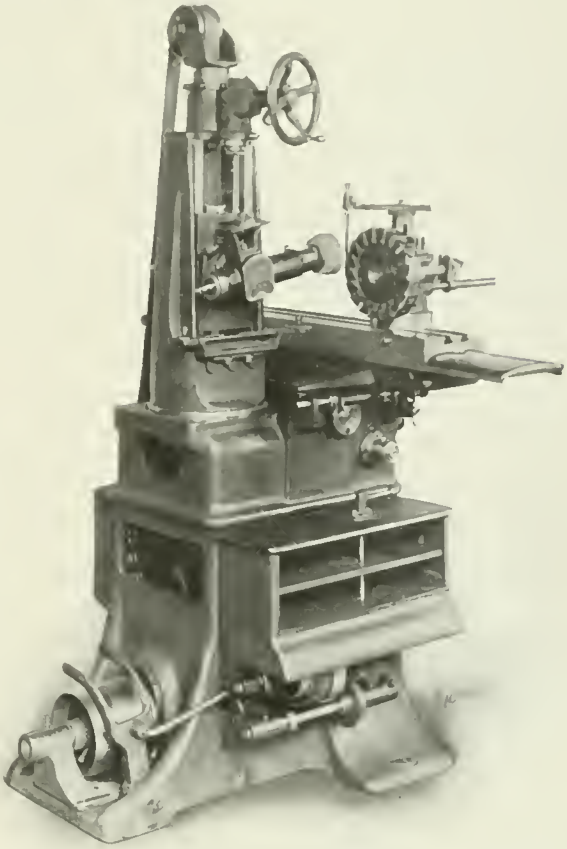


Fig. 2. Grinding an Inserted-tooth Cutter on Walker Grinder

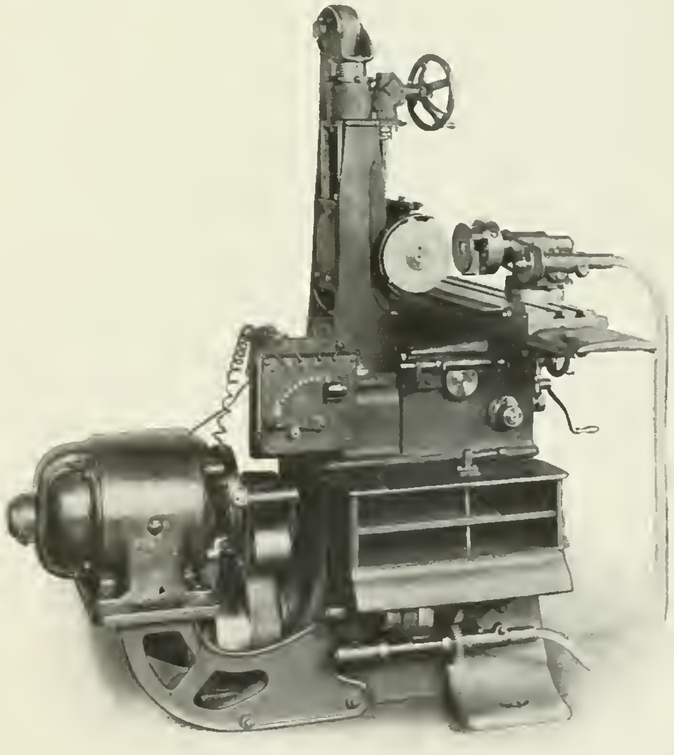


Fig. 3. Application of Motor Drive to Walker Grinder

Hinged in the base of the column there is a frame *J* carrying an idler which is held against the belt connecting shafts *A* and *B* by a coil spring, so that constant tension is maintained. When it is desired to change the belt on the pulley, this tension is removed by withdrawing handle *K*; then the belt can easily be shifted through an opening in the side of the column. The driving belt operating on the tight and loose pulleys at the rear of shaft *A*, is shifted by a belt-shifter *L*, conveniently located at the front of the machine.

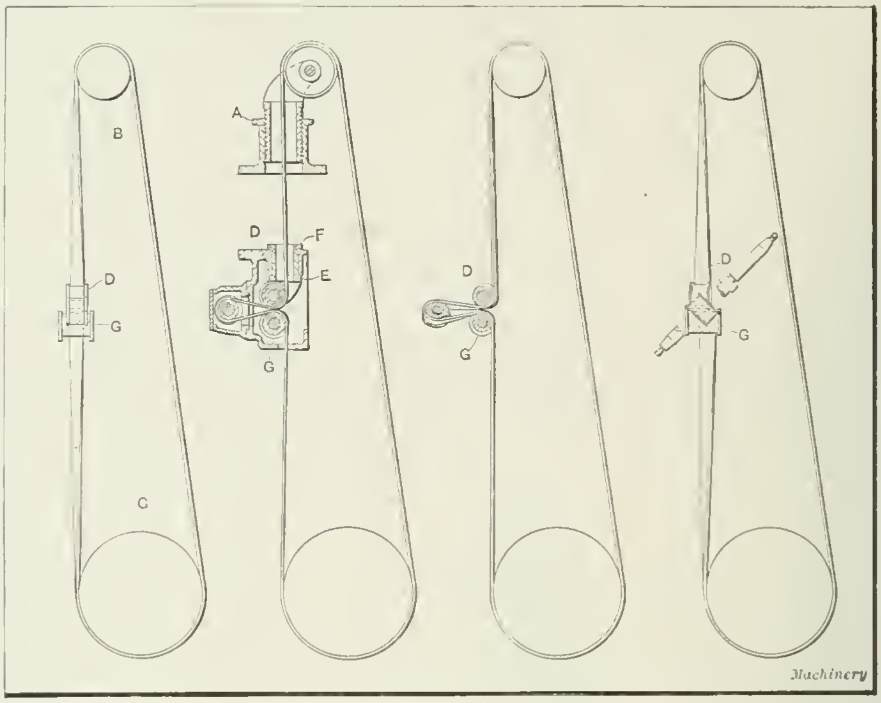
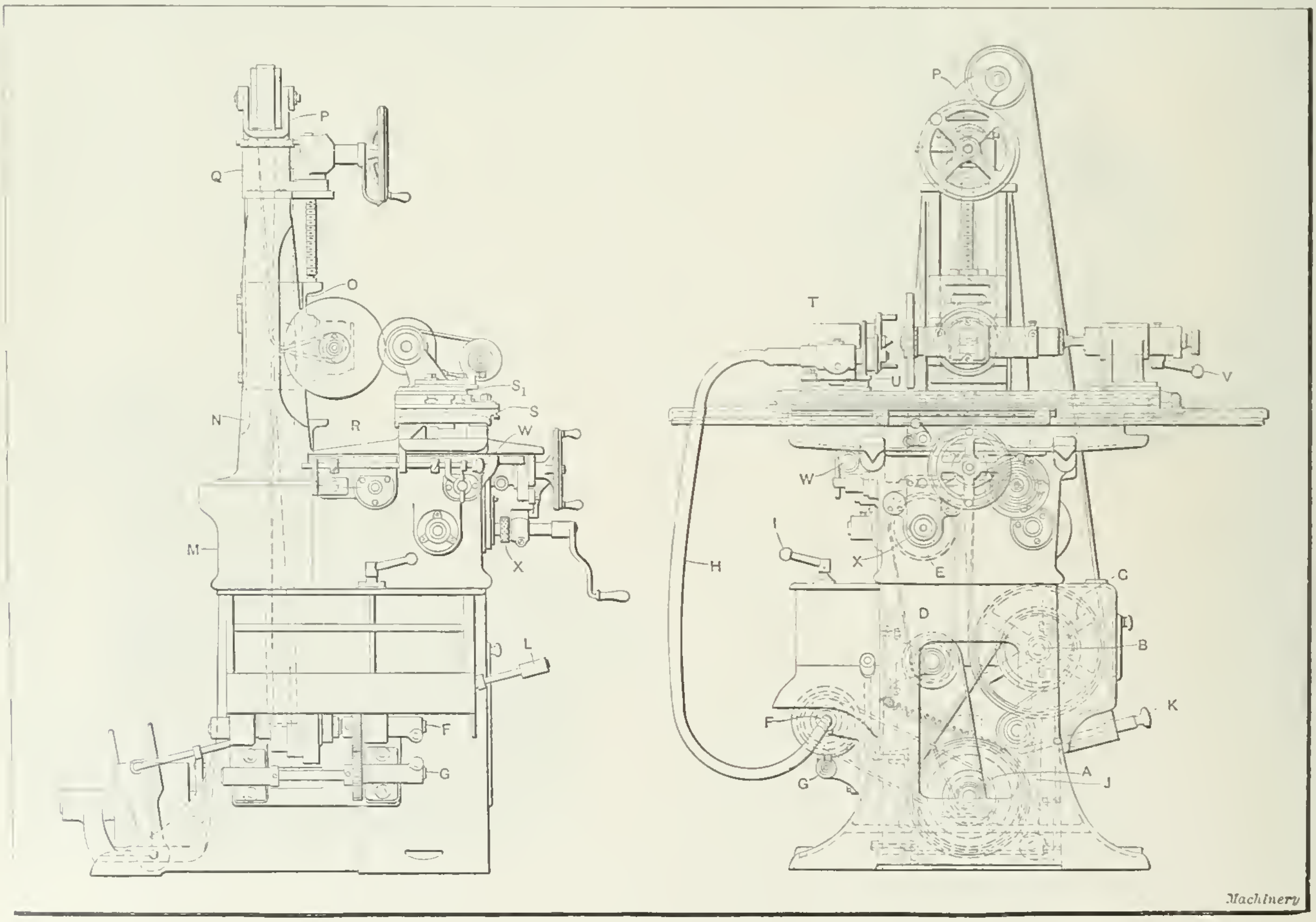


Fig. 6. Showing Course of Spindle Driving Belt for Various Positions of Grinder Head

Upon the main base of the machine there is a pedestal *M* carrying the feed gearing and supporting the grinding-wheel housing *N*, which, by simply loosening one screw, can be swiveled 90 degrees about a vertical axis in either direction. Upon housing *N* is mounted the wheel-slide *O*, which is raised or lowered by a vertical screw, operated through bevel gears and the handle seen near the top of the machine. On the top of housing *N* is mounted an idler bracket *P*, which is provided at its lower end with a sleeve of large diameter through which the driving belt passes. This sleeve is threaded upon its exterior with a square thread of coarse pitch and the outside of this thread centers the sleeve in housing box *Q* when the housing is swiveled.

The grinder carriage *R* is mounted upon the pedestal *M* and slides on elongated V tracks which are lubricated automatically with rollers operating in oil wells. This method of lubrication is also provided for the platen *S*, upon which is mounted the swiveling platen S_1. This swivel platen, which carries the headstock and tailstock, can be set for tapers up to three inches per foot and has a fine screw adjustment. Upon the headstock, there is mounted an adjustable bracket *T*, which carries the pulley that connects with the upper end of the flexible shaft. This bracket is held by three cap-screws passing through slots and providing an adjustment for the short belt which rotates the driving faceplate.



Figs. 4 and 5. Endand Front Elevations of Walker Tool-room Grinder

The headstock has a universal chuck-spindle which can also be driven from pulley *U*. This chuck-spindle is interchangeable with the spindle which carries the revolving faceplate. The chuck-spindle, the driving faceplate and the flexible-shaft bearing are reversible in heads, so that the drive can be from whichever end is most convenient. This feature is found desirable when, for instance, the machine is set up for face grinding, as illustrated in Fig. 3. In this case, both the chuck-spindle and the flexible-shaft bearing have been reversed.

The tailstock spindle is provided with an adjustable spring to allow for any expansion of the work.

This grinder is not arranged for wet grinding but sectional shields or guards are provided for the top of the platen to take care of the dust. These shields are shown in position in Fig. 1, which illustrates the machine set up for a cylindrical grinding operation. The machine is equipped with an automatic stop mechanism located at the left side of the carriage as shown in Figs. 4 and 5. The knob *W* is attached to a horizontal rod carrying adjustable collars, which can be set to disengage the automatic cross-feed at any desired point. An instantaneous hand stop is also provided. The hand stop is operated by knob *X*, conveniently placed at the front of the machine, as shown in Fig. 5.

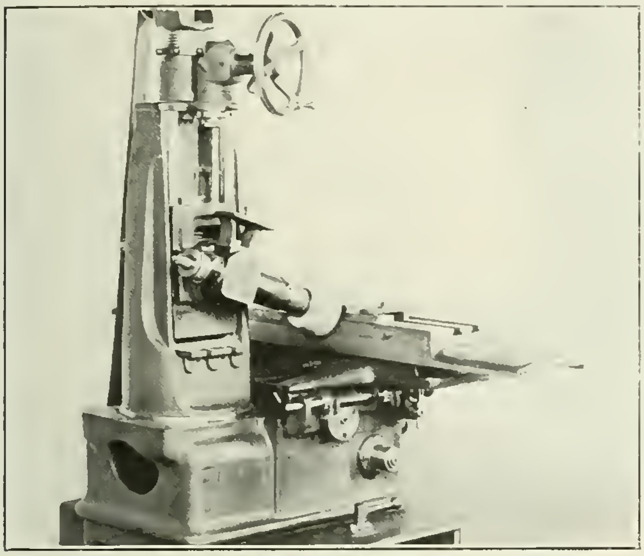


Fig. 7. Example of Work illustrating Use of Tilting Head

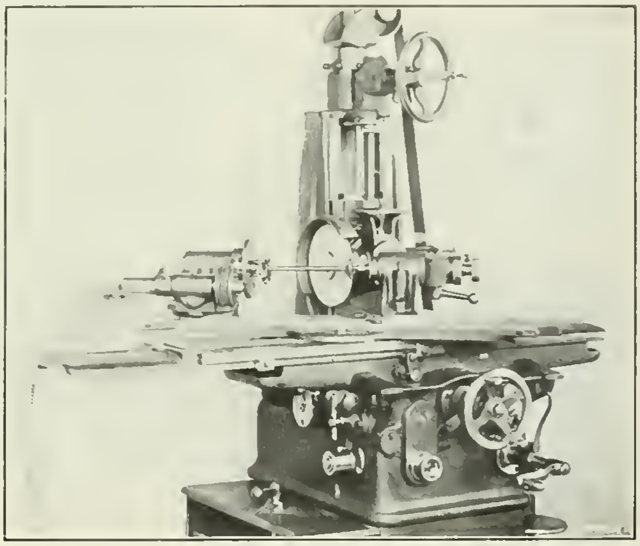


Fig. 8. Grinding Poppet Valves

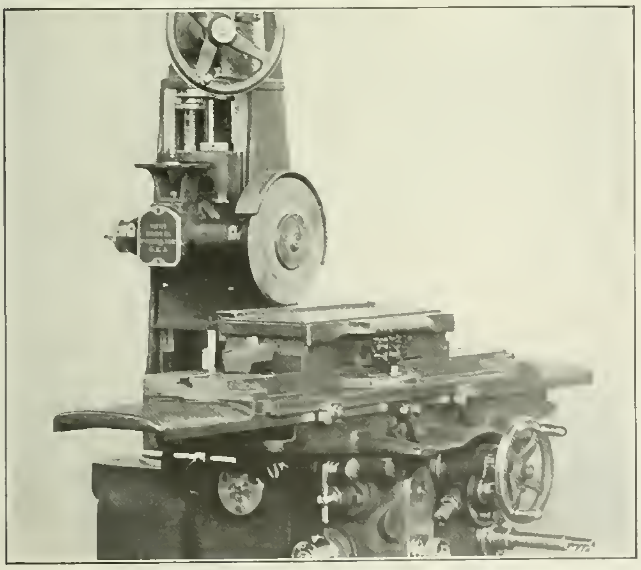


Fig. 9. Surface Grinding—Spindle provided with Extension

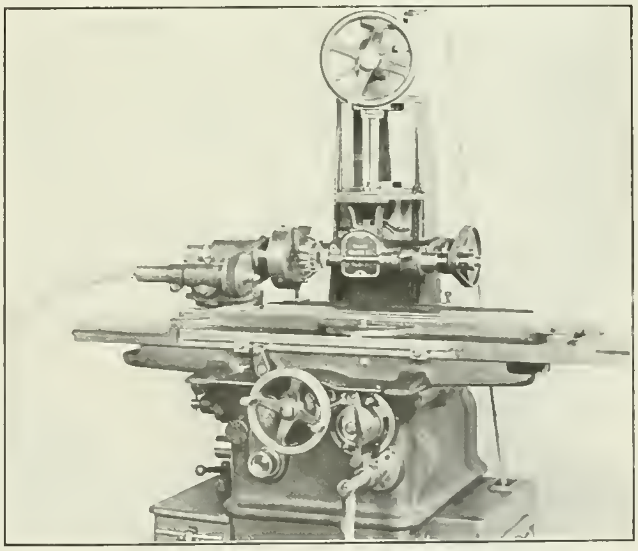


Fig. 10. Example of Internal Grinding

The diagrams in Fig. 6 show the course of the spindle driving belt for various positions of the grinder head. It will be noted that the pulleys *B* and *C* always remain in the same position, and that the various adjustments affect only the vertical side of the belt. The belt idler *D* is mounted in a swivel bracket *E*, which is held in place by nut *F*, and can swivel when the grinding spindle is tilted in a vertical plane. This swiveling action is largely automatic and the various positions are indicated by the diagrams. It will be seen that the part of the belt passing through the idler bracket is vertical, and only one side of the belt is affected by the swiveling action. The belt simply runs in a twist above and below the spindle when it is swiveled in a vertical plane. Bracket *E* turns so that the belt leads in the proper direction towards the periphery of the grinding-spindle pulley, thus obviating the tendency of the belt to crowd on the flanges that would develop if the bracket were not swiveled.

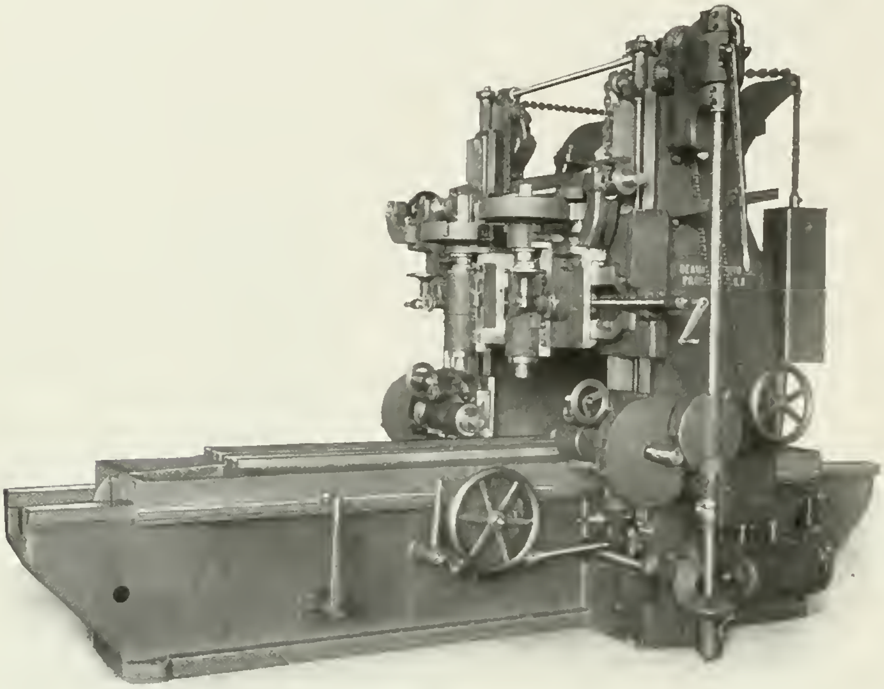
The idler pulley *G* is much wider than idler *D*, so that the belt, when leaving the spindle pulley, finds its own position. It has been found that with this construction, the grinding spindle can, if necessary, be run at a vertical angle of 45 degrees without any distortion. Figs. 2 and 7 illustrate the advantages of the vertical spindle adjustment. Fig. 2 shows the operation of grinding a milling cutter, and Fig. 7 illustrates an application of the tilting head to the grinding of the beveled edge of a machine part.

Fig. 3 shows the method of driving the machine with an electric motor. The latter is mounted on a bracket rigidly attached to the machine base, and the tension of the grinding belt is maintained by a spring-actuated idler. Fig. 8 shows the machine arranged for grinding the beveled seat of gasoline engine poppet valves. The swivel platen is set at an angle of 45 degrees, in which position it could not be operated by an overhead drum, but is readily driven by the flexible shaft. At first thought, it might seem that this flexible shaft would cause vibration of the work, but this has not proved to be the case. Any vibration in the shaft itself is not transmitted to the work, on account of the belt connection. Moreover, the overhang of all parts of the machine has been reduced to a minimum so that the construction is very rigid and the grinding smooth and even.

Fig. 9 shows the machine arranged for surface grinding. An extension to the spindle is provided for work of this kind. Another application of the machine is illustrated in Fig. 10, which shows the internal attachment in use. This grinder is, of course, applicable to a very large range of work, and on account of its rigidity, has proved efficient for all the different operations within its range.

BEAMAN & SMITH FOUR-SPINDLE MILLING MACHINE

The Beaman & Smith Co., Providence, R. I., has developed an improved design of four-spindle milling machine. One of the advantages of this machine is the independent control of the spindles, it being possible to operate the spindles singly or in unison. The vertical spindles can be run at twice the speed of the horizontal spindles and *vice versa.* Provision is also made for reversing the spindles, and there is a second feed-box which gives a reverse feeding movement to the table when the spindles are reversed, thus making it possible to feed the work to the cutters from either direction.


Beaman & Smith Four-spindle Milling Machine

The general construction of this improved design is clearly shown by the accompanying illustration. There are two horizontal spindles carried by the uprights or housings, and two vertical spindles on the cross-rail. The table is of the square-lock construction with one side gib and two under gibs, which provide means of compensating for wear. The automatic feeds can be varied independently of the spindle speeds, and there is a quick power movement in either direction ranging from 7 to 14 feet per minute. The table has a working surface 30 inches wide and 10 feet long and a movement of 11 feet on the bed. There are five T-slots for the reception of clamping bolts and two rows of holes for stop-pins.

The automatic feeds to the table are positive in either direction and are obtained through a geared feed-box. There are nine changes varying from 2 to 12 inches for any spindle speed. As previously mentioned, there is a second feed-box, the gearing of which is so arranged that feeds can be reversed when the rotation of the spindles is reversed.

The spindles are of crucible steel and run in phosphor-bronze boxes. The front bearings are 4 inches in diameter and 6 inches long, and the rear bearings, 3⅝ inches in diameter and 4¾ inches long. Both the front and rear bearings are tapered and means are provided for taking up wear. The speeds vary from 6½ to 50 revolutions per minute. The ends of the spindles are made to fit cutters according to specifications.

This machine can be arranged for either a belt or motor drive. When a motor is used, one capable of developing 15 H. P. is employed. The cross-rail is raised or lowered by power, and it also has a hand adjustment. The spindles have a 6-inch independent longitudinal adjustment, effected by the handwheels shown, by means of worm gearing and a rack-and-pinion movement.

The centers of the vertical spindles are 6 inches in advance of those on the uprights. The minimum distance from the ends of the vertical spindles to the top of the table is 1 inch, and the maximum 30 inches, whereas the minimum and maximum distances between the centers of the vertical spindles are 12 and 30 inches, respectively. The horizontal spindles have a minimum distance between the ends of 18 inches, and they can be adjusted longitudinally to give an opening of 30 inches. The minimum height from the top of the table to the center of the horizontal spindle is 1 inch, and the maximum height, 26 inches. The weight of this machine is approximately 28,000 pounds.

STANDARD PORTABLE ELECTRIC DRILLS AND GRINDERS

The Standard Electric Tool Co., Cincinnati, Ohio, is placing on the market a line of high-power electric tools. One of the portable electric drills is shown in Fig. 1. This machine has ball bearings throughout and the bearings are dust-proof. The gears are generated from chrome-nickel steel, case-hardened, and are mounted on ball bearings packed in grease. The motors have a strong series winding which gives an excess of power over the rated capacity, thus preventing overloads and "burn-outs." The mechanical construction is high grade

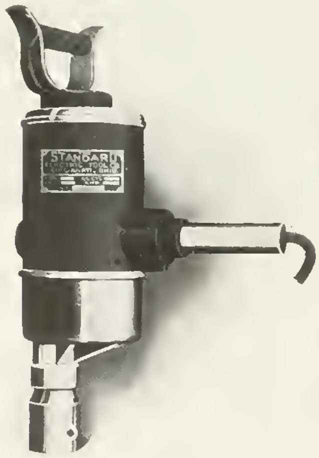


Fig. 1. Portable Electric Drill

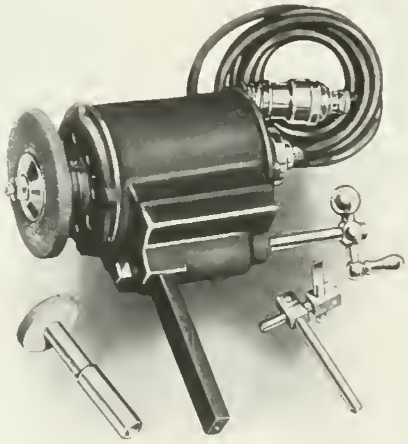


Fig. 2. Grinder with Toolpost Attachment

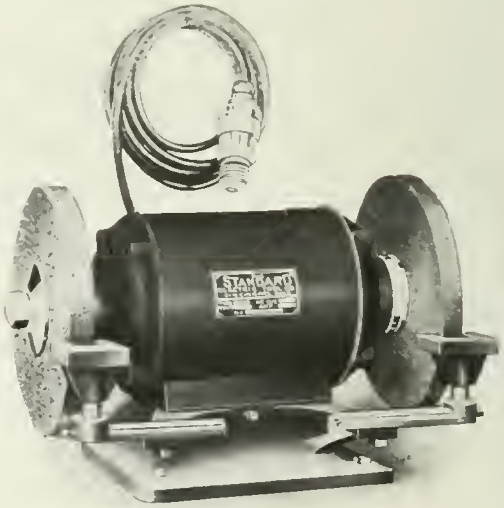


Fig. 3. Grinder shown in Fig. 2 converted into Bench Grinder

throughout. The drills are built in ⅜- and ½-inch sizes for direct or alternating current. The ½-inch direct-current drill is guaranteed to ream metal up to a thickness of 7/16 inch. This company also manufactures a universal drill of ⅜-inch capacity that will operate on either direct or alternating current.

The grinders are made for toolpost and bench work. The toolpost or center grinder, illustrated in Fig. 2, can be converted into a bench machine by removing the dovetail slide and placing the motor on top of a suitable base having a corresponding dovetail groove, as shown in Fig. 3. This feature greatly increases the range and utility of the tool.

All motors in both drills and grinders have forced ventilation by means of fans of a special design. The armatures and poles in both drills and grinders, are made of the best soft electrical sheet steel and are uniformly insulated. The grinders are equipped with ball bearings, when specified, instead of adjustable phosphor-bronze bearings.

ROCKFORD UNIVERSAL MILLING MACHINE

The universal milling machine illustrated in the accompanying halftone Fig 1 is manufactured by the Rockford Milling Machine Co., Rockford, Ill. This new machine is known as the No. 2 size. The table has a working surface of 38 by 9 inches, an automatic longitudinal travel of 25 inches, an automatic transverse travel of 7½ inches, and a vertical power movement of 18 inches. The feeds are all positively driven through gearing and 14 changes are available. The levers for changing and reversing the feeds are conveniently located on the left side of the column, as shown in the illustration. The gears in the feed-box are cut from machine steel and the bearings are of bronze. The automatic feeds can be changed or reversed while the machine is in motion.

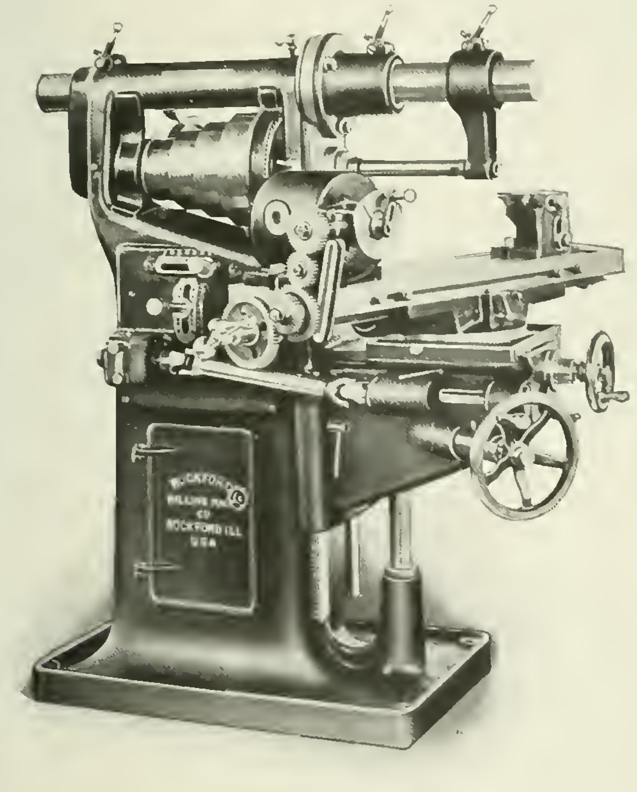


Fig. 1. Rockford No. 2 Universal Milling Machine

The main spindle of the machine has taper journals which run in bearings fitted with felt oil retainers. The wear of the spindle bearings can be quickly taken up by means of a nut at the rear of the spindle. The overhanging arm is equipped with a flanged support which reduces vibration and increases the cutting capacity. The knee has an extended top and an extra long bearing on the column, and the telescopic elevating screw is fitted with ball thrusts. The handwheels for the cross and vertical feeds are fitted with disengaging clutches.

Sixteen spindle speeds are available (with a two-speed countershaft) which range from 22 to 309 revolutions per minute. The equipment includes a two-speed countershaft, a swivel vise, an arbor, a flanged support for the overhanging arm, a dividing head and center-rest, a universal chuck, the necessary change gears, index plates, wrenches, etc.

The new dividing head is illustrated in Fig. 2. This head has been designed to combine rigidity and accuracy with simplicity and convenience. The worm-wheel, which is securely keyed to the spindle inside the head-block between the front and rear spindle bearings, has a diameter of 5⅜ inches on a 10½-inch head. The worm runs in oil, and there is an eccentric adjusting screw on the outside to take up wear between the worm and wheel. The worm can easily be disengaged from the worm-wheel for rapid indexing.

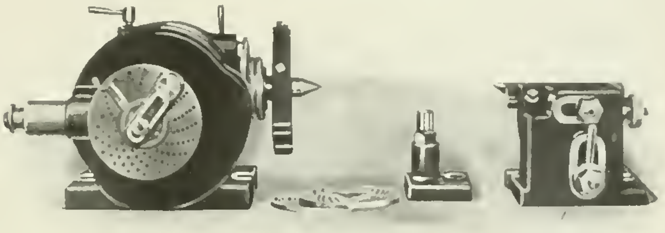


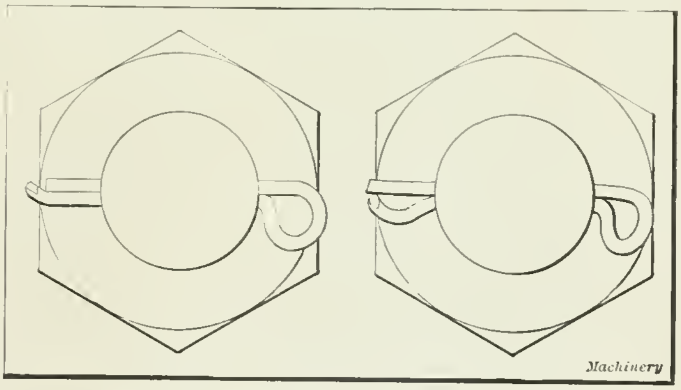
Fig. 2. Universal Dividing Head and Tailstock

Three index plates are regularly furnished, providing standard divisions up to 380. The spindle has adjustable taper bearings and is provided with a powerful and simple locking device. The front end has a No. 10 B & S taper hole and the nose is threaded to receive a chuck. The taper hole and threaded nose correspond in size to the main spindle so that tools can be interchanged. The swivel block carrying the spindle, swings from a position 10 degrees below the horizontal to 10 degrees beyond the perpendicular.

The center of the tailstock is held at an angle in order to locate the center close to the rear side and top, thus permitting the use of large end-milling cutters for squaring shafts, etc. The center is easily and quickly adjusted and is elevated for milling tapers by a cam. Ten change gears are supplied for spiral milling, and the worm is driven direct from the change-gear shaft.

CAMPBELL SELF-LOCKING COTTER-PIN

A. C. Campbell of Waterbury, Conn., has placed on the market an ingenious form of cotter-pin designed to replace the well-known spring cotter. This new cotter-pin is easily inserted in a hole and can be locked by simply hitting the loop or eye with a hammer; it is also removed easily. The cotter is made of half-round stock, the same as the ordinary type, but it is bent to a different shape. The eye is offset instead of being central, and the two limbs forming the body of the pin are of unequal length, as will be seen by referring to the left-hand view in the accompanying illustration. The long half of the pin is bent at an angle across the tip of the short member, in order to form a lock for the pin. This



Campbell Self-locking Cotter-pin before and after Locking bent end also forms what is practically a conical point, which makes it easy to enter the pin in a hole.

The method of using this pin is indicated by the illustration, which shows its application to a nut and bolt. The pin is placed in the hole as far as the head or eye will permit, as shown to the left, and then the head is flattened to about half its original height by striking it with a hammer. This forces the straight half of the pin farther into the hole which causes the bent end to be pushed downward, as shown by the view to the right. When the ends are forced apart in this way, the pin is securely locked so that it cannot work out of the hole.

This pin is not only easily inserted, but quickly and easily removed by the use of a common screw-driver, the tang of a file, or any tool having a thin, flat point which can be inserted in the loop or eye. After the point of the tool is inserted, it is twisted in the proper direction to draw back the straight half of the pin to its original position. This releases the bent or locking end and the pin can readily be withdrawn with the fingers. These pins can be inserted, locked and removed from the same side, so that they can be used in places quite difficult of access.

DIFFERENTIAL RECORDING GAGE

The Industrial Instrument Co., Foxboro, Mass., is now manufacturing a new differential recording gage which is illustrated in Fig. 1. This gage can be used for recording the differences between pressures, and it is also adapted for recording the flow of fluids by means of venturi or pitot tubes. The moving element consists of a patented pressure-tube movement, which, for pressures below 10 pounds per square inch, is similar to the diaphragm tube shown in Fig. 2; whereas, for differential pressures exceeding 10 pounds per square inch, the helical tube movement shown in Fig. 3, is used.

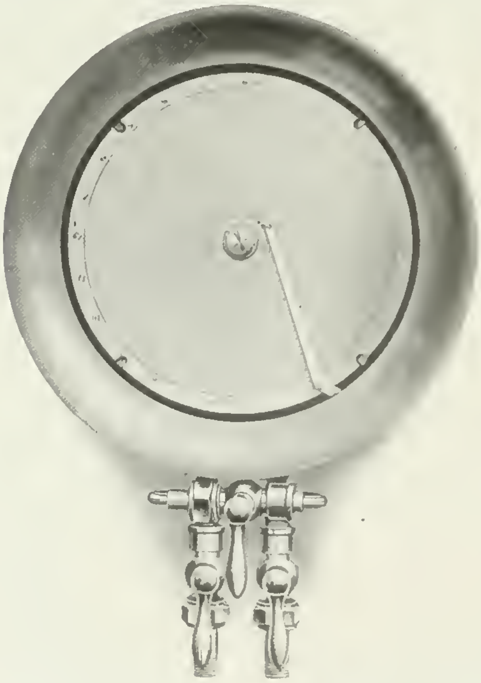


Fig. 1. Differential Recording Gage made by Industrial Instrument Co.

The pen arm is attached directly to the shaft in both of these movements, which gives a rigid support. A friction joint in line with the shaft, makes adjustment possible without affecting the length of the pen arm. A pressure tube is employed having a range sufficient to cover the differential pressure desired. One of the two pressures, the difference between which is to be recorded, is applied internally to the pressure tube, and the other externally, the principle being the same as in ordinary practice except that one pressure, instead of being atmospheric, is replaced by some other pressure. Transmission from the movement to the pen arm is obtained by means of a special bearing passing through the wall of the chamber enclosing the movement.

This gage can be employed to advantage for recording the height of water in a boiler. When so used it is applied to the water column and gives a record not only of the height of the water, but an accurate record of the time the water column or gage glass is blown, the time the boiler blows off, or of any other disturbance affecting the height of the water in the gage glass. This continuous record will result in keeping a more uniform water level and will be an efficient check against unsafe high or low water, thus insuring greater economy and safety. The recorder can be placed at a distance from the boiler, if so desired, so that in case of an explosion, the responsibility can be placed where it belongs.

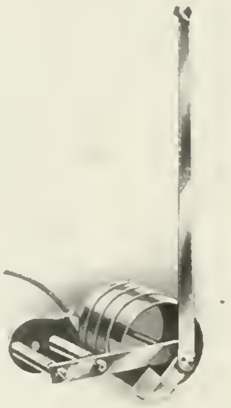


Fig. 2. Diaphragm Tube Movement

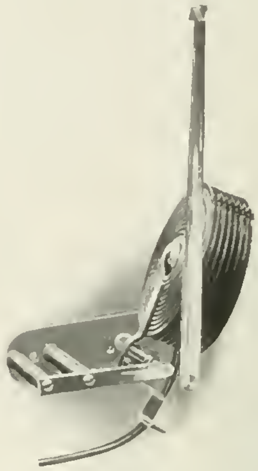


Fig. 3. Helical Tube Movement

SHADOWLESS DRAFTING TABLE

The drafting table shown in the accompanying illustration has a plate-glass top beneath which is an illuminating chamber containing three electric lights. Among the advantages claimed for this construction are, the elimination of shadows and a good light regardless of the position of the windows or the time of day. The light can be intensified to any desired degree and it can also be subdued, either by the addition of tissue sheets or by reducing the electric lamp power.

The illumination from beneath makes it possible to easily trace from blueprints or drawings of any kind. Tracings can also be made on stiff drawing paper or bristol board, by intensifying the light, as may be required. The glass top has a cork pine frame to which the drawings may be attached with either ordinary thumb-tacks or a special suction clamp furnished with the table. The construction of the table is such that the angular position or height can be quickly adjusted, and it is rigidly held in position.

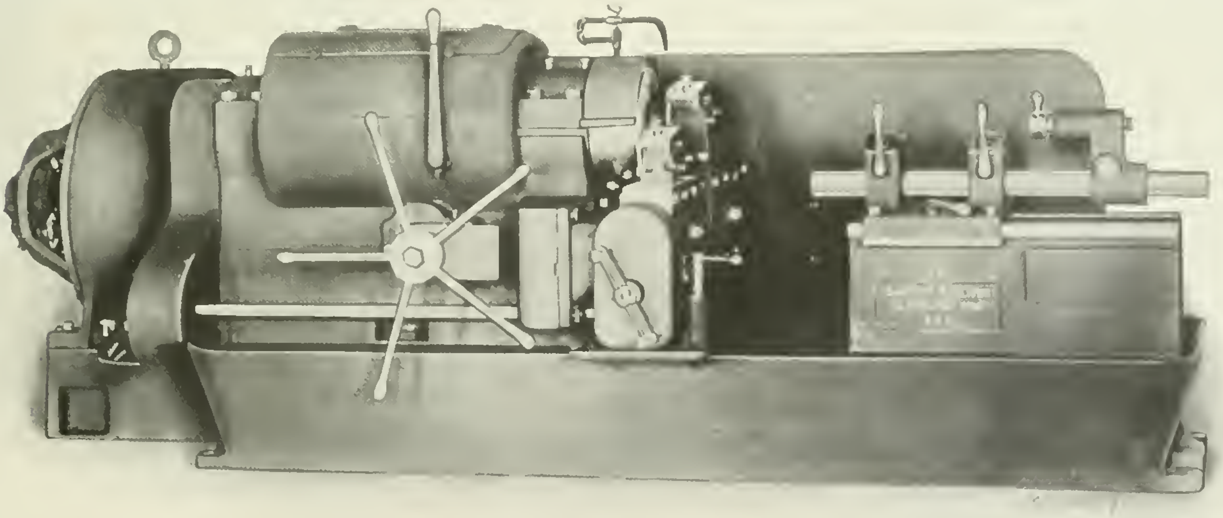
Ulrich Shadowless Drafting Table

By adjusting a ventilator beneath the drawing board, the warmth from the electric lamps under the plate-glass top, can be so regulated that the ink will dry as rapidly as it is applied, thus making it possible to work over these lines immediately. There is a shelf on the left side of the table and a cabinet on the opposite side, which are very convenient for holding drawing instruments and other equipment. This table is manufactured in five different sizes by Eugene Dietzgen Co., 166 W. Monroe St., Chicago, Ill.

BARDONS & OLIVER CUTTING-OFF MACHINE

The cutting-off machine shown herewith is a 6-inch size built by Bardons & Oliver, Cleveland, Ohio. This is an exceptionally heavy and compact machine designed for rapid and efficient operation. The spindle speeds vary from 29 to 152 revolutions per minute with 10 per cent speed increments. The changes are obtained by means of a geared head and a Westinghouse 15-horsepower, adjustable-speed motor having a variation of from 300 to 1200 revolutions per minute. The motor is regulated by a drum controller having 16 points. This wide range of speeds makes it possible to use the most economical cutting speed.

The time required for inserting and removing the stock has been reduced to a minimum by means of the automatic chuck, the adjustable stop and the drum controller. The cutting-off tool-slides are so designed that all interference from chips is avoided. The support for these slides is fastened to the front of the head which has an extension on the side, as the illustration shows. This support or bracket has openings between the slide and head, thus allowing the chips to fall directly into the pan without interfering with the operation of the slides. This construction also permits shortening the main bed. There is an open space to the right of the cutting-off tool-slide which makes it convenient to remove the chips. An ample supply of oil for the cutting tools is furnished by a suitable pump, and there is a pan to catch the lubricant.



Bardons & Oliver Six-inch Cutting-off Machine

The motor is attached to the left-hand end of the machine and forms an integral part of the construction, so that the machine is an independent unit which can be placed in the most advantageous position. The automatic chuck has a capacity of 6 inches, and the hole through the chuck plunger is $6\frac{3}{8}$ inches, whereas the hole through the spindle is $7\frac{1}{16}$ inches. The front spindle bearing has a diameter of $9\frac{1}{4}$ inches and is 8 inches long. The rear bearing has a diameter of $8\frac{5}{8}$ inches and a length of $6\frac{3}{4}$ inches. The cutting tools measure $\frac{3}{8}$ x $2\frac{1}{2}$ inches. The weight of the machine, including the motor, is about 16,000 pounds

BESLY PATTERNMAKERS' DISK GRINDER AND DRUM SANDER

The patternmakers' combination disk grinder and drum sander shown in Fig. 1 is manufactured by Charles H. Besly & Co., Chicago, Ill. All gear guards have been removed in order to show the arrangement of the driving mechanism. The machine is driven by a 3 horsepower motor mounted on a bracket bolted to the rear of the bed. This motor connects with the main spindle through sprockets and a Link-Belt silent chain.

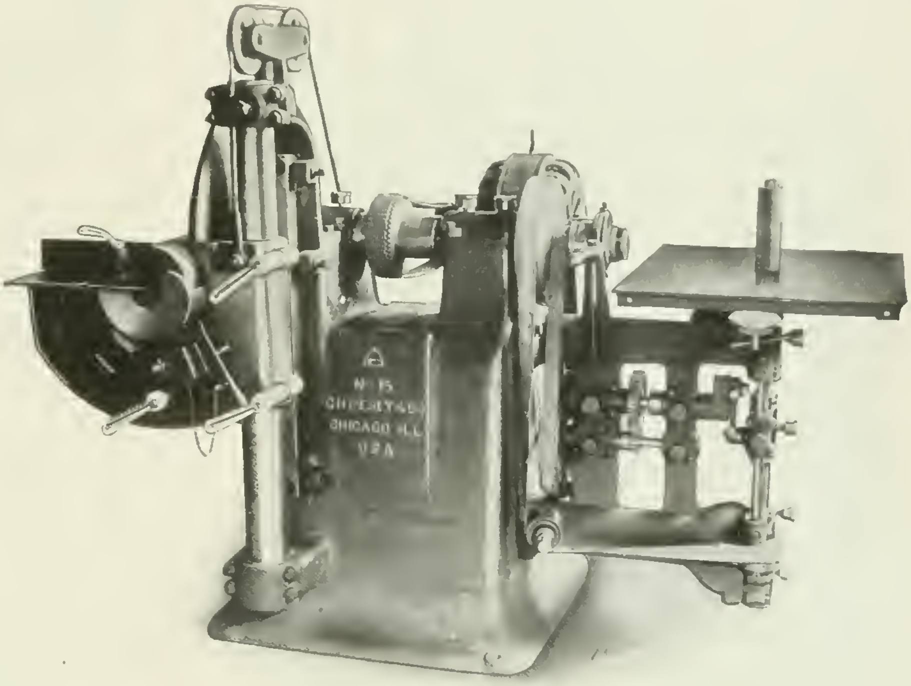


Fig. 1. Besly Combination Disk Grinder and Drum Sander for Wood Patternmaking

The steel disk wheel is 30 inches in diameter, $\frac{3}{4}$ inch thick and runs at a speed of 750 revolutions per minute. The work-table for the disk wheel is 14 inches wide and 40 inches long and can be tilted and locked at any angle from 75 degrees to 135 degrees from the plane of the grinding disk. Large distinct graduations are provided to indicate the angular position.

The work-table is so arranged that the inside or working edge remains within 1/32 inch of the grinding disk, regardless of the angular position, and the supporting mechanism is back of the disk wheel and below the face of the work-table, so that there are no obstructions to interfere with the work. The work-table has a vertical adjustment of 25 inches and is supported by a round vertical shaft which permits swinging the table away from the grinding disk for convenience when re-setting a wheel or facing off extra large patterns.

The machine is equipped with four work-table attachments which include a sizing circle gage for cylindrical and conical grinding, a sliding bevel gage for simple and compound angle grinding, a sizing bevel gage for simple and compound angle grinding to dimensions, and an angle-plate for the free-hand cornering of thin work. There is a telescoping dust hood which may be piped to an exhauster for withdrawing the grinding dust.

The drum sanding attachment at the right is driven through a Johnson self-oiling friction clutch which enables the operator to stop the drum sander independently of the disk wheel. This is very essential, as the disk wheel is usually allowed to run continuously, whereas the drum sander must be stopped in order to attach drums of various sizes for different classes of work. The work-table of the drum sanding attachment measures 24 by 28 inches. It can be tilted and locked at any angle from 85 degrees to 105 degrees from the axis of the sand drum, and the position of the table is shown by large graduations which can easily be seen.

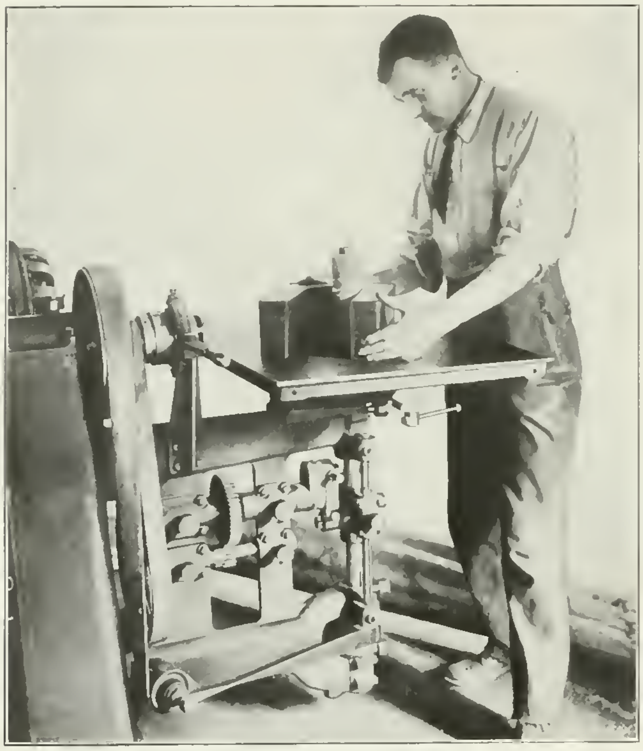


Fig. 2. View illustrating Use of Drum Sanding Attachment

The sand drum illustrated is 2½ inches in diameter and 8 inches long, but drums varying from 1 to 6 inches in diameter and of any reasonable length can be used. The work-table has a central annular opening 8½ inches in diameter into which are fitted circular plates with center holes to accommodate drums of different sizes. The sand drum runs at 2250 revolutions per minute and when in operation, it is given a vertical reciprocating movement to equalize the wear of the abrasive. This reciprocating movement is obtained from the crank seen beneath the table, and it is adjustable from 0 to 4 inches. The sand drum spindle is driven by a 2-inch quarter-turn belt, and the reciprocating crank is driven by a 1½-inch belt, which transmits power to the crankshaft through the intermediate shaft and gearing shown.

Fig. 2 illustrates how the sand drum attachment is used for finishing straight and curved inside surfaces. The table is tilted to an angle of 1½ degree, in this particular instance, to give the required draft.

This machine occupies a floor space of 54 by 84 inches and weighs 2800 pounds. It is made with either 30- or 40-inch disk wheels and for a belt or motor drive.

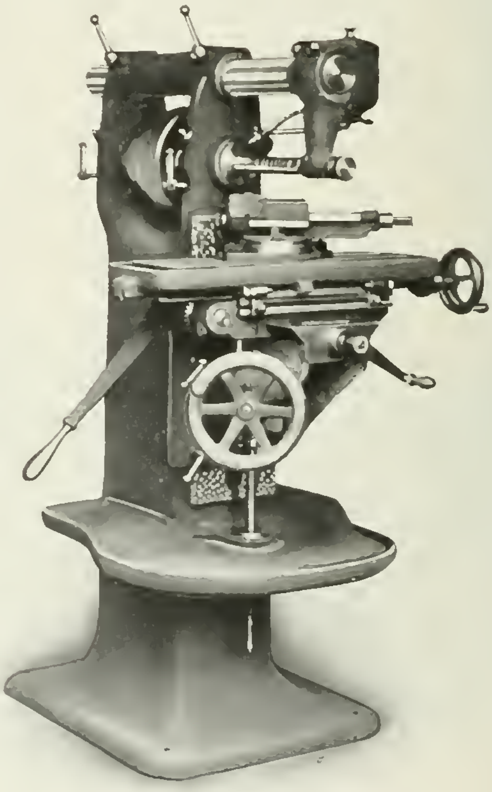
IMPROVED POLISHING MACHINE

The accompanying illustration shows an improvement which has recently been made on the 12- and 14-inch ring-oiling polishing machine manufactured by the Builders Iron Foundry, Providence, R. I. The loose pulley has a diameter ½ inch less than the diameter of the tight pulley in order to relieve the tension on the driving belt when the spindle is stationary. This well-known feature permits the use of an extra-tight belt without subjecting the loose pulley to excessive strain; consequently there is less wear on both the belt and pulley. The loose pulley has a beveled flange on the tight pulley side, so that the belt can be shifted easily. This polishing machine has a positive method of lubrication which permits it to be run at very high speeds without lubrication troubles.

Spindle Mounting and Belt Pulleys of Polishing Machine made by Builders Iron Foundry

STEPTOE HAND MILLING MACHINE

The hand milling machine illustrated herewith is of a recent design now being built by the John Steptoe Shaper Co., 2951 Colerain Ave., Cincinnati, Ohio. The table of this machine can be operated either by a lever feed or a screw feed.



Steptoe Hand Milling Machine

The lever feed is intended for the rapid milling of small parts, but when desirable, either because of accuracy or for some other reason, the screw feed can be employed. This screw feed has a collar accurately graduated to thousandths of an inch.

This machine is also built with a lever elevation for the knee, when so ordered, and it will be manufactured later with a power feed for the table. The vise has a graduated base for setting it to any angle. The pan seen below the knee prevents chips and oil from falling on the floor, and it is also convenient as a tool rest. The bearings are of high-grade phosphor-bronze and are tapered and threaded on the ends to take up wear. The bearings are thoroughly oiled by means of felt oilers.

DALLETT PNEUMATIC TOOLS FOR PATTERNMAKING

In view of the fact that pneumatic tools have proved so efficient for chipping metals, carving stone, etc., it seems rather strange that they have not come into general use in woodworking establishments. In the pattern shops, for instance, there is always more or less hand carving which could doubtless be done easier and quicker with the aid of pneumatic tools. The Thomas H. Dallett Co., York and 23d Sts., Philadelphia, Pa., has placed on the market pneumatic tools for wood carving which are an adaptation of the pneumatic stone-working tools which this company has been manufacturing for years.

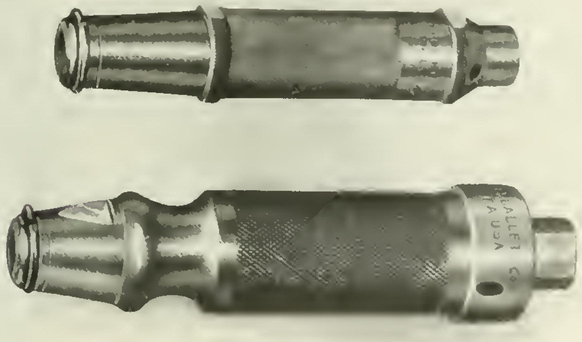


Fig. 1. Dallett Pneumatic Tools for Wood Carving and Patternmaking

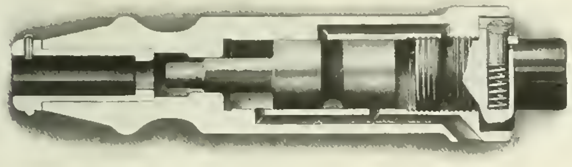


Fig. 2. Sectional View of One-inch Pneumatic Wood-carving Tool

These tools for wood carving are made in two sizes, which are illustrated in Fig. 1. The upper tool is a ¾-inch size intended for fine carving and finishing, whereas the 1-inch size below is more powerful and is adapted for gouging and heavy roughing work.

It is claimed that these tools enable one man to accomplish a great deal more than would be possible by the old method of hand carving. They can be regulated to give a light or hard blow, either by placing the thumb over the exhaust hole or cutting down the air supply by means of a stop-cock in the hose. Both tools are of the valveless type and operate on the same principle, although there is a slight difference in the design. The head of the ¾-inch tool is locked by a pin and spring, whereas, in the 1-inch "finger grip" design, the head is locked by a ratchet and pawl.

The sectional view, Fig. 2, shows the construction of the larger size. The tool-steel piston is the only moving part, and it strikes as high as two or three thousand blows per minute, the rate depending upon the pressure. The cylinder is of hardened steel and, in the case of the "finger grip" design, it is one solid piece. A renewable hardened bushing is inserted in the end of the barrel for the reception of a shank having a special "quarter-octagon" shape instead of being round. With this arrangement, the chisel can be held steady and secure without any effort on the part of the workman. Furthermore, by having a shank of this shape, the chisel can be twisted when gouging or roughing, in order to split or pry off a chip, which could not be done with a round bushing.

As wood chisels are made with both tang and socket ends, three fittings known as a plug, shank and socket shank are furnished to adapt the pneumatic tools for any style of chisel. The shanks are provided with a recess on one side which is engaged by a locking spring to prevent the shank from dropping out when the tool is in operation. This feature makes it unnecessary for the workman to hold the chisel in place.

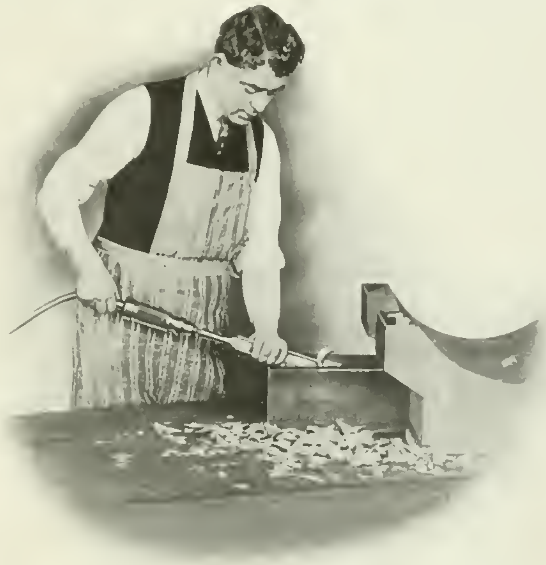
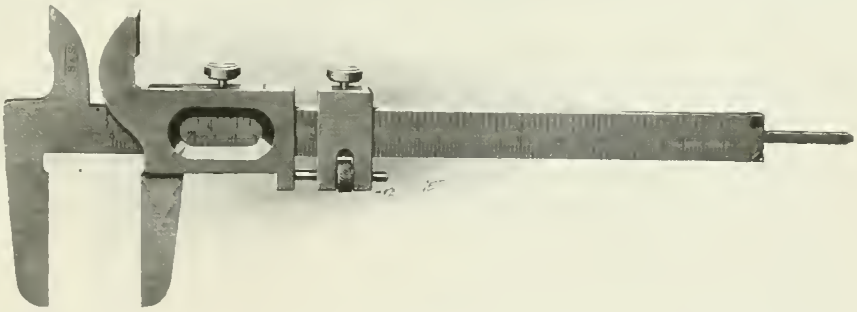


Fig. 3. Using the Dallett Pneumatic Tool for Patternmaking

Fig. 3 illustrates the application of this tool to patternmaking. The air consumption of the ¾-inch size is approximately four cubic feet of free air per minute, and that of the 1-inch size, about five cubic feet. The air pressure required depends entirely upon the character of the work and the kind of wood being operated upon. The pressures range from 40 to 100 pounds, but pressures between 70 and 90 pounds are most commonly used for general work.

SCHUCHARDT & SCHUTTE VERNIER CALIPER

Schuchardt & Schutte, Cedar & West Sts., New York, has placed on the market the improved form of vernier caliper shown herewith. This is a combination tool which can be used for measuring inside and outside diameters and also as a depth gage. The extension jaws seen above the regular caliper jaws, are used for internal measurements, and the depth gage slides in a groove on the rear side and projects beyond the end of the bar or scale, as shown to the right. The jaws and depth gage move together, so that all three measurements are obtained at one setting, and the scales give a direct reading.


Combination Vernier Caliper for Inside, Outside and Depth Measurements

The general arrangement of this caliper is similar to the type formerly sold by this company, but the construction is quite different. The fixed jaws for internal and external measurements are integral with the bar instead of being riveted in place, and the sliding jaw completely encircles the bar, instead of being retained by a flat spring, as with the older design. This construction makes the tool much stronger and adapts it for hard usage in machine shops.

The bar is 6 inches long and is graduated on the upper and lower edges. Two sets of graduations can be furnished. The upper and lower scales of one set are graduated to sixteenths and twenty-fifths of an inch with verniers reading to one-hundred twenty-eighths and one thousandths inch, respectively. The other set has one-sixteenth-inch graduations on the upper scale and millimeters on the lower scale with verniers reading to one-hundred twenty-eighths inch and one-tenth millimeter, respectively.

BATH GRINDING MACHINE FOR MULTIPLE KEY-SHAFTS

The grinding machine illustrated herewith has been designed for grinding integral multiple key-shafts or sliding-gear shafts for automobile transmission cases. A formed grinding wheel is used and the sides of two keys as well as the circular surface between them, are ground simultaneously. This machine is built by the Bath Grinder Co., Fitchburg, Mass. Fig. 1 is a front view showing the water guards in place; Fig. 2 is an end view illustrating the construction and arrangement of the grinding wheel head; and Fig. 3 shows a key-shaft in place and the wheel in position for grinding. Before taking this latter view, the water guards were removed to expose the details of the machine.

The vertical column has two wide bearing surfaces upon which the grinding wheel head is mounted. The column is strongly ribbed internally and firmly bolted to the base of the machine. The wheel-head is rigidly constructed and careful attention has been paid to the oiling system. The wheel-spindle is made of tool steel, hardened and ground, and runs in adjustable phosphor-bronze bearings, which are thoroughly protected from grit. The handwheel for feeding the grinding wheel vertically, is graduated to read to 0.00025 inch, and it is equipped with a stop for grinding duplicate parts. The thrust of the vertical feed screw is taken by ball thrust bearings.

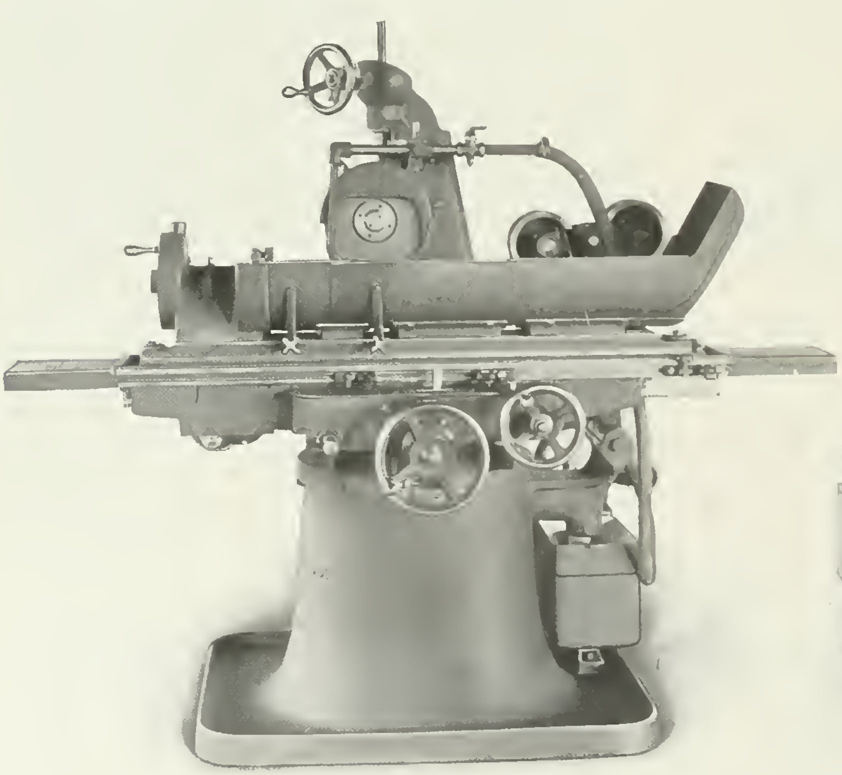


Fig. 1. Bath Multiple Key-shaft Grinding Machine

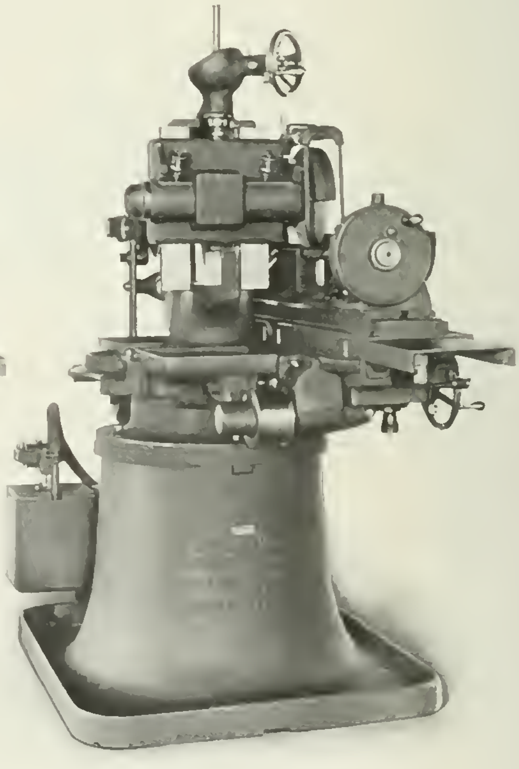


Fig. 2. End View of Bath Grinding Machine

The machine is provided with an indexing work-head, firmly bolted to the table. The indexing mechanism consists of an index dial, a tooth ratchet wheel and an index plunger-bolt, all of which are protected from water and grit. The index plunger-bolt is released by a slight backward movement of the handle shown; then by a forward movement, the work is revolved and the plunger-bolt engaged in the next taper notch. This mechanism is so designed that the dial cannot revolve backwards when free of the plunger, which insures a positive indexing action. The number of divisions on the dial are determined by the number of keys in the shaft to be ground.

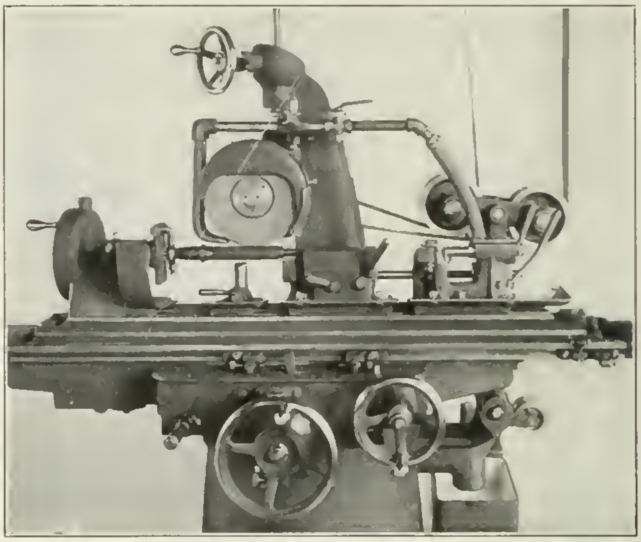


Fig. 3. View of Bath Grinder with Water Guards removed

The footstock furnished on this machine is very compact and rigid in construction. The center carrier is flat and is set into the base at an angle, thus bringing the center within one-half inch of the top and one-half inch of the inner side of the footstock. This allows the grinding wheel to pass the footstock, without disturbing its position. The center carrier is operated by a spring controlled by the lever seen at the right-hand end of the footstock. The carrier may be locked firmly in position by the handle at the left. All operating parts are thoroughly protected from water and grit.

The wheel truing device, which is illustrated in Fig. 4, is provided with three black diamonds. One is for forming the radius of the wheel and is operated by the short lever seen at the end of the fixture. The other two diamonds are for forming the sides of the wheel and are operated simultaneously by the long lever shown at the end of the fixture. The diamond for forming the radius is carried by a steel spindle which revolves in a taper bearing, and is provided with a very sensitive adjustment. The alignment of the side forming diamonds is insured by adjustable taper keys. These bearings are carefully protected from grit and water.

After this device has been properly located at the back of the footstock, it should not be disturbed. When truing the grinding wheel, the table is moved so as to bring the center of the grinding wheel over the center of the diamonds, the table being provided with a twin stop for locating it in the correct position. The master block for setting the diamonds is clamped on top of the wheel truing device base, which is provided with a dovetail to insure alignment. The master block carries a hardened tool steel plug, to which the diamonds are set. A shield is furnished to cover the bearing on the wheel truing device when the master block is not in use.

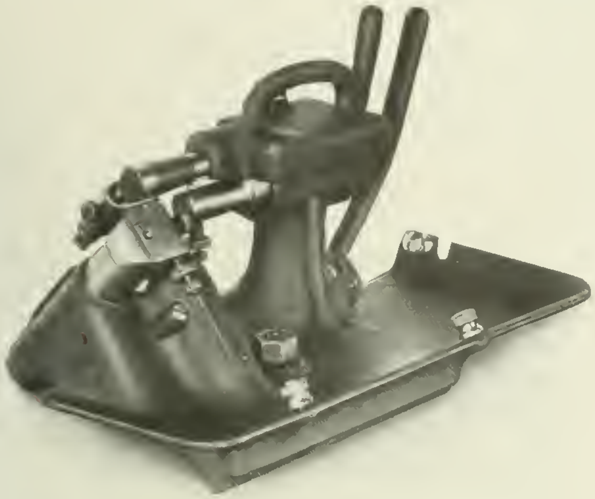
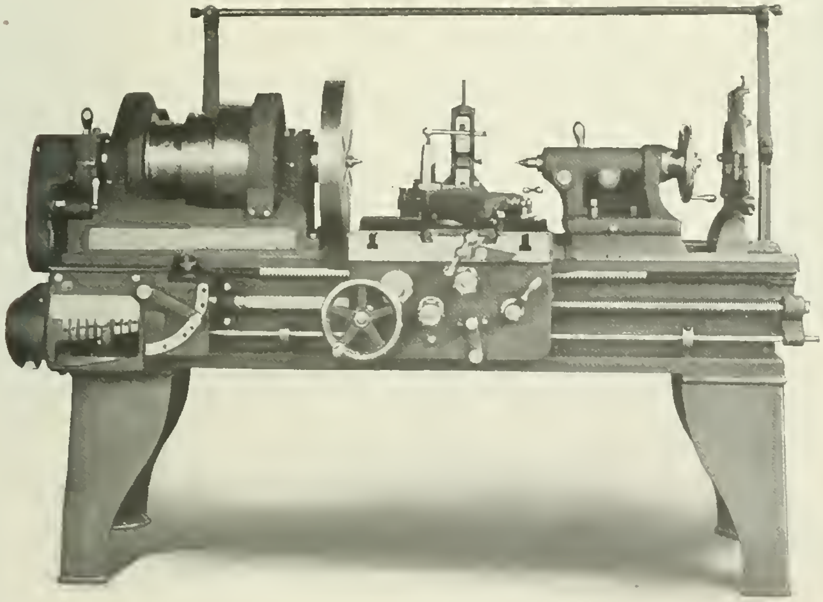


Fig. 4. Device for Truing Sides of Wheel and Forming Radius

A combination centering and rest base is furnished for centering work rapidly, and also for supporting slender work. This fixture is clamped to the table and is provided with a plunger, the top of which is formed to fit between two keys on the shaft to be ground. The plunger is actuated by a spring, and is controlled by a lever which has a cam cast integral and engages the plunger. A slight turn of this lever to the left relieves the plunger, and, when used as a support, the plunger may be clamped firmly in position by moving the lever in the opposite direction.

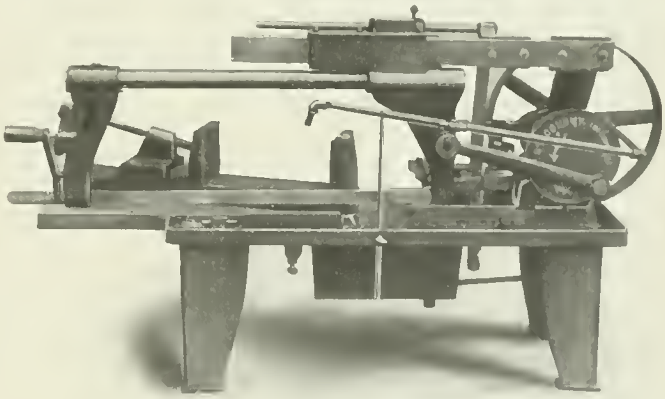


Greaves-Klusman Quick-change 17-inch Engine Lathe

The table is controlled in the usual manner by adjustable dogs operating against a reversing lever which actuate a clutch of the "load-and-fire" type. The table can also be controlled by a hand-reversing lever, which provides means for automatically stopping it at the end of its traverse, by simply giving the lever part of a turn at any time during the traverse of the table. All operating levers, handles and adjustments are within easy reach of the operator from the front of the machine. The water tank is separate from the machine, thus making it convenient for cleaning.

ROBERTSON POWER HACKSAW

In the June, 1912, number of Machinery a power hacksaw, known as No. 2, manufactured by the W. Robertson Machine & Foundry Co., 32 Greenwood Place, Buffalo, N. Y., was illustrated and described. The accompanying illustration shows a larger size of hacksaw, known as No. 5, built by the same company. This machine is designed for cutting off structural shapes and solid stock, round or square, the maximum capacity being 8 by 15 inches. The saw frame is adjustable and allows the use of a 10-inch blade for cutting small stock, which involves a great saving when large stock is not being cut continually. The vise has strong wide jaws and is provided with a quick adjustment so that the operator can open or close it instantly to take stock from 1 to 15 inches. The vise swivels to a 45-degree angle, and is graduated.



"Economy" Power Hacksaw

The saw cuts on the draw stroke, and is raised on the return stroke by an arrangement which is very simple mechanically, yet positive and durable. The saw stops automatically when the cut is completed. The tank shown under the bed is for cooling liquid, which is pumped to the blade by a rotary pump connected to the driving gear at the rear of the head.

The maximum length of the blade is 24 inches, the minimum being 10 inches; the stroke is 6 inches. The driving pulley speed is 140 R. P. M., and the net weight of the machine is 360 pounds.

GREAVES-KLUSMAN 17-INCH LATHE

Greaves, Klusman & Co., Cincinnati, Ohio, have added to their line of lathes, a 17-inch quick change-gear type having a three-step cone and friction double back-gears. The bed is a new form designed to minimize twisting strains by means of heavy reinforcements under the V's, which extend below the top of the girths. The headstock is massive and the spindle is made of high-carbon steel and runs in self-oiling phosphor-bronze bearings. The front spindle bearing is hardened and ground in position. The self-adjusting, friction, double back-gears can be engaged by the operator in any position along the bed, by simply shifting the horizontal bar shown.

With the two-speed, friction countershaft regularly furnished with this lathe, eighteen speeds are obtainable. As six of these speeds are secured without shifting the belt, it is convenient to obtain the proper speed for roughing and finishing.

The frictions of the double back-gear mechanism are of simple construction and have two rings which engage recesses in the gears. There are two toggles fitted in each ring which expand the frictions when the longitudinal bar is shifted. These frictions are self-adjusting for wear and have ample strength to transmit the maximum belt pull.

The tailstock has an extra-long spindle which is gripped by two sets of double-plug clamps at both ends of the barrel. This clamping device is operated by a single handle. The carriage has a full length bearing on each V and a flat bearing inside the front V, which shortens the bridge and gives a direct support under the tool-rest. The apron is the double-plate box form. The quick-change gear-box at the left is a simple, compact design having but two handles which control the entire range of threads and feeds. The lathe is fitted with a chasing dial for "catching" threads, and all threads from two to fifty-six per inch can be cut, including the 11½ pipe thread. There is a clutch for independently engaging or disengaging the lead-screw on the feed-rod. This clutch is operated by a handwheel on the gear-box.

This lathe has a swing over the bed of 18⅜ inches, a swing over the carriage of 13⅛ inches, and it takes 31 inches between the centers, with a 6-foot bed. The front spindle bearing is 3 3/16 inches in diameter and 5⅛ inches long, and the rear bearing is 2⅝ inches in diameter and 4 5/16 inches long. The back-gear ratios are 3.5 to 1 and 12 to 1.

BLISS TOGGLE DRAWING PRESS

The accompanying illustrations show the front and rear views of a toggle drawing press recently designed and built by the E. W. Bliss Co., 5 Adams St., Brooklyn, N. Y. This is said to be one of the largest drawing presses of this type ever built. This press is intended for drawing and forming sheet metal automobile parts made of thick stock, such as brake drums, rear axle housings, etc., but it is equally well adapted for other lines of manufacture in which very heavy stock is drawn.

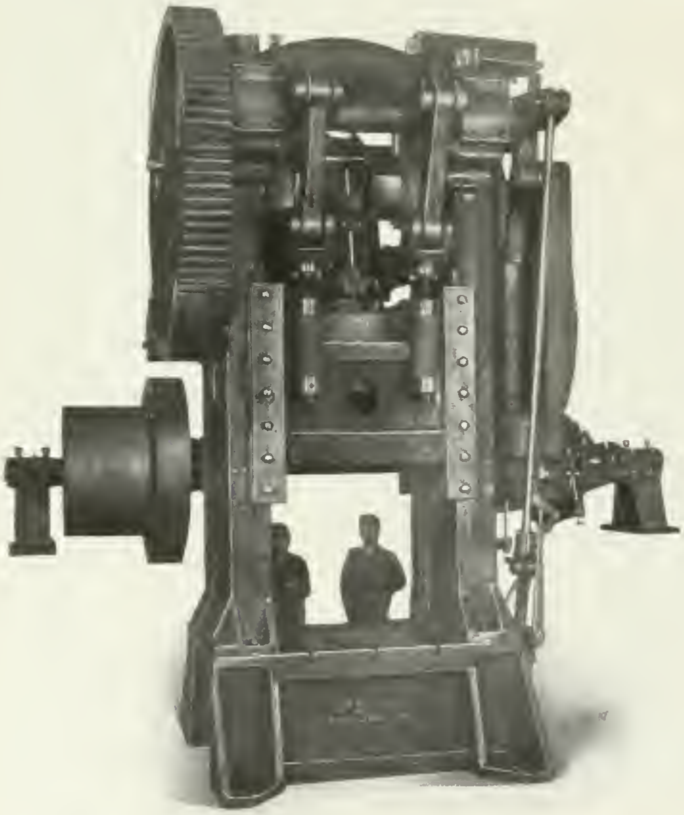


Fig. 1. Large Toggle Drawing Press built by E. W. Bliss Co.

The construction is of the built-up type, the bed, the crownpiece and uprights being separate and bound together by four 7-inch steel tie-rods, which take all the working strain. These tie-rods are heated and shrunk into place. The frame columns are of cored box section, and impart great rigidity to the entire structure. The main crankshaft is 12 inches in diameter and has a stroke of 24 inches. The stroke of the blankholder slide is 16 inches.

The entire construction of the machine is in proportion to the 12-inch crankshaft and 7-inch tie-rods, and the calculations were based on the bending strength. With a factor of safety of 2½, the machine has a safe working capacity of 600 tons. Attention is called to the basis of the calculations, because in many instances, the capacity of presses is figured on the shearing strain. If the latter method were adopted in this case the press shown would have a capacity of 1000 tons, but to have this capacity with the bending strength taken as a basis, would require 9-inch tie-rods and a 16-inch crankshaft.

The Bliss toggle movement is applied to the press and all pressure on the blank is transferred through straightened toggles directly to the frame, relieving the bearings from all friction and wear due to blank-holding, with a consequent reduction in power consumption.

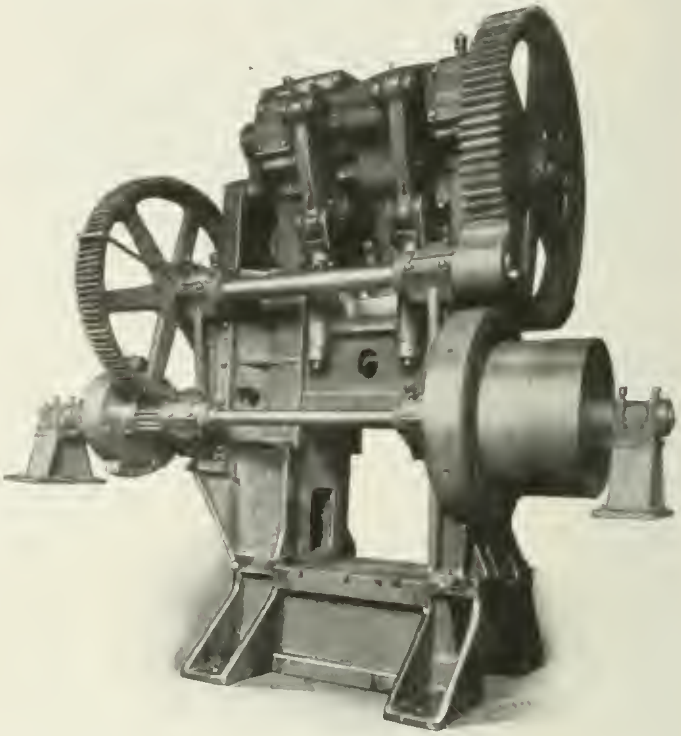


Fig. 2. Rear View of Bliss Toggle Press

The press is double geared, and the entire train of gears are of steel castings, and machine cut. The press is controlled by a powerful hand-actuated friction clutch of the double-grip type, the action of which is practically instantaneous. This clutch, in connection with the semi-automatic brake, places the movements of the press entirely under the control of the operator, so that it can be started or stopped at any point.

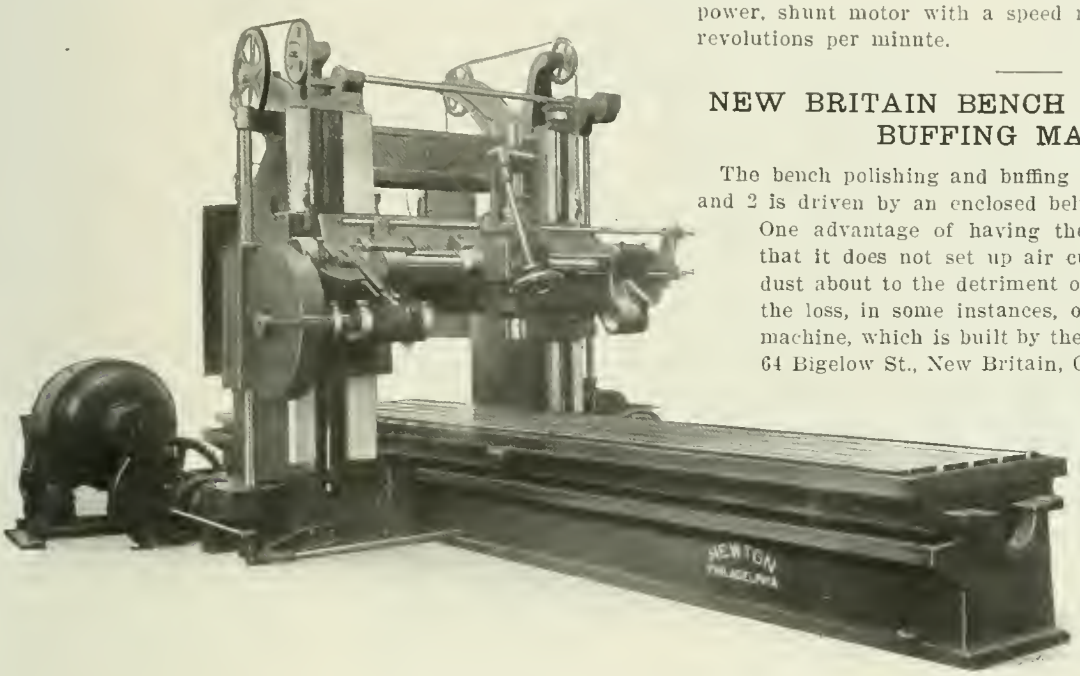
It will be noted that the bottom of the outboard bearing standards are very high from the base of the press. This arrangement was necessary because of the low ceilings in the building at the place of installation, which requires the press to be placed in a pit of considerable depth. The actual shipping weight is 170,000 pounds.

NEWTON HORIZONTAL MILLING MACHINE

The Newton Machine Tool Works, Inc., 24th and Vine Sts., Philadelphia, Pa., has recently designed a heavy type of horizontal milling machine for forge work. The bed of this machine is of an extra-heavy, double-ribbed, box-type construction having oil pans cast integral and bearings with square gibs for the table. The sides of the bed are fitted with tongues for attaching the uprights which extend to the floor line. The work-table is also exceptionally heavy, of double-ribbed box-type construction, and has an angular steel rack bolted to the bottom which is engaged by a bronze worm-gear of steep lead and large diameter.

The rail is of the inclined face type and is of large proportions. It is fitted to the uprights with square lock bearings. Adjustments are made by taper shoes, and the alignment is maintained by the narrow guide bearing on the left-hand upright. The bearing of the rail on this upright, for alignment, is on both sides of one shear, to prevent any distortion of the bearing surfaces. The bearing for the driving worm-wheel sleeve and the driving worm are cast solid with the rail, which gives a strong resistance to thrust and tends to eliminate chatter.

The spindle revolves in a bronze bushed capped bearing, which has a hand side adjustment on the rail for convenience in setting cutters. The rail is of sufficient length to permit removing the cutters without taking off the outer support. The spindle is arranged to drive the cutter arbor by means of a broad face key, and the arbor is held in place by a through retaining bolt. The outer end of the cutter arbor is supported in bushings that have parallel internal and taper external bearings, fitted with adjusting nuts to compensate for wear. Individual screws fitted with micrometer measuring collars are furnished for moving both the horizontal spindle and the vertical spindle saddles. The outer support is adjusted rapidly by means of a rack and pinion. The cross-rail elevating screws have a top and bottom bearing, and as the counterweights are heavier than the rail, tension is always maintained and lost motion eliminated.



Newton Horizontal Milling Machine for Forge Work

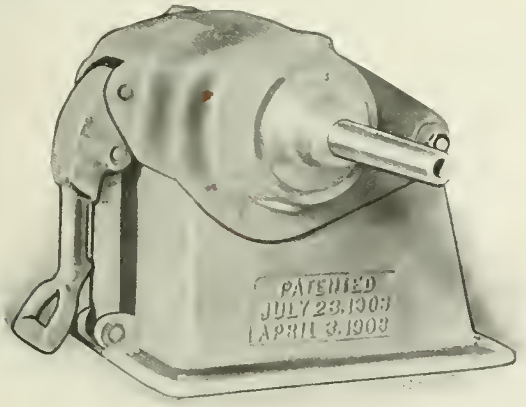


Fig. 1. The New Britain Bench Polishing Machine

As many forgings, such as large driving shafts, require feather keyways, this machine has been equipped with a vertical spindle to mill the ends of the keyways. The vertical spindle is five inches in diameter, and is arranged to drive the cutters by a broad face key. It is fitted with a No. 6 Morse taper, retaining and drift key slots, and a micrometer measuring shoulder. The vertical spindle is driven from a spur gear placed beside the worm-wheel for the horizontal spindle. The motion is transmitted through a clutch so that the vertical spindle can be disengaged when not needed.

This machine has a reversing fast power traverse, positive geared feeds with nine changes, and a reversing fast power elevation for the cross-rail, in addition to hand adjustment for the table and rail. One handwheel controls the hand movement of the rail and table, and the lever controlling the direction of the rapid traverse for the table always controls the movement of the cross-rail.

The diameter of the horizontal spindle is 6⅜ inches; side adjustment of the spindle by hand, 12 inches; distance from the center of the spindle to the under side of the cross-rail, 4 inches; independent hand adjustment of the vertical spindle, 9 inches; width of work-table on the working surface, 42 inches; length that can be milled, 12 feet; width between the uprights, 48 inches; maximum distance from the center of the spindle to the top of the work-table, 52 inches.

This machine is driven by a General Electric 50/60-horsepower, shunt motor with a speed range of from 400 to 1200 revolutions per minute.

NEW BRITAIN BENCH POLISHING AND BUFFING MACHINE

The bench polishing and buffing machine shown in Figs. 1 and 2 is driven by an enclosed belt from beneath the bench. One advantage of having the driving belt enclosed is that it does not set up air currents which would carry dust about to the detriment of the worker's health, and the loss, in some instances, of valuable material. This machine, which is built by the New Britain Machine Co., 64 Bigelow St., New Britain, Conn., has been designed to facilitate cleaning, there being plain, smooth surfaces with rounded corners, so that all valuable material that is polished and buffed off can be recovered.

The drive from beneath keeps the spindle down in the bearings, which is said to give a smoother running head than when the pull of the belt holds the spindle against the box cap. The drive from beneath also makes possible a simple means of starting and stopping without any loose pulleys. This is accomplished by swiveling the upper portion of the head which is hinged at the rear and is held by a toggle lever. When the head is lifted by pushing the lever down, as in Fig. 1, the belt is tightened and the spindle set in motion. On the other hand, when the lever is raised, as in Fig. 2, the spindle is dropped onto a brake-block which stops it quickly, and the belt sags away from the driving pulley beneath the bench. The toggle lever is so designed that as the belt tightens, the leverage increases, and, at the end of its downward movement, the toggle becomes self-locking.

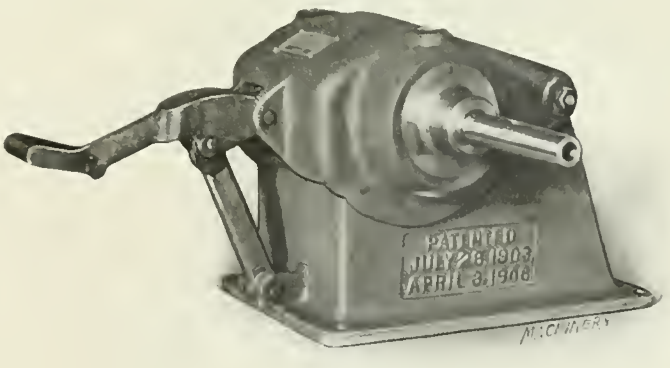


Fig. 2. Starting Toggle raised to disengage Belt from Driving Pulley

The machine is equipped with either a double- or single-end spindle. The boxes are self-aligning and have a ball section in the center which allows the bearings to adjust themselves, if the shaft is sprung either by heavy belt pull or excessive polishing pressure on the end of the spindle. The spindle is oiled by solid internal collars which dip into the oil and carry it up to the strippers above, which distribute it to each end of the bearings. This collar also serves to take up end motion.

GORTON HEAVY-DUTY CUTTING-OFF MACHINE

The accompanying illustrations show a 16-inch heavy-duty, high-speed cutting-off machine recently built by the George Gorton Machine Co., Racine, Wis. This machine has been under development by the Gorton company during a period of several years, the various details being covered by numerous patents both in the United States and abroad. The special feature of the machine is its great capacity; it will sever round, 30 to 40 point carbon open hearth steel bars, 6 inches in diameter, in thirty seconds, and 12-inch bar can be cut off in one minute; but the working speed recommended is one minute for a 6-inch bar of the material mentioned, other sizes being operated upon in the same proportion.

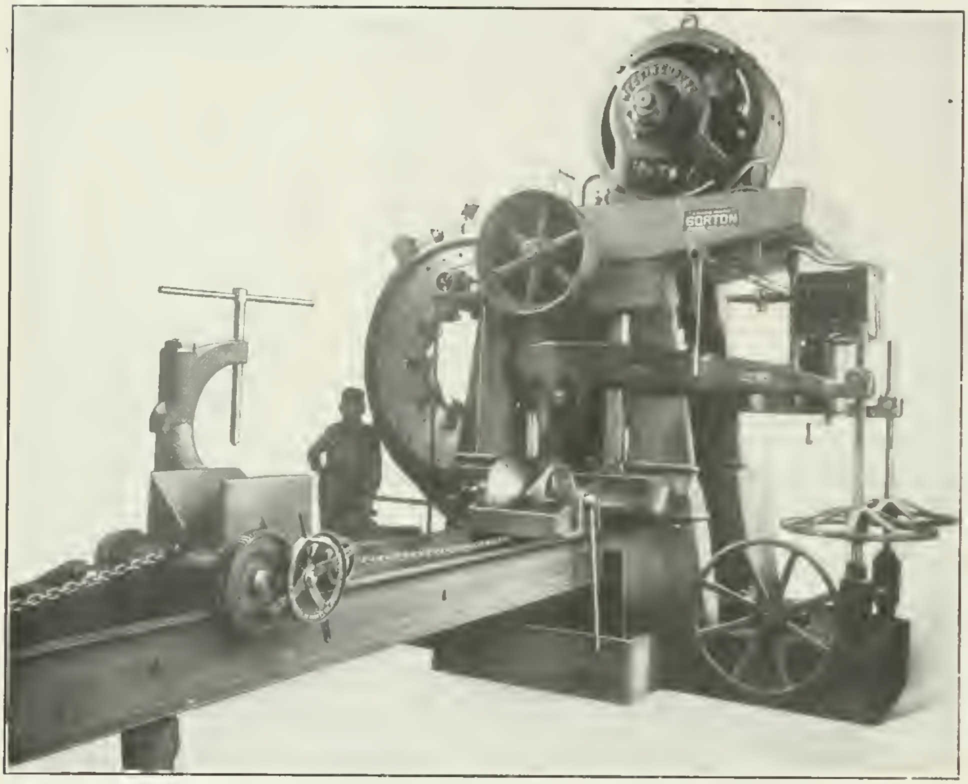


Fig. 1. Gorton Sixteen-inch Cutting-off Machine with Drum raised to provide Access to Cutters

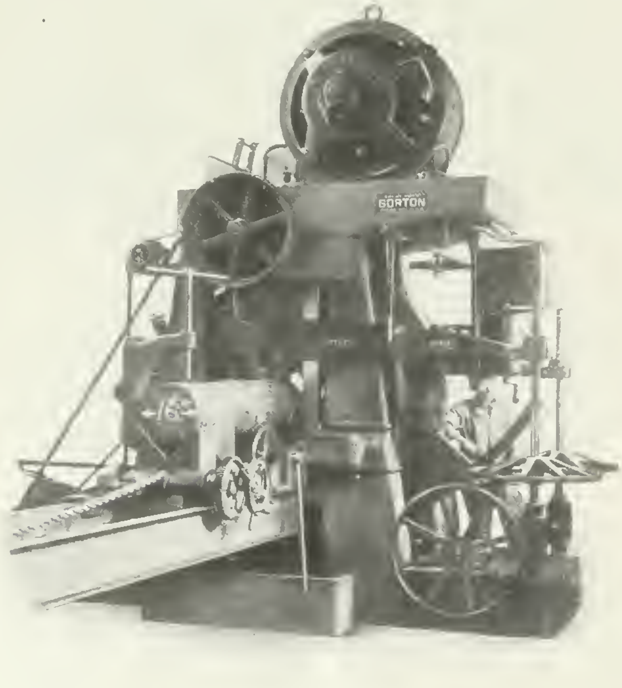


Fig. 2. Cutting-off Machine with Bar in Place ready for Cut

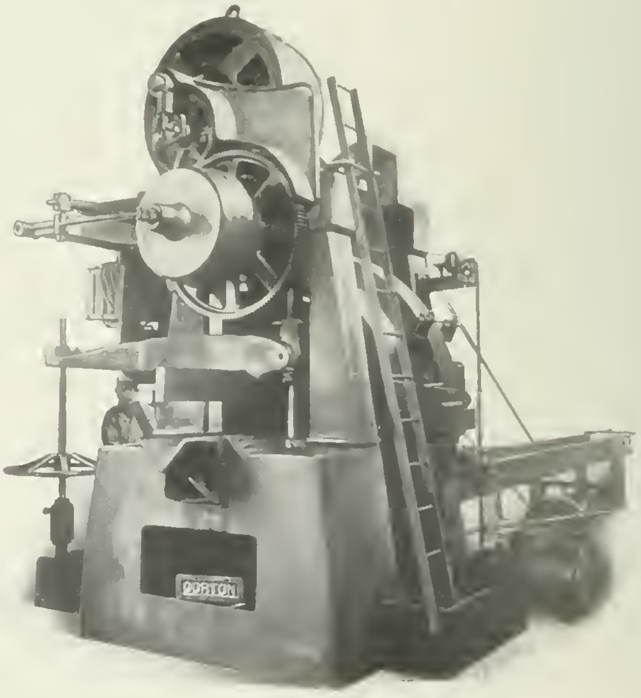


Fig. 3. Rear View of Gorton Cutting-off Machine

The machine is driven by a 40 H. P. variable-speed motor. The main driving gear is 72 inches in diameter with a 4½-inch face, and is made of semi-steel. It meshes with a main driving pinion, integral with its shaft, made of a crucible steel forging. The diameter of the pinion is 5 inches, and as the cutter points are 10 inches from the center of rotation of the saw drum, this arrangement makes an exceedingly powerful drive. The outside clutch gear, shown in Fig. 3, is 36 inches in diameter and is driven directly from the motor through an intermediate gear as indicated. The cutter travel can be varied from 17 feet per minute up to 51 feet per minute, according to the kind of stock being cut. The cutter blade is ¾ inch thick, and the opening between the cutter points is 20 inches in diameter. To avoid accidental breakage of cutters, the main clutch is provided with a shearing pin which will release the driving mechanism when undue strain is placed upon the cutter. This shearing pin is so located that the cutter is disconnected from all parts of large diameter which continue to revolve until the motor is shut down. This arrangement avoids any flywheel effect which would tend to continue to rotate the cutter after the shearing of the pin.

The stock is fed through the machine by means of a stock carriage, as indicated in Fig. 2. The amount of stock fed may be measured off accurately by means of a measuring bolt. The stock severed is forced on through the V-block at the rear of the machine, indicated in Fig. 3. Simple and powerful clamping arrangements are provided. These may be operated either by hand, or by hydraulic or pneumatic means.

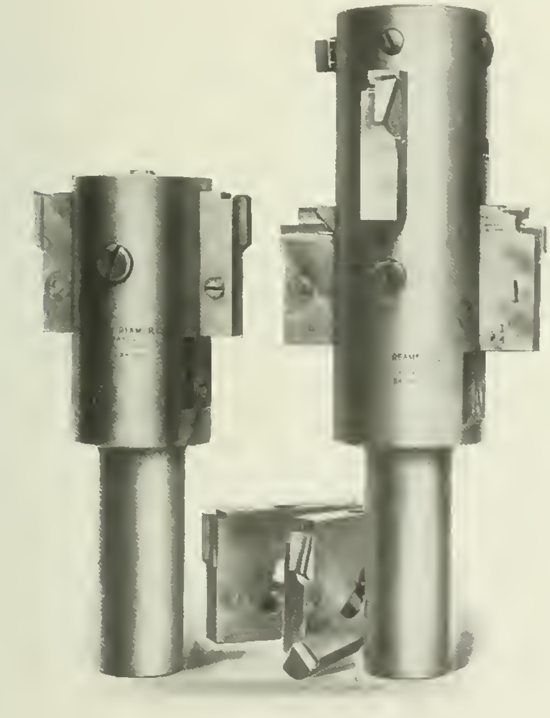
An important feature of this machine, as well as of other Gorton cutting-off machines, is that the cutter blade with its drum is driven through spur gearing, as this means of driving is most economical in power consumption, most durable, and least expensive to manufacture and to maintain. The feed is by means of a worm and worm-gear segment.

The question of lubrication has been given special attention. The saw drum bearings operate in a flood of oil, and the construction is such that it is impossible for the cutting compound, chips or dirt to enter these bearings. The main pinion bearings, which are 3½ inches in diameter, also operate in a flood of oil. The feed work cases are also flooded with oil, and the main driving clutch is partially so lubricated. A pump is provided for flooding the cutters with lubricating compound when in operation.

The total net weight of the machine, as shown in the illustrations, exclusive of the stock rack, is 55,000 pounds. The total height of the machine, including the motor, is 12 feet, the shipping height, with motor removed, being 9 feet 6 inches. The length of the base on the floor line is 9 feet 6 inches, the width being 7 feet.

KELLY AUTOMOBILE HUB REAMERS

The accompanying illustration shows a boring and reaming outfit for automobile wheel hubs made by the Kelly Reamer Co., Cleveland, Ohio, the tools as shown being especially intended for use on the Jones & Lamson turret lathe. The tool shown to the right is the boring tool used for roughing only, while that shown to the left is the finishing reamer. The tools shown at the bottom, between the shanks of the holders, are exchange-tools used for the small end of the hub.



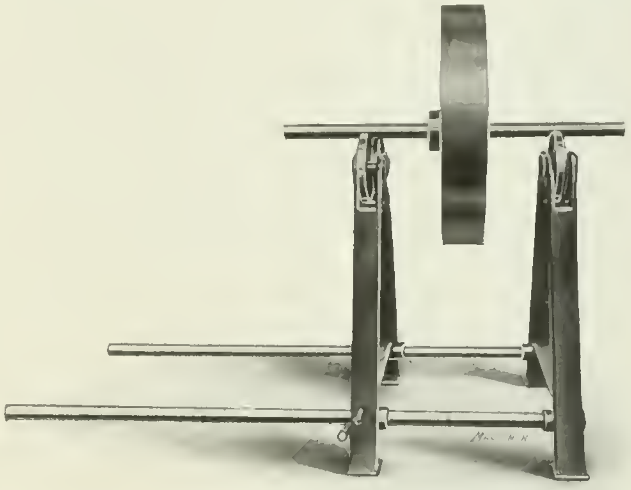
Kelly Roughing and Finishing Reamers for Automobile Wheel Hubs

One of the improvements introduced in these tools as compared with the ordinary design of Kelly reamers, illustrated and described in the July, 1908, number of MACHINERY, is that the reamer blades do not extend outside of the flat reamer holder body in the lengthwise direction. Thus the tools can be easily slid in and out of the holder and rapidly exchanged. This feature is especially valuable for crankcase work, where it is imperative that the boring and reaming be done at one setting of the work, to insure alignment. The special construction then permits the change from boring or roughing reamer bodies to floating finishing reamers to be made rapidly and without difficulty.

TWENTIETH CENTURY BALANCING STAND

The balancing stand shown in the accompanying illustration has been brought out by the Rockford Tool Co., Rockford, Ill., and is designed for balancing pulleys, flywheels, armatures, etc. It will swing wheels 8 feet in diameter, and has a carrying capacity of 5 tons. The distance between the standards is adjustable, the maximum distance being 8 feet and the minimum distance 2 feet. The adjustment is by means of a rack and pinion, the hand-crank shown in the foreground being used for this purpose.

The size of balancing stand shown in the illustration is known as No. 4. Besides this one, four other sizes are built, known as Nos. 1, 2, 2A and 3. Size No. 1 is intended for bench use and is 20 inches between the standards. It will swing 22 inches, and carry a weight of 1000 pounds. No. 2 and 2A both swing 46 inches and have a distance of 30 inches between standards. No. 2 has a carrying capacity of 1000 pounds, while No. 2A will carry one ton. Size No. 3 has a carrying capacity of 2½ tons with a maximum distance of 6 feet between standards, and a swing of 6 feet.

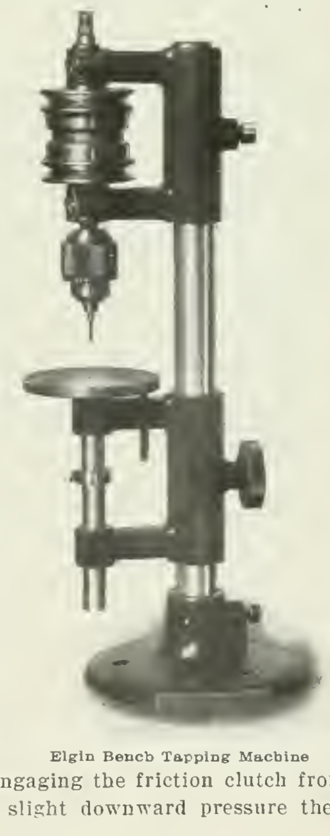


Twentieth Century Balancing Stand, built by the Rockford Tool Co.

The rotating disks which carry the shaft of the wheel to be balanced run in ball bearings. The disks on stands Nos. 1 and 2 are made from steel, hardened and ground, while the disks on sizes 2A, 3 and 4 are made from chilled cast iron and ground.

ELGIN BENCH TAPPING MACHINE

The Elgin Tool Works, Elgin, Ill., has brought out a new tapping machine of the bench type. The construction of this machine is very simple, as will be seen by referring to the engraving. The two heads which carry the tapping spindle and the work table respectively, are mounted on a vertical column or shaft which can be furnished in different lengths so that holes in the side of a box or frame can be tapped. The tap spindle is driven through a friction clutch interposed between the belt pulleys shown. One of these pulleys carries an open belt, and the other a cross belt for obtaining a reverse movement.



Elgin Bench Tapping Machine

To operate the machine, the work is placed on the table and is lifted up until the tap enters the hole. A stop-collar on the table spindle is set for the required depth, and when this collar comes against the under side of the table bracket, the upward movement is arrested and the tap spindle is drawn downward, thus disengaging the friction clutch from the upper driving pulley. A slight downward pressure then engages the reversing clutch, and the tap is backed out of the hole.

SANDERSON PORTABLE BORING-BAR

The accompanying illustrations show a portable boring-bar for straight and taper holes, which has been brought out by the Sanderson Tool Sales Co., 438-439 Brown-Marx Bldg., Birmingham, Ala. Fig. 1 shows the general appearance of the tool, while the line engraving, Fig. 2, shows the details of the design. The special features of the boring-bar are that it is readily adjusted, easy to operate, and simple in construction; it can be applied to ordinary drill presses, radial drills, lathes, electric or air motors, and in fact to any machine or appliance having a revolving element.

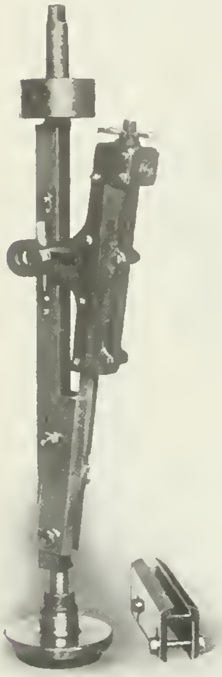


Fig. 1. Sanderson Portable Boring-bar

The tool consists, as shown in Fig. 2, mainly of a tool carriage *A*, a tool bar guide *D*, and a driving bar *I*. The tool carriage consists of a rack and worm, and a holder with a graduation segment. The rack holds the cutting tool *B* which is inserted at right angles to it at the bottom end. The tool is operated by a star feed at *C*. The rack is guided by the tool bar guide *D* which is dovetailed so as to hold the rack and tool firmly and prevent the tool from chattering or vibrating. Adjustment for different tapers is easily obtained by loosening the nuts *E*, *F* and *G*. If a straight hole is to be bored, the tool is merely set over by means of the nuts and slots to any diameter within the capacity of the bar.

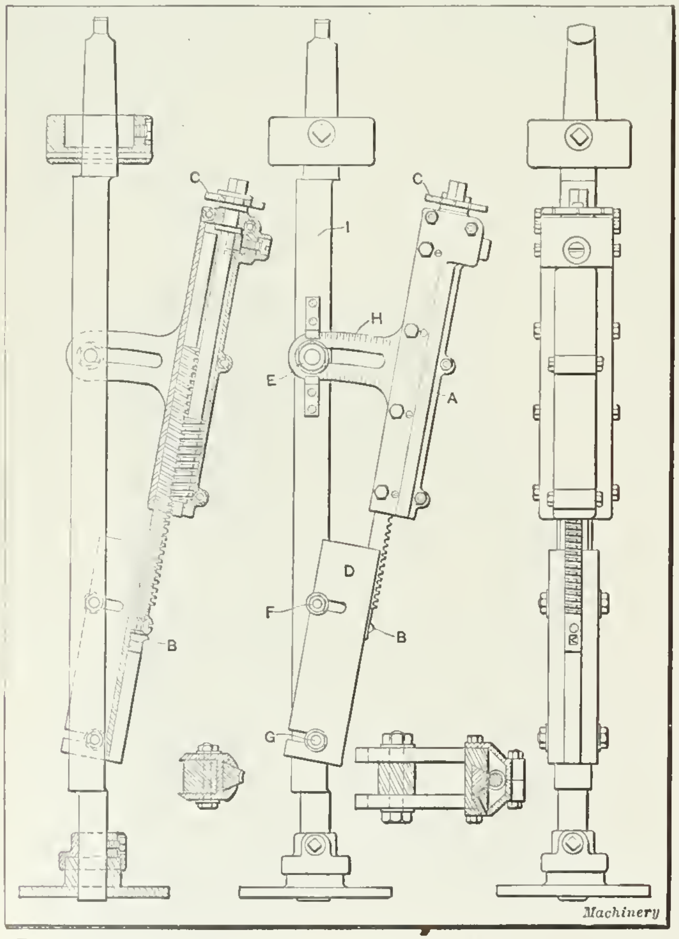


Fig. 2. General Design of Portable Boring-bar for Straight and Taper Holes

The length over-all of the device is 32 inches. The taper shank fits a No. 4 Morse taper socket. The tool has a capacity for boring holes varying from 2½ to 5 inches in diameter, straight or taper, to a depth of 8 inches. The taper adjustment allows tapers up to 6 degrees to be bored. Special bars can be made to take care of holes of other dimensions and tapers.

* * *

NEW MACHINERY AND TOOLS NOTES

Knurling Tool: A. B. Campbell, Fairport, N. Y. Hand-operated knurling tool having three knurls. The part to be knurled is placed in a vise and the tool, which is turned like a die, feeds itself along the surface of the work.

Die-head: Pottstown Machine Co., Pottstown, Pa. Die-head having a machinery steel body and four chasers which are securely held in internal slots, the angle of which conforms to Briggs standard pipe tapers. These heads are made in several sizes having capacities from 1 to 6 inches.

Radial Drilling Machine: Cincinnati Bickford Tool Co., Oakley, Cincinnati, Ohio. Plain radial drilling machine of an improved design. This machine is equipped either with a cone drive, speed-box drive, variable-speed motor drive, or a motor and speed-box drive. All gearing is enclosed and the construction throughout is along modern lines.

Sensitive Drill Press: Francis Reed Co., Worcester, Mass. Sensitive drilling machine which is provided with six spindle speeds. Three speeds are obtained from cone pulleys and this number is doubled by shifting the position of the quarter-turn idler at the top of the column. This idler is controlled by a lever and is automatically locked in position.

Electric Welders: Geuder, Paeschke & Frey Co., Milwaukee, Wis. Automatic electric spot-welders made in four sizes, ranging from 10 to 50 kilowatts capacity. The machine is set in motion by a foot pedal, and all welding operations are entirely automatic. The capacity is from 100 to 200 welds per minute when operating on sheets of from 19 to 31 gage thickness.

Tap Grinder: Wells Bros. Co., Greenfield, Mass. Machine for grinding taps correctly. The tap to be ground is held between centers and it is kept in the proper position by an adjustable spring-finger which regulates the clearance. The grinding is done by a cup wheel. The machine has a self-contained countershaft, and will take taps up to 12 inches in length.

Bench Lathe Attachments: Elgin Tool Works, Elgin, Ill. Auxiliary equipment for the bench lathe, including a filing attachment, two milling attachments and cylindrical and surface grinding attachments. One of the milling attachments has a horizontal spindle carried upon a vertical slide, and the other a vertical spindle which can be set in any desired position.

Turret Lathes: Warner & Swasey Co., Cleveland, Ohio. Hollow hexagon turret lathes of recent design, known as Nos. 2A and 3A machines, respectively. The 2A size has a capacity for bar stock up to 2¼ inches in diameter and, with a chucking outfit, will take castings or forgings 12 inches in diameter. The 3A machine has a capacity for bar stock up to 3¼ inches in diameter and for chuck work up to 15 inches.

Drilling, Boring and Milling Machine: Detrick & Harvey Machine Co., Baltimore, Md. Heavy drilling, boring and milling machine of the horizontal type, having a box-shaped runway on which a large vertical column is mounted. The latter has a traverse of 168 inches and the saddle a vertical movement of 144 inches. Power for traversing the column and saddle is obtained from a 7½-horsepower motor, and the spindle is driven by a 20-horsepower motor.

Drilling Machine Vise: Easton Tool & Machine Co., Easton, Pa. Vise for use on table of drilling machine. The front jaw has a travel of 3½ inches and the rear jaw can be turned to present different sides to the clamping or front jaw. One side of the rear jaw corresponds to the clamping jaw; another side serves as an angle-plate, and the two remaining sides are provided with V-grooves for holding cylindrical work, one groove being vertical and the other horizontal.

Bevel Gear Shaper: Browning Engineering Co., Cleveland, Ohio. Automatic bevel gear shaper having a revolving templet which gives the proper shape to the teeth, so that epicycloidal, involute or any special form of tooth can be cut by providing the proper templet. Twenty-five templets are supplied with the machine. When the shaper is in operation two tools plane opposite sides of the same tooth, alternately, and a gear is finished complete in one revolution of the blank.

Automatic Bevel Gear Shaper: Fred Mill, 622 William Ave., Detroit, Mich. When this shaper is in operation, cuts are taken from first one tooth and then the next, and so on around the blank. The arbor bearing is then moved on its horizontal axis to give a new depth of cut, and the teeth are planed successively as before. This operation is repeated until the teeth are formed to the required depth. The tool is relieved on the backward stroke and all movements are automatic.

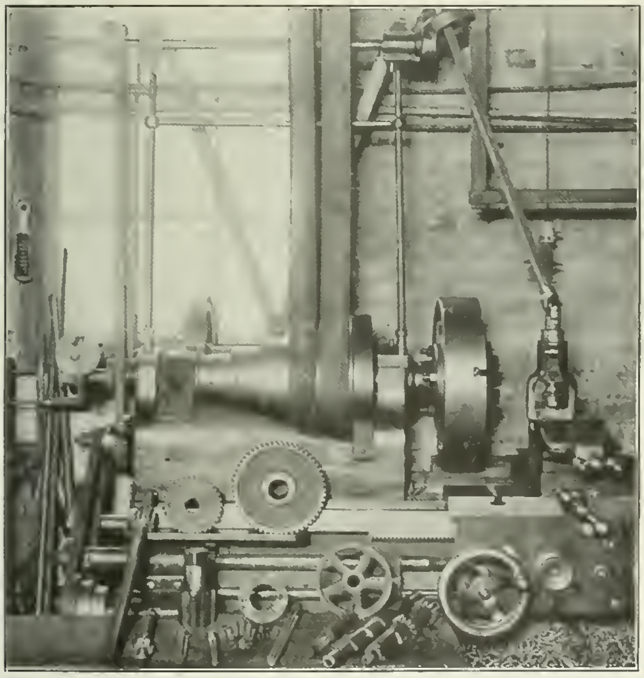
Spring Coiling Machine: F. H. Sleeper, 12 Shafner St., Worcester, Mass. Universal coil-making machine which will coil and cut springs of various shapes, and has a capacity for diameters varying from ¼ to 2 inches. The wire enters the machine between rolls and it is pushed through guides to the coiling and cutting-off mechanism. The rolls have two grooves for receiving either large or small stock. On the main shaft of the machine there are three cams; one of these varies the diameter of the coil, another gives the pitch or opening between the coils, and the third is for cutting off. The output of this machine varies from 35 to 100 springs per minute.

Inverted Spindle Drilling Machines: Foote-Burt Co., Cleveland, Ohio. One machine is a special design for drilling oil holes ¼ inch in diameter and 8 inches long. It is a 4-spindle inverted type, the spindles projecting through the table and the work being held in the upper heads. When drilling, the heads are fed downward either by hand or power. This company has also built two other machines of the inverted type, each of which has six spindles. One is designed for machining 6-cylinder automobile engine castings, and the other is for drilling long oil holes in cast-iron belt conveyor brackets. One of the advantages of this inverted construction is the absence of overhang and the ease with which chips may be disposed of.

* * *

LATHE MILLING ATTACHMENT

The Haase Machine Works, 411 Fifth Ave., So., Minneapolis, Minn., is manufacturing an attachment for converting a lathe into a milling machine, whenever milling operations can be performed to advantage in connection with turning. This attachment is shown applied to a lathe, in the accompanying illustration. The milling spindle is vertical and is carried by a housing clamped to the toolpost. The drive to the spindle is through a square, universal-jointed shaft connecting through gearing with an overhead countershaft, which, in turn, is driven by a belt from the headstock cone. The feeding movement for the milling cutter is also obtained from the overhead countershaft, which connects by belt with the regular carriage feeding mechanism, as the illustration shows.

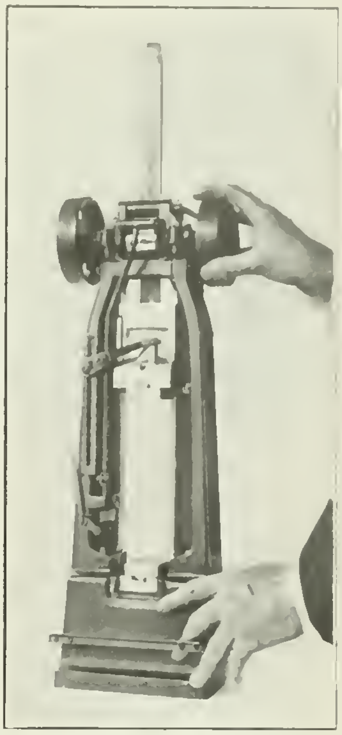


Haase Lathe Milling Attachment

This attachment is intended for cutting teeth in spur and bevel gears, fluting taps and reamers, splining, etc. When the lathe is to be used for milling, the cone pulley is disengaged from the face-gear, so that the spindle remains stationary. The spindle is indexed for gear cutting, fluting, etc., by the index-plate and worm-gearing seen attached to the left-hand end of the spindle. This indexing mechanism is held stationary by the yoke extending from the lathe, and it is expanded in the end of the hollow spindle by a bolt which holds it in position. The overhead driving mechanism for this attachment does not interfere with the regular operation of the lathe, and it can be attached without drilling any holes. The countershaft has, in addition to the two vertical supports, diagonal braces at the rear, which are attached to the back-gear spindle. Some examples of the work done by this milling attachment are shown in front of the lathe in the illustration.

DROP-HAMMER MODEL FOR SALESMEN

When selling or attempting to sell any machine or tool, it is often difficult to make a prospective customer fully appreciate the good points of the design by a verbal description, even though photographs and drawings are used for illustrating the noteworthy features. The Billings & Spencer Co. has adopted a novel plan of using a model in connection with the selling of drop-hammers, for demonstrating the advantages. This miniature drop-hammer, which is illustrated in the accompanying illustration is an exact duplicate of the 3000-pound hammer built by this company. The model only weighs sixteen pounds, whereas the large hammer has a base weighing approximately 5000 pounds and has a height of about twenty feet. This working model is shown to every prospective customer called upon, and it enables the salesman to back up his claims in a very forceful way.



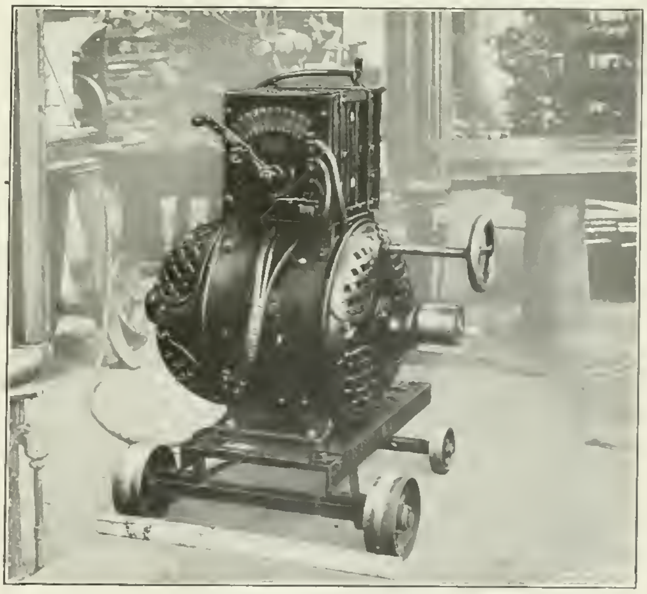
Miniature Drop-hammer used by Billings & Spencer Salesmen

The Billings & Spencer Co. also uses one of these models in the plant at Hartford for instructing new workmen in the proper operation of drop-hammers. This makes it unnecessary to use a large hammer for purposes of instruction.

* * *

PORTABLE MOTOR OUTFIT

The portable motor outfit shown herewith is used in a printing press manufacturing plant for testing presses on the assembling floor. The motor is carried on a four-wheeled truck so that it can be moved about easily, and the starter is mounted on top of the motor, which makes a very compact arrangement.



Reliance Adjustable-speed Motor and Starter mounted on Truck for Testing Printing Presses

A 7½-horsepower Reliance adjustable-speed motor of the armature-shifting type, is used. The motor has a speed range of from 470 to 1880 revolutions per minute, and, in addition, the starter is provided with a special heavy resistance which gives a further speed reduction of 50 per cent for very slow speeds. The main line switch and fuses are mounted on the rear of the starter. An insulated cable of any desired length may be used for connecting the motor to line plugs at different points about the shop. A similar outfit in another printing press plant is equipped with a flexible shaft and is used for certain boring, drilling and facing operations which can be done to better advantage while the press is being assembled.

* * *

BAR AND CHUCK WORK IN CLEVELAND AUTOMATICS

Automatic and semi-automatic machines are employed at the present time for doing such a large variety of work that a study of the tool equipment used in the production of different machine parts should be of value to the designer and shop man, as well as educational to the builder who is interested in economical manufacturing methods. Fig. 1 of the accompanying illustrations shows three interesting examples of work recently done on some of the machines built by the Cleveland Automatic Machine Co., Cleveland, Ohio.

Sectional and end views of a phosphor-bronze bearing for a gas engine are shown at *A*, and Figs. 2 and 3 illustrate the method of turning this part in a standard model turret machine, which is fitted with a tilting magazine attachment. The part is finished in two operations. The rough castings are taken from the magazine and placed in the chuck by means of conveyer *B*. Fig. 2 shows the position of the turret just after the conveyor has received the casting from the magazine, and Fig. 3 shows the conveyor after it has been indexed in line with the chuck.

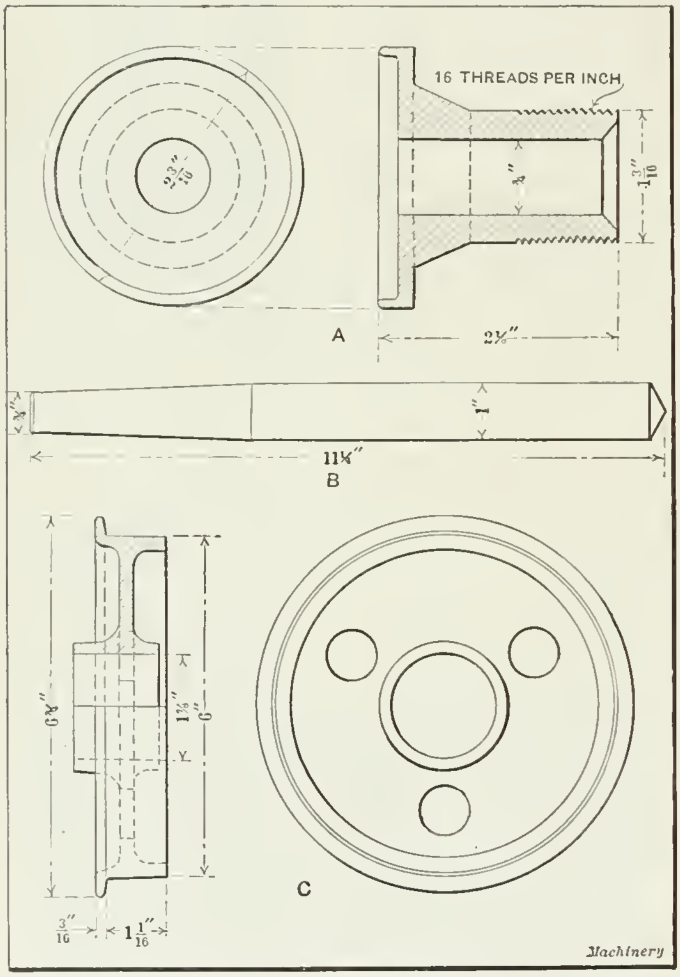


Fig 1. (A) Phosphor-bronze Bearing. (B) High-speed Steel Drill Blank (C) Cast-iron Flanged Wheel

The end of the casting is faced and the hole drilled and chamfered by the tools shown at *C*, which include a three-fluted drill, a chamfering tool for the mouth of the hole and a facing tool for the end. The center turning tool *D* carries a cutter for roughing the taper part next to the flange (see Fig 1), and there is also a cutter for roughing the straight part and a chamfering tool for the corners. These outside roughing operations are performed at the same time that the tools at *C* are in operation, so that six tools are working simultaneously.

Tool *E*, mounted on the tool-block at the rear of the cross-slide, finishes the taper part next to the flange and also the side of the flange. The boring tool *F*, which is mounted in an adjustable tool-holder in the turret, next comes into operation, after which the hole is accurately finished by a floating reamer *G*. While the reaming operation takes place, an overhanging tool which is mounted in the same holder with the reamer finishes the outside diameter of the flange.

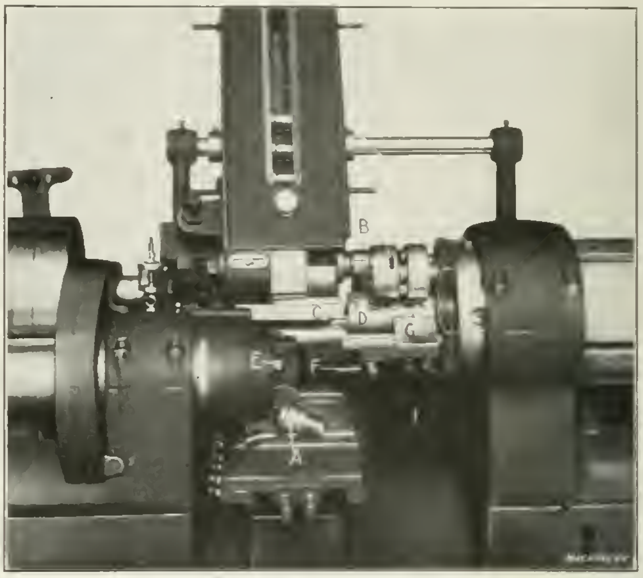


Fig. 2. Cleveland Standard Model Turret Machine equipped with Magazine for Turning Part shown at A, Fig. 1

The thread on the end of the casting is cut by a button die. At the time the thread is being cut the peripheral speed of the work is 59 feet per minute, whereas the speed while the other tools are in operation is 90 feet per minute. This completes the first operation, which requires 2 minutes and 30 seconds.

The second operation is that of recessing the flanged end (see Fig. 1). This work is done on the same machine and with the same magazine, but there is a cross-slide tool held in the turret for finishing the flange and counterbore. The second operation requires 50 seconds, so that the casting is finished complete in 3 minutes and 20 seconds. The rough casting weighs 17 ounces, and the finished piece 9 ounces. The principal dimensions are given in Fig. 1.

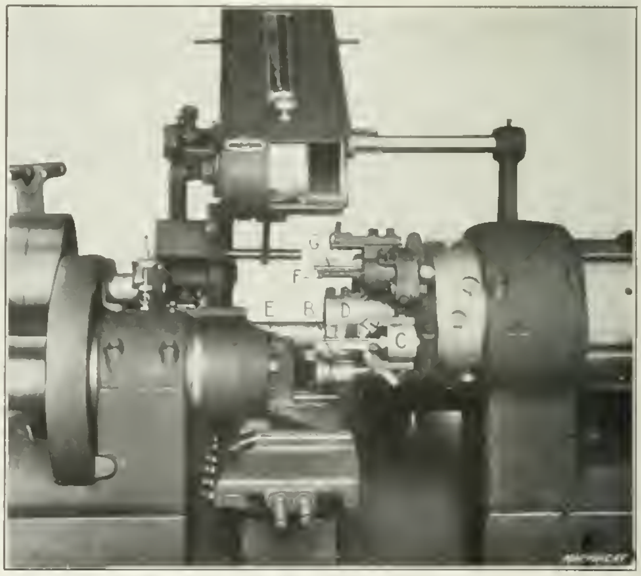


Fig. 3. Conveyor in Position to insert Rough Casting in Chuck

Another example of work done on the automatic is shown at *B*, Fig. 1. This is a high-speed steel drill blank which is finished in 6 minutes 35 seconds. It is 1 inch in diameter, 11¼ inches long and has a No. 3 Morse taper shank. The machine used for this work is a regular plain screw machine which is cammed double, one drum being used to operate the box turning tool, and the other the longitudinal slide and tool for turning the taper shank.

The bar stock is fed through the spindle against a swinging gage stop; then a roller-rest box-tool *A* (Fig. 4) which is mounted on the tailstock spindle, advances and starts turning the body of the drill blank. On the front cross-slide there is another slide *B* which moves in a longitudinal direction and is set at an angle for turning the taper shank of the drill blank. This slide is operated by the cams *H* and *I* on the large cam drum. These cams control the movement of a sliding guide *D*, which moves independently upon the tailstock spindle and connects with slide *B* by connecting-bar *C*. The tool which turns the taper shank of the drill is shown at *E*. This tool and the box-tool for turning the straight part start and finish their cuts at the same time. The taper shank is considerably shorter than the straight part of the drill blank, so that a slower feed can be used, which is desirable owing to the gradual increase in the depth of the cut. The slide *B* is adjustable so that it can be set for different tapers.

At the rear of the roller-rest box-tool *A* there is a holder carrying another set of steadying rolls and a tool *F* which finishes the point of the drill to the correct angle. A combination tool *G* on the rear of the cross-slide rough-turns the point of the next drill and breaks the corner of the taper shank end of the finished blank as the latter is being cut off. The actual labor cost for producing this drill blank is about 7 mills per blank.

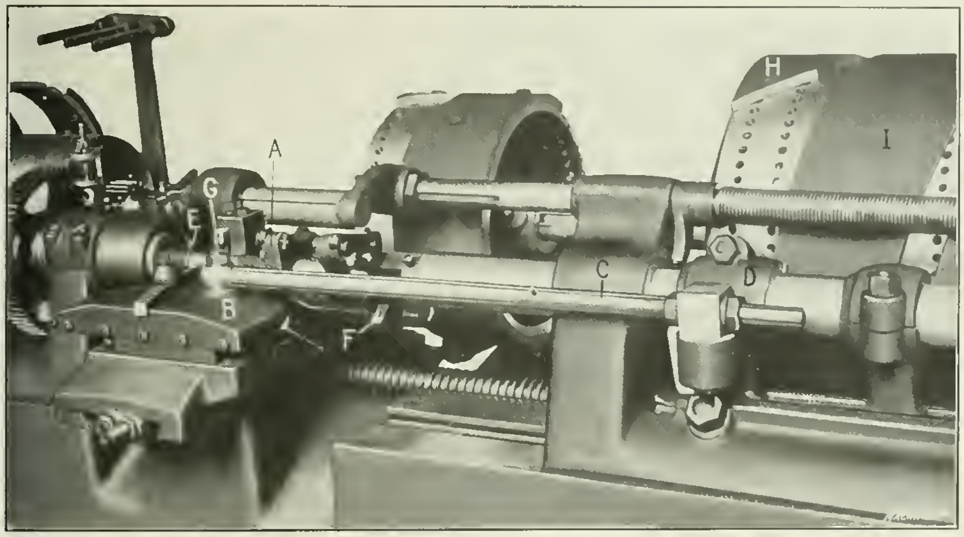


Fig. 4. Cleveland Plain Automatic fitted for Turning Drill Blanks

An example of chuck work is shown at *C*, Fig. 1. This is a cast-iron flanged wheel having a diameter of 6 inches. These wheels are turned in a standard-model, convertible automatic turret machine having a special equipment for this particular job, as illustrated in Fig. 5. The outside of the wheel is turned to within 0.0015 inch of the given size, and because of the accuracy required, a single-pointed tool is used instead of a forming tool, and two cuts are taken. The machine is fitted with a three-jaw universal chuck which has special jaws that engage the three cored holes in the web of the casting. The work is chucked by hand as in any ordinary chucking machine.

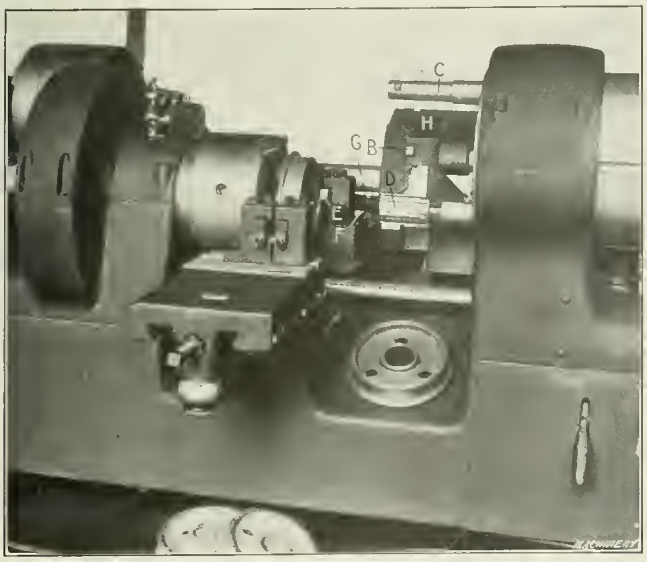


Fig. 5. Cleveland Convertible Automatic Turret Machine having Special Equipment for Turning Flanged Wheel C, Fig. 1

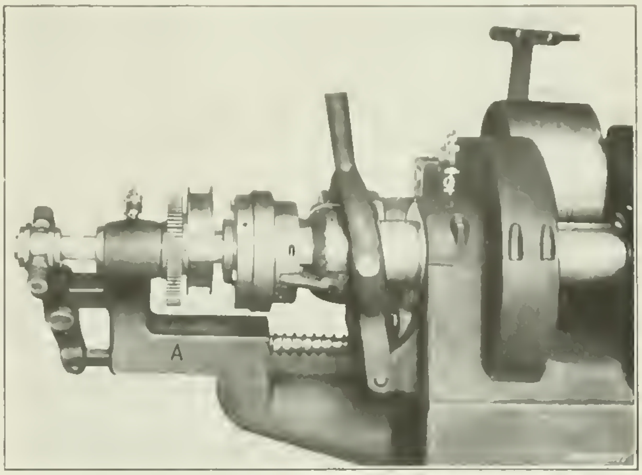


Fig. 6. Driving Mechanism for Boring and Back-facing Attachment

There is a boring and back facing attachment having an independent drive mounted at the left-hand end of the spindle head. The rear end of this bar and the driving mechanism are supported by a framework *A*, as illustrated in Fig. 6. The bar extends through the spindle and, in this particular case, carries a boring tool for roughing and a facing cutter which faces the rear end of the hub. At the same time, tool *B*, which is mounted in the turret, rough-faces the front end of the hub, and a tool on the rear cross-slide rough-turns the outside diameter of the wheel and also the top of the flange, so that five tools are working simultaneously at this time. The outside of the wheel has a peripheral speed of 50 feet per minute, and the boring cutter is operated at the rate of 80 feet per minute by the independent driving mechanism previously referred to. By changing the driving pulley on the countershaft, the speed of the bar can be varied to suit different classes of work.

The next tools which come into operation are the two held in bar *C*, which is mounted in the turret. These are finish-boring and facing cutters. While these cuts are being taken, the spindle speed is increased to give a peripheral speed inside the hole of 80 feet per minute. After the finish-boring cut is taken, the speed is reduced to 50 feet per minute on the outside diameter. The hole is then accurately sized by reamer *D*, and the tread of the wheel is finished by tool *E* on the rear cross-slide. The flange of the wheel is finished by one of the two tools mounted on the front cross-slide, while the other faces the rim of the wheel.

The tools on the rear cross-slide move in a longitudinal direction, and the slide upon which the rear tool-block is mounted can be seen at *F*. The longitudinal movement is obtained by cam drum *H* which imparts motion to the slide through connecting-bar *G*. A bell and stop-motion attachment stops the machine after each piece is completed. One of these castings is finished in 3 minutes 45 seconds. This operation shows the adaptability of this machine for chucking operations, as well as for handling bar work of various kinds.

* * *

Always have all bearing surfaces for nuts or heads of cap-screws spot-faced.

THE ABILITY OF BILL

By A. P. PRESS

Bill came in to see us the other day. Bill was one of our apprentice boys five years ago, and he was noted more for what he didn't do than for what he really accomplished—not but that his ability to turn off work was good enough, but his inherited ability to get clear of doing it was greater still. So putting the two together his abilities seemed to be largely of the last described order.

When Bill came in looking pretty prosperous, and seated himself in the best chair in the office, and took out a fat cigar with a gold band around it, and offered us one of the same brand, we knew that we were right.

"Yes," said Bill, as he got warmed up a little, "I was down to Baltimore one day last week, and as I was strolling around, I wandered into a big machine shop, that had just gone into the assignees' hands. The auctioneer was showing off the machinery in the usual manner, and, of course, I was interested. I did not have any money, but I had on a good suit of clothes, good friends, and a pocket full of these same cigars (which, by the way, are some that my wife gave me at Christmas), pretty good aren't they?

"I was inspecting a big boring mill which was a fine machine, when I noticed a little bunch of buyers over in the corner. When I had sized up the mill, and some of the other large tools pretty well, one of the bunch came over to me."

"Say, Mister, are you interested in this outfit?"

"Sure I am."

"Well, how high do you think you could go?"

"The sky is my limit."

"Now say, stranger, we are making up a little pool on this to buy the whole shop. Do you want to come in?"

"No, I think I had better stick by my lonesome."

"Now see here, that's going to queer the whole thing. What will you take to keep out?"

"Well, I have come quite a ways. I don't like to go home with an empty pocket. What is it worth to you?"

He went back and the bunch got together and back he came.

"Now then if you will keep out of it entirely we will give you an even $500."

"Yes, $500 is all right, but it looks to me as though there was more than $500 in it. Is that cash?"

"No, we will have to give you a check."

"I don't seem to see that. Make it $500 cash and it is a bargain."

Back he went and there was a great taking out of pocketbooks for a few minutes, and then he came back.

"We have got just $450. If you will take it we will make it cash."

"And take it I did," said Bill, "and that is where these good clothes came from, and the vacation too."

Bill has gone, although the flavor of that cigar still lingers in the office, and our opinion of Bill is that he will be noted all his life, not for the things he does, but for the things that others think he is going to do.

And there are others.

* * *

5.15 | 1.28
45
25
90
350
360
8

In a paper entitled "The Effect of the Relation of Stroke and Bore in Automobile Engines," presented by Mr. John Wilkinson, before the summer meeting of the Society of Automobile Engineers, at Detroit, June 27-29, 1912, the author stated that as a pure thermal question there is no apparent reason why the stroke to bore ratio cannot be carried up to and even exceed a ratio of 2. In the mechanical design, however, difficulties begin to appear when the ratio exceeds 1.33, and when the ratio exceeds 1.5 the objections become so strong that there appear to be no compensating features for the increase in weight and expense. An excessively long stroke involves too much weight in the valve mechanism. It might, therefore, be fair, according to the author, in placing general limits on the stroke to bore ratio, to say that it is limited in one direction to 1 by the cooling limit of the piston, and in the other direction to 1.5 by the limits of mechanical adaptability.

COLORING ALUMINUM

A process for coloring aluminum is described in the *Brass World*. This process has been patented by S. Axelrod of Oberschoneweide, Germany. It consists in treating the aluminum surfaces with a solution of cobalt nitrate and then heating the object. The heat changes the color of the surface, and gradations ranging all the way from steel gray to brown and finally black may be obtained, according to the temperature to which the article is heated. The salts should be either neutral or alkaline. The aluminum article is dipped in the salt solution, or the solution may be applied with a brush, the salt having been dissolved in water previous to application. The exact temperature to be used is not stated, but it is rather low, as aluminum melts at a comparatively low heat. It is stated that the colors thus produced will not rub or scale off, and that they are permanent. The inventor also claims that zinc, tin and other metals may be colored by cobalt nitrate or other cobalt salts in the same manner.

* * *

During the first week in August, the centenary of the great Krupp works at Essen, Germany, will be celebrated. The celebration will be attended by the Emperor and many other German rulers, military officers, admirals and civil officials. The festivities will be largely military in nature in order to give emphasis to the important part that the Krupp works have played in military and naval armaments. One feature will be a series of sham battles. Men armed with weapons of the era of the Emperor Maximilian will fight with an army equipped with modern rifles and artillery.

* * *

PERSONALS

John Bath, designer of the Bath grinder and formerly manager of the Bath Grinder Co., Fitchburg, Mass., has been made sales manager of the Reed-Prentice Co., Worcester, Mass.

Robert H. Lasch has resigned his position of chairman and managing director of the Selson Engineering Co., Ltd., London, England, and Mr. Henry M. Sonnenthal has been appointed in his place.

Ira J. Peat has resigned as assistant foreman of the Simplex Time Recorder Co., Gardner, Mass., to take the position of general superintendent of the Long Mailing Machinery Co., of Minneapolis, Minn.

Edward Rivett of the Rivett Lathe Mfg. Co., Boston, Mass., who sailed for Europe in June, will return in October to resume his duties as president of the reorganized company now known as the Rivett Lathe & Grinder Co.

H. A. S. Howarth, a valued contributor to MACHINERY, who for the past year has been assistant professor of mechanical engineering of the Lehigh University, South Bethlehem, Pa., has been appointed assistant professor of machine design at the Carnegie Technical Schools, Pittsburg, Pa.

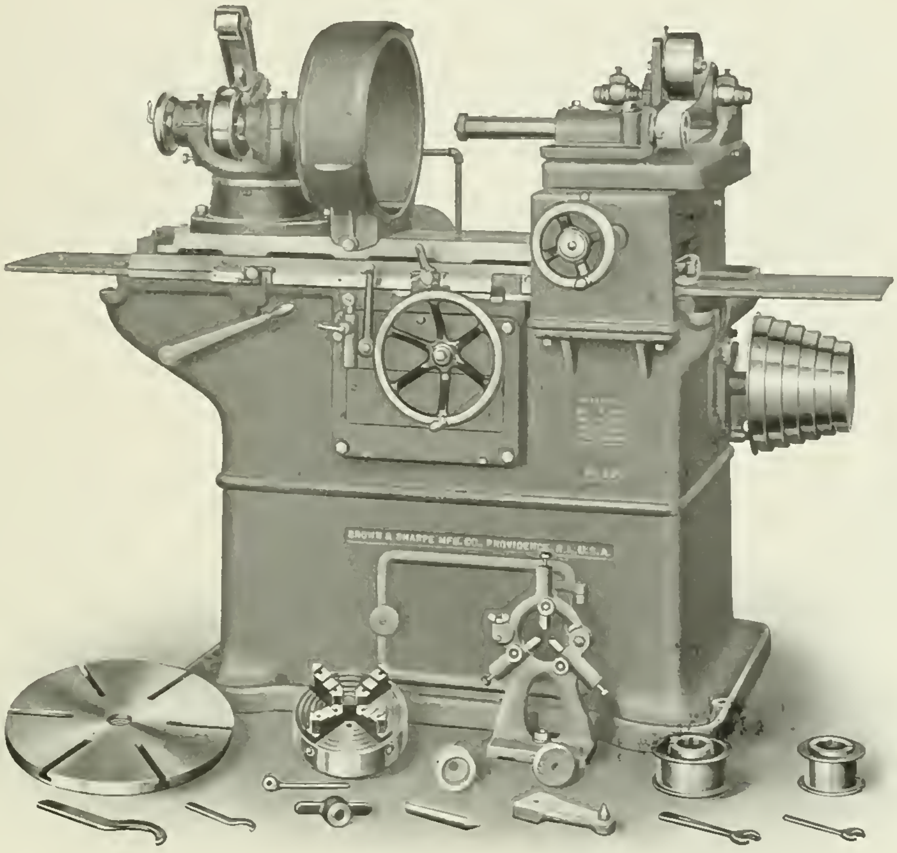
Edwin Rust Douglas, mechanical and electrical engineer, has resigned the position of works manager of the Hero Mfg. Co., Philadelphia, Pa., and is now acting as consulting engineer with that company and with David Lupton's Sons Co., and S. L. Allen & Co., all of Philadelphia. Mr. Douglas will be able to serve others also, to a limited extent, in problems concerning manufacturing and factory organization.

Joseph E. Martin, formerly in charge of the estimating and boring mill department of the Bullard Machine Tool Co., Bridgeport, Conn., has resigned his position to take that of superintendent of the Foster Engineering Co., Newark, N. J. Mr. Martin was with the Bullard Machine Tool Co. for eight years. His friends in Bridgeport and associates in the Society of Mechanical Foremen, of which he was president, gave him a farewell reception.

Gilbert H. Pearsall has been made vice-president of the Jacobs-Shupert U. S. Firebox Co., and will be in charge of the Eastern sales office of that company with headquarters at Room 732, 30 Church St., New York City. Mr. Pearsall will retain his position as secretary of Joseph T. Ryerson & Son with which concern he has been identified since May, 1901. He has been in general charge of the sales of the Ryerson company since January 1, 1905. Prior to that connection he held positions in the traffic and transportation departments of several railway companies.

Charles B. Moore has resigned as vice-president of the American Arch Co., and has been elected vice-president of the Jacobs-Shupert U. S. Firebox Co. Mr. Moore will be in charge of the Western sales department of the company with offices in the Railway Exchange Bldg., Chicago, Ill. Mr. Moore organized the Columbia Boiler Co. in 1900 for the

A New Machine for Grinding Straight or Taper Holes in Gears, Cutters, Collets, Bushings, Etc.



No. 22 Internal Grinding Machine

This machine meets the requirements of all varieties of internal grinding within its range that can be revolved. Taper holes can be ground as easily as straight ones.

New and interesting features in design, combined with many of the successful constructions of our universal grinding machines, insure accuracy, handiness, rapid operation, and great durability in this latest addition to our line.

The advantages of a machine designed especially for internal grinding are worth investigating. We will gladly send you an interesting circular, on request.

BROWN & SHARPE MANUFACTURING COMPANY
PROVIDENCE, RHODE ISLAND, U. S. A.

purpose of manufacturing house heating apparatus and boilers. In 1902 he organized the American Locomotive Equipment Co., and was general manager and a director of that company uutil 1911, when he was elected its president. He assisted in the organization of the American Arch Co. in 1910 and was elected vice-president and a director of that company in 1911. He also organized the Boss Nut Co., of which he is a director. Mr. Moore is the inventor of a number of locomotive devices, the best known of which are his locomotive brick arches.

* * *

COMING EVENTS

August 20.—Annual convention of the International Railroad Master Blacksmiths' Association at Hotel Sherman, Chicago, Ill. J. E. Carrigan, Rutland Railway, Rutland, Vt., chairman of the executive committee.

September 2-7—Sixth congress of the International Association for Testing Materials at the Engineering Societies Building, 29 W. 39th St., New York. H. F. J. Porter, secretary, 1 Madison Ave., New York.

September 9-11.—Ninety-third meeting of the National Association of Cotton Manufacturers at the Griswold, Eastern Point, New London, Conn. C. J. H. Woodbury, secretary, Boston, Mass.

September 24-26.—Annual convention of the American Foundrymen's Association and allied bodies, in Buffalo, N. Y.; Hotel Statler, headquarters. Richard Moldenke, Watchung, N. J., secretary.

September 30-October 4.—Autumn meeting of the Iron and Steel Institute at Leeds, England. G. C. Lloyd, secretary, 28 Victoria St., London.

October 4-26.—International Machinery Exhibition at Olympia, London, England, organized by the Machine Tool and Engineering Association, Ltd.

October 7-11.—Annual convention of the American Electric Railway Association and allied associations in Chicago, Ill. The exhibit will be at Dexter Pavilion, 43d and Halstead Sts. H. C. Donecker, secretary-treasurer, 29 W. 39th St., New York.

SOCIETIES, SCHOOLS AND COLLEGES

Upper Iowa University, Fayette, Iowa. Catalogue for 1911-1912.

University of New Mexico, Albuquerque, N. M. Catalogue 1911-1912, and announcements for 1912-1913.

Working Men's College, Melbourne, Australia. Prospectus for 1912. Frederick A. Campbell, director.

Louisiana State University, Baton Rouge, La. Catalogue for 1911-1912, and announcements for 1912-1913.

New Mexico School of Mines, Socorro, N. M. Annual Register for 1911-1912 with announcements for 1912-1913.

Delaware College, Newark, Del. Catalogue of the officers and students for the year 1911-1912, and announcements for the year 1912-1913.

University of Utah, Salt Lake City, Utah. Catalogue of students for 1911-1912 and announcements for 1912-1913 in the schools of arts and sciences, education, mines and medicine.

Iowa State College of Agricultural and Mechanic Arts, Ames, Iowa. Directory of graduates of the division of engineering, giving the individual records of between 1100 and 1200 graduates.

NEW BOOKS AND PAMPHLETS

The Polytechnic Engineer. Volume XII, 1912. 129 pages, 6 by 9 inches. Published by the undergraduates of the Polytechnic Institute of Brooklyn.

Personal Efficiency. By Charles Frederick Loweth. 16 pages, 6 by 9 inches. Published by the University of Illinois, Urbana, Ill., as No. 5 of the College of Engineering Series.

Organization in Engineering. By Henry Marison Byllesby. 14 pages, 6 by 9 inches. Published by the University of Illinois, Urbana, Ill., as No. 4 of the College of Engineering Series.

Molding Concrete Fountains and Lawn Ornaments. By A. A. Houghton. 56 pages, 5 by 7¾ inches. 14 illustrations. Published by Norman W. Henley & Son, New York. Price 50 cents.

Molding Concrete Flower Pots, Boxes, Jardinieres, etc. By A. A. Houghton. 52 pages, 5 by 7¾ inches. 7 illustrations. Published by Norman W. Henley & Son, New York. Price 50 cents.

Report of the Commissioner of Education for the Year ended June 30, 1911. Vol. I. 675 pages, 6 by 9 inches. Published by the Bureau of Education of the United States, Washington, D. C.

A Rapid Method for the Determination of Vanadium in Steels, Ores, etc. Published by the Department of Commerce and Labor, Washington, D. C., as No. 8 of the Technologic Papers of the Bureau of Standards.

On the Measurement and Division of Water. By L. G. Carpenter. 48 pages, 6 by 9 inches. Illustrated. Published by the Agricultural Experiment Station of the Colorado Agricultural College, Fort Collins, Col., as Bulletin No. 150.

Conference Committee Methods in Handling Railway Legislation on Mechanical Matters. By Charles Arthur Seley. 15 pages, 6 by 9 inches. Published by the University of Illinois, Urbana, Ill., as No. 2 of the College of Engineering Series.

A New Analysis of the Cylinder Performance of Reciprocating Engines. By Paul Clayton. 104 pages, 6 by 9 inches. Illustrated. Published by the University of Illinois Engineering Experiment Station, Urbana, Ill., as Bulletin No. 58.

The Strength of Reinforced Concrete Beams; Results of Tests of 333 Beams. By Richard L. Humphrey and Louis H. Losse. Published by the Department of Commerce and Labor, Washington, D. C., as No. 2 of the Technologic Papers of the Bureau of Standards.

The Effect of Added Fatty and Other Oils Upon the Carbonization of Mineral Lubricating Oils. By C. E. Waters. Published by the Department of Commerce and Labor of Washington, D. C., as No. 4 of the Technologic Papers of the Bureau of Standards.

Tests of the Absorptive and Permeable Properties of Portland Cement, Mortars and Concrete, together with Tests of Damp-Proofing and Water-Proofing Compounds and Materials. By Rudolph J. Wig and P. H. Bates. Published by the Department of Commerce and Labor, Washington, D. C., as No. 3 of the Technologic Papers of the Bureau of Standards.

Lectures Delivered at the Centenary Celebration of the First Commercial Gas Company, to sell Gas as an Illuminant. 174 pages, 6 by 9 inches. Illustrated. Published by the American Gas Institute, 29 W. 39th St., New York.

This interesting series of lectures is prefaced with the chronology of the development of gas lighting, beginning 1450 B. C. The importance of gas as an illuminant and fuel, and the growing importance of producer gas in the industrial field, makes this series of lectures of historical and commercial value.

Analysis of Metallurgical and Engineering Materials. By Henry Wysor. 82 pages, 8½ by 10¼ inches. Published by the Chemical Publishing Co., Easton, Pa. Price, $2.

This manual, which is the outcome of an effort to raise the efficiency of the students' work in the laboratory, is a systematic arrangement of laboratory methods, compiled by the assistant professor of analytical chemistry and metallurgy in Lafayette College. Each page of text is accompanied by a blank page for the insertion of notes and data by the user. The condensed, step-by-step directions for making analyses should be appreciated by all chemists and students of chemistry.

The Effects of Cold Weather upon Train Resistance and Tonnage Rating. By Edward C. Schmidt and F. W. Marquis. 24 pages, 6 by 9 inches. Published by the University of Illinois Engineering Experiment Station, Urbana, Ill., as Bulletin No. 59.

The bulletin presents the results of tests made to determine the amount of increase in train resistance in cold weather, and the tests show that even in moderately cold weather there is a very definite increase in train resistance over the resistance which prevails at air temperatures above 30 to 40 degrees F. This increased resistance is chiefly due to the lower temperatures of the car journals, and the tests show that the temperature rises very slowly, requiring twelve to fifteen miles travel from the starting point before the resistance has reached its minimum value.

Modern Illumination, Theory and Practice. By Henry C. Horstman and Victor H. Tousley. 273 pages, 4⅜ by 6¾ inches. Published by Frederick J. Drake & Co., Michigan Ave., Chicago, Ill. Price $2.

This is a handbook of practical information for users of electric light, contractors, electricians, etc. It treats of light, principles of vision, reflection, refraction and diffusion, photometry, calculation of flux from photometric curves, illumination calculations, characteristics of electric illuminants, shades and reflectors, location and height of lamps, color of light, choice of lamps, choice of fixtures, indirect lighting, practical considerations, table of intensities in foot candle for various classes of service, plans and specifications, illumination tables, incandescent light wiring and other tables, glossary of terms and phrases, etc.

Engineering Valuation of Public Utilities and Factories. By Horatio A. Foster. 345 pages, 6 by 9 inches. Published by D. Van Nostrand Co., New York. Price, $3 net.

The demand for information regarding the valuation of public utilities has been growing rapidly during the last few years mainly because, with the increase in supervision of public utilities by commissions which require valuations of properties when permission is asked to change rates or to add to securities for any purpose, engineers have extended their field of activity to include problems of rate-making. This fact and the public demand that corporations shall receive a fair return on the fair value only of their properties, make it important that those in charge of appraisals shall be familiar with the elements which courts and commissions will consider in passing upon the merits of a valuation. The investigation leading to a decision as to a satisfactory schedule of rates requires the services of a technical expert. Mr. Foster, who has been extensively engaged in appraisals, has produced an excellent work on a subject which is now of broad public importance. After a short discussion of "value," the purposes of its determination, and the directions for obtaining it, an important court opinion by Judge Savage of Maine is given in full, as embodying the best instructions for valuation yet pronounced. An excellent feature of the book is the compilation of forms to be used in making an appraisal, and there are included also extended depreciation tables at various percentages and for various terms of usefulness, which will be found of much service in making valuations. After a short chapter devoted to the cost of appraising a property, the value of "good will" and "going concern value" are defined and discussed, and the opinions of commissions, courts, and individuals are given at some length. Considerable space is devoted to the subject of depreciation, which, like the author's treatment of "intangible value," contains a number of original views. The chapters on amortization, handling of depreciation, and appreciation are interesting. The study of the court decisions as to franchises should go far toward elucidating this complex subject. A clear discussion of capitalization and the control of public utilities follows, and the book closes with copies of some of the decisions of the courts and the syllabuses of a large number of others. In one volume are thus brought together the gist of virtually all important rulings bearing on the subject of valuations, so that not only the engineer but the layman may learn their application in any given case. Mr. Foster's work is distinctly of value.

The Human Factor in Works Management. By James Hartness. 159 pages, 6 by 9 inches. Published by McGraw-Hill Book Co., New York. Price $1.50 net.

The views on works management of a manufacturer who is a mechanic and inventor, and the president of a well-known and highly successful concern would attract attention, and when those views are on the neglected human factor element, they become extraordinarily interesting. This work by Mr. Hartness sets forth some of the essential principles of industrial economics as represented by his experience and that of many who regard some of the theories of scientific management laid down by its leading exponents with doubt and misgivings. In the discussion of habit the idea is brought out that success depends more on the man than the plan, and that systems are but a means and not the end. Repetition forms habit, and is necessary for success. Contrary to the popular idea, repetition does not degrade, but simplifies and makes work easy. The mere size of an organization does not give it strength; but whether the organization is large or small the advantage lies with that one in which each operation is repeated the most times per individual. Skill is due to continued application. A lathe hand does the most and best work with his own lathe and tools under the conditions with which he has become familiar. But there are all kinds of minds, and not all have the same ambitions and aspirations. There is often lack of sympathy and understanding between those who would lift the masses to what they conceive to be a better plane of thought and living. Inertia of habit and consequent dislike of change of methods is characteristic of workers generally. When the conditions of work are such that methods must be continually changed, inefficiency results. The notorious inefficiency of plumbers on repair work is attributed by the author largely to the strange surroundings of each job and the new conditions that must be met. To make a business pay in the long run, it must be conducted so as to build up those conditions most conducive to the well-being of the workers as a whole; hence the folly of trying to "make a business pay" from the financial side alone. Space will not permit quoting or paraphrasing many more interesting statements bearing on the human factor element in business. The chapters "Some of the Non-Technical Phases of Machine Design" and "Machine Building for Profit," deal with some of the intangibilities of manufacturing. Courage to

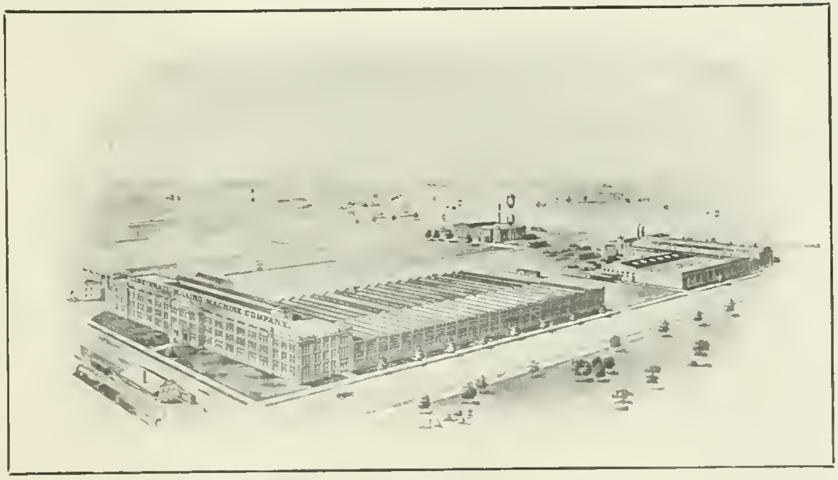
COME AND SEE OUR NEW PLANT

SOME OF OUR VISITORS

This is part of a group of Superintendents and Foremen who made a trip from Chicago especially to see our new plant. When are you coming? It will pay you to visit us, because you will see one of the most up-to-date machine tool plants in the world. It contains more than 6¼ acres of floor space. The buildings have all been constructed to provide as nearly as possible ideal conditions as to lighting, heating, ventilation, sanitation and the routing of materials. We would like to show you how we accomplish these things.

Our equipment includes many special machines for individual operations requiring a high degree of accuracy and special devices for manufacturing in large quantities. Our advanced foundry practice produces iron castings of the highest quality for the service required of each important part of our machines.

These are some of the things that make it possible for us to supply you with Milling Machines of the highest quality in all particulars.



THE PLANT DRAWN TO AN EXACT SCALE

The Cincinnati Milling Machine Company

Cincinnati, Ohio, U. S. A.

EUROPEAN AGENTS—Alfred H. Schutte, Cologne, Berlin, Brussels, Milan, Paris and Barcelona. Donauwerk Ernst Krause & Co., Vienna, Budapest and Prague. Sam Lagerlofs, Stockholm, Sweden. Axel Christiernsson, Abo, Finland. Chas. Churchill & Co., London, Birmingham, Manchester, Newcastle-on-Tyne and Glasgow. CANADA AGENT—H. W. Petrie, Limited, Toronto, Montreal and Vancouver. AUSTRALIAN AGENTS—Thos. McPherson & Son, Melbourne. JAPAN AGENTS—Andrews & George, Yokohama. CUBA AGENT—Krajewski-Pesant Co., Havana. ARGENTINE AGENTS—Robert Pusterla & Co., Buenos Ayres.

discard is as desirable as courage to accept and use. The hero of the drafting-board is the one not afraid to use the eraser, and the hero manufacturer is he who sticks to one thing and makes it successful. The weakness of many concerns and a prolific cause of failure is a constantly changing policy and product. The tendency of individuals to be jacks-of-all-trades is exemplified by manufacturers who will not concentrate on one line long enough to become proficient in its production. "The manufacturer of a great variety of machines in response to a demand by the selling organization is a relic of other days", expresses the perception of the author. His own experience has amply demonstrated the value of developing a specialty and then sticking to it. The book is full of interest and value for manufacturers and students of industrial economics.

NEW CATALOGUES AND CIRCULARS

Green Fuel Economizer Co., Matteawan, N. Y. Catalogue No. 142 on the Green boiler economizers.

International Gas Engine Co., Cudahy, Wis. Catalogue No. 12 of "Ingeco" engines operating on gas, gasoline, oil and producer gas.

J. Faessler Mfg. Co., Moberly, Mo. Bulletin No. 28 illustrating and describing "Faessler" safety sectional boiler tool expander with quick-acting knockout.

Sanderson Tool Sales Co., Brown Marx Bldg., Birmingham, Ala. Circular of Sanderson adjustable portable boring-bar for boring straight and taper holes.

C. W. Hunt Co., West New Brighton, N. Y. Catalogue No. 12-1 on industrial narrow gage railways for handling raw and finished materials in foundries, iron mills, power plants, factories, etc.

Chicago Pneumatic Tool Co., 1010 Fisher Bldg., Chicago, Ill. Instruction booklet for operating the "Little Giant" car, containing directions for the operation of gasoline engines and motor cars.

Westinghouse Electric & Mfg. Co., E. Pittsburg, Pa. Circulars 1516, on Baldwin-Westinghouse Electric Locomotives; 1155, on Series Arc Lighting Systems, with Westinghouse Cooper-Hewitt Rectifiers.

Watson-Stillman Co., 192 Fulton St., New York. Catalogue No 85 on hydro-pneumatic wheel presses, listing and describing over seventy variations in types and sizes of from 60 to 600 tons capacity.

Electric Controller & Mfg. Co., Cleveland, Ohio. Bulletins 1022 on Automatic Motor Starters for Non-Reversing Direct-Current Motors; 1023, on Type A Knife Switches; and 1024, on Type MC Solenoids.

Joseph Dixon Crucible Co., Jersey City, N. J. Booklet entitled "Painting the Smokestack," setting forth the qualities of Dixon's silica-graphite paint that meet the trying service demanded of a smokestack paint.

Crocker-Wheeler Co., Ampere, N. J. Bulletin No. 151 on "Remek" distributing transformers. The bulletin is well printed on pebbled paper which brings out very clearly the characteristics of the halftone illustrations.

Fort Wayne Engineering & Mfg. Co., Fort Wayne, Ind. Circular of Paul pumping machinery, air compressors, water supply systems, suction pressure systems, deep well pressure systems and pneumatic displacement systems.

Becker Milling Machine Co., Hyde Park, Mass. Catalogue of carbon and high-speed steel standard cutters, form cutters, hobs for spur and spiral gears, saws, shell end-mills, T-slot cutters, arbors, spring collets, inserted tooth cutters, etc.

Fosdick Machine Tool Co., Cincinnati, Ohio. Circular illustrating and describing new style 2½-foot and 3-foot National radial drills having back gears and tapping attachment, and adapted for belt, variable speed motor or constant speed motor drives.

F. B. Shuster Co., New Haven, Conn. Catalogue of automatic wire straightening and cutting machinery and sheet metal straightening and cutting machinery for straightening and cutting wire and sheet metal to exact lengths from the coil: elastic blow riveting machines; etc.

Thomas H. Dallett Co., York and 23rd Sts., Philadelphia, Pa. Bulletin No. 304 describing the Dallett pneumatic wood carving tools. These tools are useful in any branch of the woodworking industry where gouging, roughing and carving work of any description is being done in the usual manner with hand chisels.

American Vanadium Co., 325 Vanadium Bldg., Pittsburg, Pa. Pamphlet on vanadium steels and classification of heat-treatment with directions for application to iron and steel. This valuable treatise should be of great interest to all concerned with the use of steels required to withstand repeated shocks without crystallization.

Montgomery & Co., 105-107 Fulton St., New York. Price list of Grobet Swiss files, illustrated. These are the original Swiss files made by F. L. Grobet, the business of which was originated over 100 years ago. The catalogue shows a large variety of toolmakers' files, and should be in the hands of everyone ordering fine files.

Lamson Consolidated Store Service Co., Boston, Mass. Bulletins of pneumatic tubes, wire cash carriers, cable cash carriers, parcel carriers, message carriers, pickup carriers, sweep-off carriers, selective carriers, tray conveyors, library conveyors, mail conveyors, belt conveyors, special conveyors, small lifts, and light elevators.

General Electric Co., Schenectady, N. Y. Bulletins 4953, Large Shell Type Transformers; 4959, The Electrical Operation of Railroad Shops; 4960, Lightning Arresters for Electric Railways; 4962, Electric Power in the Lumber Industry; 4963, Small Direct and Alternating Current Motors Drawn Shell Type; and 4966, Hydro-Electric Power Development.

Industrial Instrument Co., Foxboro, Mass. Bulletin No. 65, of Foxboro improved recording gages, listing nearly 2000 ranges in three sizes covering all purposes and pressures from full vacuum to 10,000 pounds per square inch. Lists are arranged to facilitate quick and easy selection of instruments, and each instrument is assigned a code word for convenience in identification.

United Steel Co., Canton, Ohio. Booklet on vanadium steel, giving the results of tests on chrome-vanadium steel, demonstrating that this steel has unusually valuable properties. Illustrations show the results of tests on springs, gears, axles, bars, etc. The company is a pioneer in the manufacture of chrome-vanadium steel, and has specialized in its production ever since its introduction.

Vanadium-Alloys Steel Co., Latrobe, Pa. Booklet on vanadium steel for all purposes, giving characteristics of "Red-cut" high-speed steels; price list of "Red-cut" disks suitable for milling cutters, and information on "Vasco" special steel, etc. The general effect of vanadium on steel is discussed, and, altogether, the booklet will be found of much interest to users of steels.

Kelly Reamer Co., 1547-65 Columbus Road, Cleveland, Ohio. Catalogue of Kelly adjustable reamers, with high-speed steel blades, for boring automobile cylinders, connecting-rods, jigs and all holes requiring accuracy and smoothness of finish. The Kelly reamer has floating cutters which compensate for errors of alignment by "floating" to the center of holes previously bored true.

Watson-Stillman Co., 192 Fulton St., New York. Catalogue No. 86 on the Chambersburg throttle valve, which is claimed to be superior to the ordinary throttle valve in the following particulars: single seat; regrind without removal; no lost motion; internal boiler inspection without removal; provision of inlet for steam at highest point in dome; perfect balance; easy operation; screw or lever control.

Fort Wayne Electric Works of General Electric Co., 1616 Broadway, Fort Wayne, Ind. Bulletins 1140, on Single-Phase Repulsion Induction Motors, Type SR; 1137, on Belt-Driven Revolving Field Alternators, Form B; 1136, Direct-Connected Type MPL Direct-Current Generators; 1139, on Motor Drives; also instruction book No. 3053 on Multi-Phase Revolving Field AC Generators and Belted Exciters.

Joseph Dixon Crucible Co., Jersey City, N. J. Circular on graphite products comprising flake graphite, heavy graphite, machine greases, waterproof graphite grease, "Graphitoleo," "Everlasting" axle grease, pipe joint compound, traction belt dressing and leather preservative, solid belt dressing, automobile lubricants, silica-graphite paint, stove cement, plumbago crucibles, graphite brushes for motors and generators, etc.

Treadwell Engineering Co., Easton, Pa. Colored card illustrating the coloring of patterns to indicate finished surfaces, rough surfaces and core prints. The standard colors adopted are those recommended at a joint meeting of the Steel Founders' Society and the American Society for Testing Materials, for use on patterns in steel foundries, and are: red for finished surfaces, yellow for rough surfaces, and black for core prints.

Curtis & Curtis Co., 8 Garden St., Bridgeport, Conn. Catalogue of Forbes patent pipe cutting and threading machinery for hand, belt, or electric power. The catalogue is a very complete production, giving full data on all of the many sizes and styles of portable machines built. The largest machine cuts off and threads pipe from 2½ to 12 inches diameter, and its approximate net weight is 3650 pounds, while the smallest is adapted for ¼-inch to 2-inch pipe, and weighs 155 pounds.

Gould & Eberhardt, Newark, N. J. Catalogue of high-duty shapers and attachments, illustrating details of construction and giving full data of 14-inch, 16-inch, 20-inch, 24-inch and 34-inch sizes. These shapers are regularly furnished with four-step cone pulleys and are also provided with electric motor drive for either direct or alternating current. A large variety of shaper attachments is illustrated, including tilting base for shaper vises, circular or cone mandrel, automatic vertical feed, traverse head, index centers, circular table, concave attachment, convex attachment, auxiliary front cross feed, etc.

National Tube Co., Frick Bldg., Pittsburg, Pa. Booklet entitled "The Modern Boiler Tube," containing the story of its evolution and development and some expert opinions on its efficiency. The booklet is a valuable contribution to the literature on boiler tubes, briefly tracing their development since the patent of Henry Osborn of Birmingham was granted in 1812 for the manufacture of gun barrels by bending wrought-iron plates over a circular and tapered mandrel and welding the heated metal under a tilt hammer. Illustrations show the tests applied by the National Tube Co. to boiler tubes, and the data of tests supplied by the American Society for Testing Materials are included.

TRADE NOTES

Reed-Prentice Co., Worcester, Mass., requests manufacturers' catalogues for the Prentice Bros. department, 667 Cambridge St.

Blakeslee Forging Co., Plantsville, Conn., is about to erect a three-story machine shop, 30 by 160 feet, and a forge shop 220 by 50 feet; also an annealing room 32 by 76 feet.

Tate-Jones & Co., Inc., Empire Bldg., Pittsburg, Pa., report that orders were recently received for large oil burning furnaces from the Falls Hollow Staybolt Co., of Cuyahoga Falls, Ohio, and the Pennsylvania Steel Co., of Steelton, Pa.

Taylor Iron & Steel Co., High Bridge, N. J., has opened an office in Pittsburg at 301 Oliver Bldg., in charge of Mr. James S. Morrison The office was opened to meet the increased demand for manganese steel castings in Pittsburg and vicinity.

Rhineland Machine Works Co., 140 W. 42nd St., New York, will open a place of business in Cologne or Frankfort, Germany, in the near future for the purpose of selling American machinery and tools and other manufactured products. The company is interested particularly in articles which will be used by manufacturers in general, and especially patented devices.

W. M. Pattison Supply Co., 197-211 St. Clair Ave., Cleveland, Ohio, has purchased the real estate, buildings, factory and power equipment of the Long Arm System Co., of Cleveland, manufacturers of automobile engines, transmissions, axles, gears, etc. The factory equipment consists of 205 machine tools, 10 furnaces, 21 motors and a large assortment of smaller tools which will probably be offered in lots to suit purchasers.

H. W. Johns-Manville Co., Madison Ave. and 41st St., New York, has applied the J-M "Line-O-Lite" electric light lamps with much success to showcases in hardware stores, especially those containing machinists' tools, cutters and other tools requiring bright illumination to bring out their characteristics. The "Line-O-Lite" lamp is made in tubular form, twelve inches long, which shape makes it a good light distributor, yet easily concealed.

Tate-Jones & Co., Inc., Pittsburg, Pa., report that the Massillon Bridge & Structural Co., Massillon, Ohio, has placed an order with them for a complete oil burning furnace equipment for a new plant. The placing of this order is the result of long-continued and satisfactory use of Tate-Jones & Co's. furnaces by some of the officers of the Massillon Co., while connected with another bridge plant for which Tate-Jones & Co., Inc., installed furnaces several years ago.

Hess-Bright Mfg. Co., Philadelphia, Pa., has transferred its offices to its new factory at 17 E. Erie Ave. The old quarters at 21st and Fairmount Aves. have for the past two years been inadequate for the rapidly growing business of the company, and the new site, which covers about thirteen acres, affords ample room for a much-needed expansion. The factory buildings are one-story high and embody the most advanced ideas on modern factory arrangement and construction.

Allen Mfg. Co., Inc., 135 Sheldon St., Hartford, Conn., has moved into the old Henry & Wright Mfg. Co's. plant in order to be able to care for its rapidly growing business of manufacturing the Allen safety set-screw. The company has established a Canadian branch at 29 St. David's Lane, Montreal, Canada, which will manufacture safety set-screws for the Canadian trade. Safety set-screws are now made for lathe dogs, and special safety screws will be made to order from ¼ inch to 1 inch diameter.

Warner & Swasey Co., Cleveland, Ohio, has filed an application for an increase of capital stock from $500,000 to $1,000,000. The increase of capital is to be provided for making an extension of the company's business. During the past three years the company has doubled the capacity of the plant, and is now contemplating the construction of an additional building on the east side of its present structure. The new building will be used largely for shipping and storage purposes. The officers of the company are Ambrose Swasey, president; Worcester R. Warner, vice-president; and Frank A. Scott, secretary and treasurer.

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Machinery

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